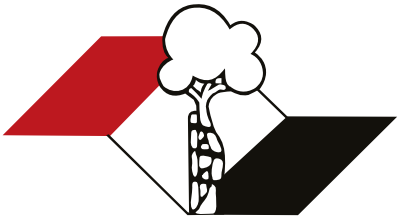
Indexed
PubMed and
PubMed Central
included
JCR (Journal Citation Reports®)



ISSN 1413-7852

Acta Ortopédica Brasileira

Volume 33 – Number 4 – Year 2025

ISSN 1413-7852

Acta Ortopédica Brasileira

Department of Orthopedics and Traumatology, Faculdade de Medicina da Universidade de São Paulo (DOT/FMUSP), São Paulo, SP, Brazil

Affiliated with Associação Brasileira de Editores Científicos

Indexed in PubMed, PubMed Central, Web of Science, JCR, Scopus Elsevier, SciELO, Redalyc (Red de Revistas Cientificas de America Latina y el Caribe,España y Portugal), LILACS (Latin America Health Science Literature) and DOAJ (Directory of open access journals).

EDITORIAL BOARD

Advisory Editor – Arthur Tadeu de Assis
Executive Editor – Ana Carolina de Assis

Administrative Editor – Atha Comunicação Editora
Logo creation – Caio Augusto de Souza Nery

Editorial coordination, creation, desktop publishing and graphic production Atha Comunicação e Editora - e-mail: 1atha@uol.com.br

SUMMARY

VOLUME 33 – Nº 4 – 2025

Original Article

DOI: http://dx.doi.org/10.1590/1413-785220253304e289483

BRAZILIAN PERSPECTIVES AND TRENDS FOR MINIMALLY INVASIVE SURGERY IN THE TREATMENT OF HALLUX VALGUS

PERSPECTIVAS E TENDÊNCIAS BRASILEIRAS PARA A CIRURGIA MINIMAMENTE INVASIVA NO TRATAMENTO DO HÁLUX VALGO

Elizabeth de Alvarenga Borges da Fonseca[1], *Caio de Almeida Oliveira*[1], *Guilherme Bottino Martins*[1], *Lourenço Galizia Heitzmann*[1], *Gustavo Demasi Quadros de Macedo*[1], *Wellington Farias Molina*[1]

1. Hospital Servidor Público Estadual de São Paulo, Departamento de Ortopedia e Traumatologia, São Paulo, SP, Brazil.

ABSTRACT

Objective: To evaluate trends in corrective surgery for hallux valgus in Brazil, focusing on minimally invasive techniques, regardless of generation. Methods: Information was obtained through a questionnaire, using the "Survey" tool, to foot and ankle orthopedists; conducted by the Orthopedics and Traumatology Service of IAMSPE. Outcomes were measured and evaluated through tables and incidence. Data from 54 orthopedic doctors were evaluated, regardless of the surgical technique used to correct hallux valgus. Results: A trend toward preference for the minimally invasive technique was observed, due to better clinical outcomes and early rehabilitation. Conclusion: There is a need for further study and in-depth analysis of the minimally invasive technique for the treatment of hallux valgus, considering that this has become the main method of choice for the treatment of this condition. ***Level of Evidence IV; Case Series.***

Keywords: Hallux Valgus; Diffusion of Innovation; Professional Training.

RESUMO

Objetivo: Avaliar as tendências da cirurgia corretiva para o hálux valgo no Brasil, com foco nas técnicas minimamente invasivas, independentemente da geração. Métodos: As informações foram obtidas por meio de um questionário, utilizando a ferramenta "Survey", a ortopedistas de Pé e tornozelo; realizada pelo Serviço de Ortopedia e Traumatologia do IAMSPE. Os desfechos foram mensurados e avaliados por meio de tabelas e incidência. Foram avaliados dados de 54 médicos ortopedistas, independentemente, da técnica cirúrgica utilizada para correção do hallux valgo. Resultados: Observou-se uma tendência de preferência pela técnica minimamente invasiva, devido aos melhores desfechos clínicos e à reabilitação precoce. Conclusão: Há necessidade de estudo e aprofundamento da técnica minimamente invasiva para o tratamento do hálux valgo, considerando que esta vem se tornando o principal método de escolha para o tratamento dessa condição. ***Nível de Evidência IV; Série de Casos.***

Descritores: *Hallux Valgus; Difusão de Inovações; Capacitação Profissional.*

Citation: Fonseca EAB, Oliveira CA, Martins GB, Heitzmann LG, Macedo GDQ, Molina WF. Brazilian perspectives and trends for minimally invasive surgery in the treatment of hallux valgus. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 4. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

The definition of Hallux Valgus (HV) was proposed by Carl Hueterem in 1871, as the lateral (valgus) deviation of the hallux, accompanied by a medial deviation from the head of the first metatarsus.[1]

HV is the most common pathology of hallux, its etiology is multifactorial, having its origin in the most varied reasons, from genetic factors to associated systemic diseases.[2] This change is often bilateral and affects mainly women in adulthood due to the presence of extrinsic factors mainly the use of inappropriate shoes.[3]

Conservative treatment should always be considered, especially for pain control and maintenance of the "functionality" of the limb, especially in cases without prior follow-up or in early stages. They are part of the non-surgical treatment: optimization of footwear with the decrease of heels height (up to 4 centimeters) and the enlargement of the anterior chamber; physiotherapy stimulating the strengthening of intrinsic musculature of the foot, and also, the use of palms to support the longitudinal arc and discharge in the central metatarsals.[4]

In situations where non-surgical methods are not effective and when we have severe deformity, surgical treatment is indicated. Several surgical techniques have been developed to try to solve the problem.[5-7]

Minimally invasive techniques are evolving and are gaining ground in all areas of orthopedic surgery. With the benefits of reduced time and surgical aggression, stress to the patient and better recovery time.[8,9]

Percutaneous surgery (PS) of the foot, began to establish itself in Spain and France over the last two decades, modifying various

All authors declare no potential conflict of interest related to this article.

The study was conducted at Department of Orthopedics and Traumatology, Hospital Servidor Público Estadual de São Paulo, São Paulo, SP, Brazil.
Correspondence: Caio de Almeida Oliveira. 144, Rua Manuel Hernandes Lopes, apt 32. caio97almeida@gmail.com

Article received on 08/17/2024 approved on 05/26/2025.

concepts and creating techniques. Although the first works developed in the United States of America (USA) were more than 50 years ago, the PS foot did not have immediate interest due to the lack of theoretical and practical foundations, as well as the scarcity of scientific works developed and published.[10]
The first method of minimally invasive surgery to treat hallux valgus was described by Isham et al.[11] and involved the use of a percutaneous drill to perform an osteotomy in a medial closure cone without the use of fixing material.
Other techniques were developed over time and percutaneous surgery was spread in clinical practice and in scientific publications. In Brazil the number of publications on the technique has been increasing, which demonstrates its growth in popularity. However, in relation to the practice of foot and ankle surgeons what are the perspectives and trends for these techniques?

MATERIALS AND METHODS

The study was approved by the Ethics Committee under number 79497524.0.0000.5463. An opinion poll of the type "Survey" was made available by a digital platform for evaluation by foot and ankle surgeons orthopedists, titled by the Brazilian Association of Foot and ankle, to answer the questionnaire.
The questionnaire was elaborated in "google forms" and the survey was made available in the first quarter of 2024 - consisting of 14 questions about the treatment and follow-up of hallux valgus by the minimally invasive technique.
Fifty-four experts participated in obtaining the data – the completion of the Survey was voluntary and the results remained anonymous. The definition of the minimally invasive technique for the treatment of hallux valgus and the proposal for this research were informed to the participants; even if another surgical technique was used this was not a reason for exclusion from the research and only differentiation; any doubt about the project was resolved via e-mail.

RESULTS

The survey had a multicenter aspect, as it was answered by 54 foot and ankle surgeons in Brazil, distributed in 12 states and all regions of Brazil (São Paulo, Rio de Janeiro, Rio Grande do Sul, Espírito Santo, Paraná, Bahia, Sergipe, Minas Gerais, Pernambuco, Goiás, Santa Catarina and Pará), plus the Federal District. São Paulo was the state with the highest number of responses (21 out of 54 or 38.8%). (Figure 1)
A large proportion of surgeons work in mixed healthcare systems (26 out of 54), others only in private services (24 out of 54) and a minority exclusively in public services (4 out of 54) (Figure 2). However, 55,6% claim to work in School Hospital.

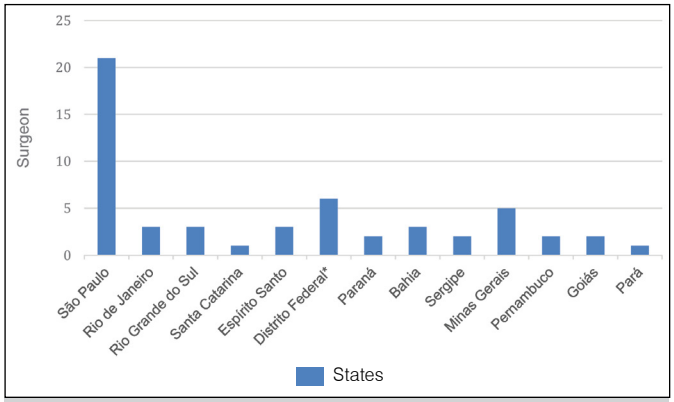


Figure 1. Geographical distribution of participants.

The training time in medicine and foot and ankle surgery of professionals was heterogeneous, with the majority in the last 5 years (Figure 3). Despite young training in foot and ankle surgery, 59.2% of participants claim to have learned the techniques through extracurricular courses. Of the 54 participating surgeons, the vast majority (90.74% or 49 out of 54) know the minimally invasive methods for hallux valgus surgery and perform them; the rest do not apply the technique in their daily life. Of these, 73.5% perform minimally invasive surgery in 75-100% of their cases, showing the current preference for minimally invasive surgery. (Figure 4)
Severe hallux deformity was the major contraindication for the procedure (reported by 9 out of 14 patients who noted some restrictions, with the main concern being the hallux itself). Other contraindications mentioned include underlying comorbidities, instability of the first tarsometatarsal joint, among other restrictions. After the minimally invasive procedure has been completed satisfactorily, almost all surgeons release the load immediately (93.8%) with appropriate sandals, other surgeons release in 2 weeks and only every 2 weeks. The change of curative in 1 week was preferred by the majority (77.6%). (Figure 5)
The indication of the use of the postoperative sandals is carried out by all surgeons, preferably by the type of *Augusta*. (Figure 6)

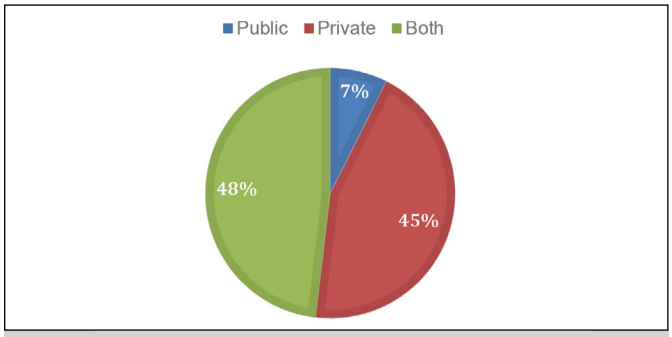


Figure 2. Type of participant performance service.

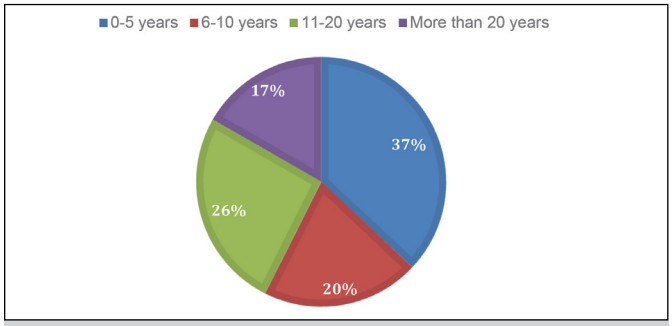


Figure 3. Training time in specialization in foot and ankle.

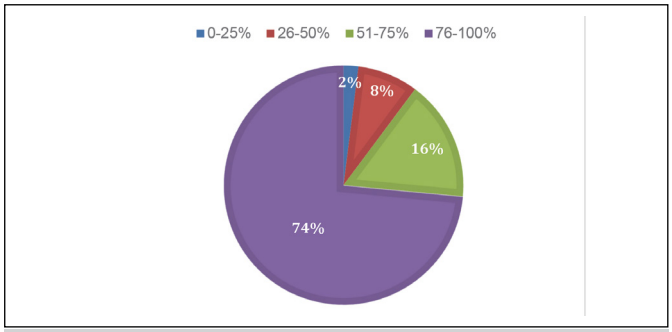


Figure 4. Proportion of cases in which the surgeon performs the minimally invasive surgery for the treatment of hallux valgus.

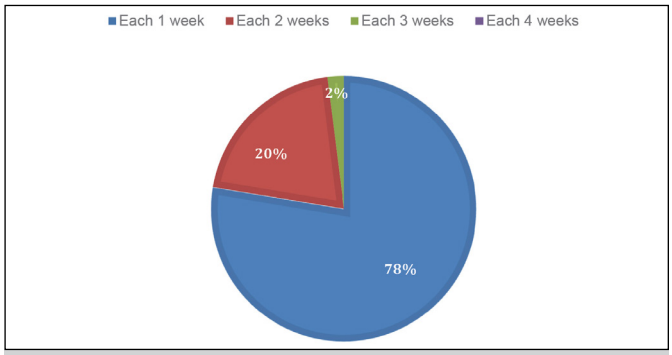


Figure 5. Time for the curative exchange.

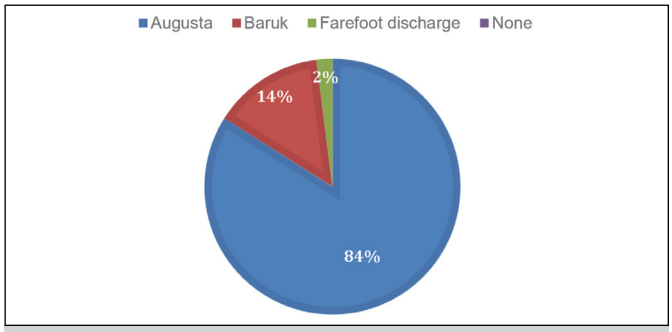


Figure 6. Type of postoperative sandal.

DISCUSSION

According to Nogueira,[12] the technological diffusion is considered very dynamic with the incorporation of innovations, and abandonments of techniques and practices considered obsolete. Thus, the minimally invasive approaches of hallux valgus are considered a technological innovation in the phase of diffusion and incorporation. The results of the research on the adoption of minimally invasive surgery to surgically treat hallux valgus in Brazil reflect this spread in clinical practice.

Of the 54 surgeons involved, 90.74% know and use the technique in their practice. This reflects a significant acceptance of percutaneous surgery for the surgical treatment of hallux valgus in all regions of Brazil, even in the northern region of the country where there are relatively few foot and ankle surgeons, although our research cannot prove this statistically due to the small number of participants in the region.

Severe hallux valgus deformity was identified as the primary contraindication by 64.29% of surgeons reporting some restriction to the use of the technique according to our study. Other mentioned restrictions include associated comorbidities and instability of the tarsometatarsal joint. This finding is in accordance with the study of Tan and Thevendran,[10] where the severity of the deformity is also pointed out as the main contraindication for the indication of percutaneous surgeries in the Asia-Pacific region. Similarly, the European study by Maffulli et al.[13] highlights that although percutaneous surgery is promising, there are limitations due to the heterogeneity of cases and the lack of conclusive evidence about its effectiveness in severe deformities.

The learning curve involves the completion of several cases until you reach the necessary proficiency, in addition to appropriate training in both specialization and extracurricular courses. The importance of rigorous training and continuous practice to overcome the learning curve is emphasized in the courses conducted by Brazilian surgeons. This search for the best technique offers substantial benefits in terms of patient recovery and satisfaction.[7,14]

After performing the minimally invasive surgery, most surgeons release the load immediately with the use of appropriate sandals. This postoperative protocol suggests confidence in the stability of percutaneous fixation performed in Brazil.[5,15,16] In contrast, in Asia-Pacific, most surgeons allow full load between four and six weeks after surgery, suggesting a more conservative approach to postoperative recovery.[10]

The clinical results obtained with percutaneous procedures for the correction of mild to moderate deformities are comparable to those obtained with other percutaneous osteotomies of the distal metatarsus and with most series of open surgical procedures.[17,18] Thus, percutaneous surgery presents advantages in the postoperative period as an immediate burden with the use of appropriate sandals and due to the reduced aggression of soft parts.

The growing popularity of minimally invasive surgery highlights the need for more comparative research between traditional open surgeries, especially in terms of medium and long-term results, especially in the detection of patient satisfaction.[7]

CONCLUSION

We concluded that the adoption of percutaneous surgery for correction of hallux valgus in Brazil is broad and well received, with positive postoperative results and rehabilitation protocols that favor the rapid recovery of patients, such as early load.

However, the severity of the deformity and other comorbidities continue to be significant challenges that limit the use of the technique in some cases. The comparison with data from Asia-Pacific and Europe provides a global context that reinforces the relevance of Brazilian findings and suggests that, despite regional differences, the trends and challenges of minimally invasive surgery are similar internationally.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article. OCA: writing of the work and essential contribution to the design; FEAB: analysis of the data and writing of the work; MWF: review of the article and final approval of the manuscript; MGB: performing surgeries and data acquisition; HLG: Realizing surgeries and intellectual critical review; MGDQ: data acquisition and analysis.

REFERENCES

1. Nery CA. Hálux valgo. Rev Bras Ortop. 2001;36(6):183-200.
2. Roddy E, Zhang W, Doherty M. Prevalence and associations of hallux valgus in a primary care population. Arthritis Rheum. 2008;59(6):857-62. doi: 10.1002/art.23709.
3. Coughlin MJ, Jones CP. Hallux valgus: demographics, etiology, and radiographic assessment. Foot Ankle Int. 2007;28(7):759-77. doi: 10.3113/FAI.2007.0759.
4. Perera AM, Mason L, Stephens MM. The pathogenesis of hallux valgus. J Bone Joint Surg Am. 2011;93(17):1650-61. doi: 10.2106/JBJS.H.01630.
5. Nix S, Smith M, Vicenzino B. Prevalence of hallux valgus in the general population: a systematic review and meta-analysis. J Foot Ankle Res. 2010;3:21. doi: 10.1186/1757-1146-3-21.
6. Ferrari J, Higgins JP, Prior TD. Interventions for treating hallux valgus (abductovalgus) and bunions. Cochrane Database Syst Rev. 2004;(1):CD000964. doi: 10.1002/14651858.CD000964.pub2. Update in: Cochrane Database Syst Rev. 2009;(2):CD000964. doi: 10.1002/14651858.CD000964.pub3.
7. Patnaik S, Jones NJ, Dojode C, Narang A, Lal M, Iliopoulos E, et al. Minimally invasive hallux valgus correction: Is it better than open surgery? Foot (Edinb). 2022;50:101871. doi: 10.1016/j.foot.2021.101871.
8. Carvalho P, Viana G, Flora M, Emanuel P, Diniz P. Percutaneous hallux valgus treatment: Unilaterally or bilaterally. Foot Ankle Surg. 2016;22(4):248-253. doi: 10.1016/j.fas.2015.11.002.

9. Prado M, Ripoll L, Golano P. Minimally Invasive Foot Surgery: Surgical Techniques, Indications, Anatomical Basis. Spain: About Your Health; 2009.
10. Tan CY, Thevendran G. Perspectives and trends for minimally invasive surgery for hallux valgus deformity in the Asia Pacific region. J Orthop Surg (Hong Kong). 202331(2):10225536231180332. doi: 10.1177/10225536231180332.
11. Isham SA. The Reverdin-Isham procedure for the correction of hallux abducto valgus. A distal metatarsal osteotomy procedure. Clin Podiatr Med Surg. 1991;8(1):81-94.
12. Nogueira MP. Difusão do Método Ponseti para o tratamento do Pé torto no Brasil – o caminho para adoção de uma tecnologia. [Tese]. Faculdade de Saúde Pública da USP; 2011. doi: 10.11606/T.6.2011.tde-05042011-142326.
13. Maffulli N, Longo UG, Maffulli GD, Khanna A, Denaro V. Achilles tendon ruptures in elite athletes. Foot Ankle Int. 2011;32(1):9-15. doi: 10.3113/FAI.2011.0009.
14. Vernois J, Redfern DJ. Percutaneous Surgery for Severe Hallux Valgus. Foot Ankle Clin. 2016;21(3):479-93. doi: 10.1016/j.fcl.2016.04.002.
15. Pacheco F, Mac-iver PEM, Elgueta S, Díaz AK, Radkievich RD, Villagran DA, et al. Hallux Valgus Multiplanar Correction Surgery Through a Minimally Invasive Technique. Our Initial Experience. Foot Ankle Orthop. 2022;7(1):2473011421S00053. doi: 10.1177/2473011421S00053.
16. Lucas y Hernandez J, Golanó P, Roshan-Zamir S, Darcel V, Chauveaux D, Laffenêtre O. Treatment of moderate hallux valgus by percutaneous, extra-articular reverse-L Chevron (PERC) osteotomy. Bone Joint J. 2016;98-B(3):365-73. doi: 10.1302/0301-620X.98B3.35666.
17. Lim WSR, Rikhraj IS, Koo KOT. Simultaneous bilateral hallux valgus surgery: Percutaneous or conventional? Early results of a matched study from a tertiary institution. Foot Ankle Surg. 2021;27(4):377-380. doi: 10.1016/j.fas.2020.04.014.
18. Xu Y, Guo CJ, Li XC, Xu XY. Radiographic and clinical outcomes of minimally invasive surgery versus open osteotomies for the correction of hallux valgus. Int Orthop. 2022;46(8):1767-1774. doi: 10.1007/s00264-022-05419-9.

DOI: http://dx.doi.org/10.1590/1413-785220253304e291300

RADIOGRAPHIC AND FUNCTIONAL EVALUATION OF HIGH POROUS METAL OSSEOINTEGRATION IN ACETABULAR REVISIONS WITH PELVIC DISSOCIATION

AVALIAÇÃO RADIOGRÁFICA E FUNCIONAL DA OSSEOINTEGRAÇÃO DE METAL DE ALTA POROSIDADE EM REVISÕES ACETABULARES COM DISSOCIAÇÃO PÉLVICA

Reuder Pereira Prado[1], *Lauro Barbosa Neto*[1], *Gabriel Rodrigues Silva*[1], *Leandro Alves de Oliveira*[1,2]

1. Clinica de Ortopedia e Traumatologia (COT), Goiania, GO, Brazil.
2. Hospital das Clinicas da Universidade Federal de Goias, Goiania, GO, Brazil.

ABSTRACT

Introduction: Pelvic dissociation is a complex condition with a high rate of surgical complications and no established standard treatment. Surgery aims to preserve limb function by restoring bone structure and hip biomechanics. Conventional orthopaedic implants are made from materials such as stainless steel, cobalt-chrome or titanium. High-porosity implants have been introduced to improve the durability of hip arthroplasty. Objective: To evaluate osseointegration after revision total hip arthroplasty in cases of pelvic dissociation. Method: A descriptive observational study carried out at the Hospital das Clínicas of the Federal University of Goiás and at the Orthopedics and Traumatology Clinic (COT) in Goiânia. Data was collected from the medical records of patients who underwent total hip arthroplasty between 2012 and 2020, using titanium or tantalum implants, both high-porosity materials. Results: The study included 26 patients, 53.8% female and 46.2% male. The majority (34.6%) were aged between 60 and 69. Of the patients, 53.8% used titanium implants and 46.2% tantalum. After surgery, 38.5% had a Harris Hip Score between 70 and 80, with 61.5% of patients showing osseointegration in less than six months. Conclusion: Tantalum, due to its high porosity, was effective in treating patients with pelvic dissociation undergoing revision total hip arthroplasty. ***Level Of Evidence IV; Descriptive Observational Study.***

Keywords: Arthroplasty, Replacement, Hip; Radiography; Osseointegration; Acetabulum; Tantalum.

RESUMO

Introdução: A dissociação pélvica é uma condição complexa com alta taxa de complicações cirúrgicas e sem um tratamento padrão estabelecido. A cirurgia visa preservar a função do membro ao restaurar a estrutura óssea e a biomecânica do quadril. Implantes ortopédicos convencionais são feitos de materiais como aço inoxidável, cobalto-cromo ou titânio. Os implantes de alta porosidade foram introduzidos para melhorar a durabilidade da artroplastia do quadril. Objetivo: Avaliar a osteointegração após revisão de artroplastia total de quadril em casos de dissociação pélvica. Método: Estudo observacional descritivo realizado no Hospital das Clínicas da Universidade Federal de Goiás e na Clínica de Ortopedia e Traumatologia (COT) em Goiânia. Foram coletados dados de prontuários de pacientes que realizaram artroplastia total de quadril entre 2012 e 2020, utilizando implantes de titânio ou tântalo, ambos materiais de alta porosidade. Resultados: O estudo incluiu 26 pacientes, 53,8% do sexo feminino e 46,2% do masculino. A maioria (34,6%) tinha entre 60 e 69 anos. Dos pacientes, 53,8% utilizaram implantes de titânio e 46,2% de tântalo. Após a cirurgia, 38,5% apresentaram Harris Hip Score entre 70 e 80, com 61,5% dos pacientes mostrando osteointegração em menos de seis meses. Conclusão: O tântalo, devido à sua alta porosidade, foi eficaz no tratamento de pacientes com dissociação pélvica submetidos à revisão de artroplastia total de quadril. ***Nível de evidência IV; Estudo Observacional Descritivo.***

Descritores: *Artroplastia de Quadril; Radiografia; Osseointegração; Acetábulo; Tantálio.*

Citation: Prado RP, Barbosa Neto L, Silva GR, Oliveira LA. Radiographic and functional evaluation of high porous metal osseointegration in acetabular revisions with pelvic dissociation. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 5. Available from URL: http://www.scielo.br/aob.

All authors declare no potential conflict of interest related to this article.

The study was conducted at Hospital das Clinicas of the Universidade Federal de Goias and the Clinica de Ortopedia e Traumatologia (COT), Goiania, GO, Brazil.
Correspondence: Reuder Pereira Prado. 1462, Av. T-2, Setor Bueno, Goiânia, GO, Brazil. 74215-010. reuderprado@hotmail.com

Article received on 10/28/2024 approved on 02/13/2025.

INTRODUCTION

Pelvic dissociation is an uncommon condition that usually occurs in the total hip arthroplasty review population. Having increased incidence due to the number of primary hip total arthroplasties (HTA) and the need for revisions. The goal of the surgical treatment is to preserve the restoring function of the limb, bone structure and hip biomecany.[1-3] Currently, HTA is the gold standard for this type of health condition, with excellent clinical results and long-term survival. However, the growth of this procedure corroborates the increase in failures.[1,4]

The acetabular review is indicated for patients who have progressive osteolysis, severe wear or bone loss that may compromise future reconstruction, including symptomatic aseptic release, failure to fix, infection, wear, osteolysis and instability, given the loss of the acetabular bone structure and the condition of soft tissues, the acetabular review represents a procedure that requires more attention.[4,5]

Bone defects involving less than 50% of the acetabulum are considered mild to moderate. Defects involving more than 50% are defined as massive. Biological fixation in cases of hip review with moderate pelvic bone defects requires sufficient contact between the bone and the acetabular dome, thus allowing primary stability and bone growth. A 50% contact between a porous dome and native bone is considered the bottom limit for reliable reconstruction using these devices. Less extensive surface contacts with native bone can be accepted if there is a good support with the edge or dome of the acetabula.[1]

The use of X-rays helps predict the severity and location of bone loss and guide treatment options, some classification systems are used to assist the surgeon in surgical planning, as in the case of the acetabular classification of *Paprosky* in total hip arthroplasty with failure, being based on the severity of bone loss and the ability to obtain cementless fixation for a certain pattern of bone loss.[4]

Orthopedic implants are generally made of stainless steel, cobalt-chrome (CoCr) or titanium alloys. Hip implants with high porosity coating were introduced about 30 years ago with the aim of improving the durability of hip arthroplasty. Initially used were sintered spheres of chrome-cobalt, diffusion-linked metal fiber mesh, sponge-structured titanium and titanium plasma spray. These materials allow bone growth inward or outward and remodel in the metal-bone interface, and longer rigid fixation. However, in acetabular review surgery, these materials demonstrate limitations when the native bone surface available for osteointegration is minimal.[4,6-9]

High porosity metal is a metal with special porous structures, which can offer high biocompatibility and low Young module to satisfy the need for orthopedic applications. Titanium and tantalum are the high-porosity metals most used in orthopedics due to their bio-mechanical properties and biocompatibility.[10]

High-porosity metals have been developed to improve the properties of the biomaterial of uncemented implants. The open cell structure of these materials is ideal for acetabular review surgery due to high volumetric porosity, low module elasticity and high friction characteristics. The new generation of high porosity metals has characteristics that allow bone consolidation and high osteointegration of metal implants.[4,5,11]

The main characteristics of an ideal high porosity metal require normal cellular activity without any local and systemic toxic effects on the host tissue, which offer mechanical properties similar to the host bone with sufficient mechanical strength, the seats must have macro (porous size > 100 mm) and microporosity (porous size < 20 mm) and the pores must be interconnected, have initial resistance to safe handling, be reproducible and processable in a three-dimensional structure and must tolerate sterilization according to the international standards required for clinical use, in addition to having reasonable manufacturing cost.[7,11] The main disadvantage of metallic biomateria is the lack of biological recognition on the surface of the material, another limitation is possible release of ions and/or metallic particles by toxic corrosion or discharge by possible inflammatory cascades and allergic reactions.[7,11]

Metals such as tantalum and titanium have been commonly used. as bone substitutes or implants in orthopedic surgery because they present excellent corrosion. The high porosity tantalum has a biological performance equivalent to traditional high porosity titanium implants in repairing small bone defects.[12] The tantalum has a elasticity module (GPa) between 2.5 and 3.9, mean pore size at 550 μm, 75% porosity and 0.88 friction coefficient. Titan has a elasticity module (GPa) between 106 - 115, average pore size at 616 μm, 60% porosity and 0.65 friction coefficient.[4,13]

Titanium alloys were first used in orthopaedics around 80 years ago and continue to be used because of their unique properties, including high specific strength, low weight, excellent corrosion resistance and biocompatibility.[14] However, for bone replacement components, the strength of pure titanium is not enough and alloys of this material are used because of their superior mechanical properties, but it is a low porosity coating, ranging from 30-50%, which limits the maximum interfacial force that can be formed by bone growth.[11,15] Titanium in the form of metal foam is indicated in the manufacture of high porosity metal implants in primary and revision total hip, knee and shoulder arthroplasty. The use of high porosity titanium acetabular components in cases of total hip arthroplastia and review is associated with satisfactory clinical outcomes in the short and medium term.[16]

Tantalum has been introduced in an effort to increase the osseointegration potential of uncemented components.[15] High porosity tantaum is a tantalum structure of repeated dodecahedron open cells with an appearance similar to spongy bone. It has excellent biocompatibility and is safe for *in vivo* use. The bioactivity and biocompatibility of high porosity tantalum derive from their ability to form a superficial layer of self-passive oxide.[6,13]

Based on the above, the objective of the present study is to evaluate the post-revision osteointegration of total hip artroplasty in cases of pelvic dissociation, in addition to verifying the performance of the acetabular component with high porosity metal in postoperative functional evaluations.

MATERIAL AND METHOD

Observational and descriptive research was conducted to evaluate osteointegration after review of total quadrillary arthroplastic in cases of pelvic dissociation in the Department of Orthopaedia and Traumatology of the Hospital of the clinics of the Universidade Federal de Goiás and the Clínica de Ortopedia e Traumatologia – COT, Goiânia.

Participants of both sexes, older than 18 years of age who had performed the Quadril Total Arthroplastia review between January 2012 and December 2020 and who had placed implants of high porosity material, titanium or tantalum, were included in the Department of Orthopaedia and Traumatology of the Hospital das Clínicas of the Universidade Federal de Goiás and the Clínica de Ortopedia e Traumatologia – COT, Goiânia. The data were collected the information concerning the place of surgery, Age, Gender, Color, Occupation, Comorbidities, Date of surgery, Material used, Surgery performed, Harris Hip Score before surgery, to evaluate the pain, Harris Hip score after surgery and time of osteointegration of the journal of the selected research participants.

For the analysis of the tabulated data, the IBM SPSS statistical analysis platform, version 21 was used. The confidence interval for this study was 95%, and the significance level of 0.05 was accepted. In these comparisons, p-values above 0.050 are considered not significant for this study as they are outside the desired confidence interval. The

t-student test and the Qui-square test were used to verify whether the frequency of observed data in a question deviates significantly or not from the frequency with which it is expected and to compare the distribution of the data for different variables, in order to verify whether the observed proportions show significant differences or whether the samples differ significantly in the proportions of these variables, being correlated the type of material used (titanium or tantalum) with the best benefit in relation to post-Revision of Total Quadril Arthroplasty in Cases of Pelvic Dissociation.

This study was registered under CAEE number: 46384621.6.0000.5078, and approved by the Research Ethics Committee of the Federal University of Goiás Clinic Hospital.

RESULTS

41 patients were selected, 36.58% of which were excluded because there was no pelvic dissociation, with 26 (63.41%) research participants included in our study, the highest frequencies of participants included had the surgeries between the years of 2018 (42.3%), 2014 (15.4%), 2015 (11.5%) and 2017 (11.5%). In terms of sex, 53.8% were female and 46.2% were male. Furthermore, 34.6% were aged 60 to 69, 23.1% were aged 80 or above and 19.2% were aged 70 to 79. In relation to the profession, 57.7% were retired, 23.1% were paid external workers and 15.4% were public officials. Of the total, 30.8% of patients had some comorbidity.

In relation to the site of the surgery in our institution, 80.8% was performed at COT. Of the total, 53.8% of patients used Titanium and 46.2% Tantalum. Furthermore, 100% of patients performed hip arthroplasty review surgery, 100% of patients had Harris Hip Score before surgery less than 70 points, after surgery, 38.5% had Harris Hip Score between 70 to 80 points and 34.6% between 80 to 90. The most frequent osteointegration time was less than six months in 61.5% of the patients, in 11.5% of the patients included there was no osteointegration.

In relation to the correlation of the materials used in surgeries with the other variables, it was possible to observe that the patients who had the use of tantalum, 58.33% were female, 58.33% were retired, 25% had comorbidities, 33.33% had ages between 60 and 69 years and 25% had ages equal to or above 80 years. Of the total, 33.33% had the surgery in 2014 and 25% in 2015 and 91.67% had the surgery in COT. It was observed that 100% had Harris Hip Score before surgery less than 70 points, after surgery, 58.33% of these patients had Harris Hip Score between 80 to 90 points and 41.67% between 70 to 80 points (Table 1). Of the patients who used Titanium, 50% were female and 50 male, 57.14% were retired, 35.71% had comorbidities, 35.71% were aged 60 to 69 years, 21.43% were aged 70 to 79 years and 21.43% were aged 80 years or older. 64.29% had the surgery in 2018 and 71.43% had the surgery in COT. Furthermore, 100% had Harris Hip Score less than 70 points before surgery, after surgery, 35.71% of these patients had Harris Hip Score between 70 and 80 points, 50% of patients who had this type of material used in surgery continued with Harris Hip Score less than 70 points after surgery. (Table 1)

DISCUSSION

During the development of this study, we observed that post-revision osteointegration of total quadrillary arthroplastic in cases of pelvic dissociation was most effective after six months of the surgical process in most patients.

Regarding the materials used, we observed that tantalum in our institution, during the study period, is used with predominance in female patients and Harris Hip Score before surgery less than 70 points, after which, more than half of the patients had Harris Hip Score between 80 and 90 points. The use of titanium also had

Table 1. Correlation of the material used with the other variables.

	Material used				Total		p-value
	Tantalum		Titanium				
Sex							
Female	7	(58.33%)	7	(50.00%)	14	(53.85%)	0.671
Male	5	(41.67%)	7	(50.00%)	12	(46.15%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Declared profession							
retired	7	(58.33%)	8	(57.14%)	15	(57.69%)	0.458
From home	0	(0.00%)	1	(7.14%)	1	(3.85%)	
Public official	3	(25.00%)	1	(7.14%)	4	(15.38%)	
Paid external work	2	(16.67%)	4	(28.57%)	6	(23.08%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Comorbidities							
Yes	3	(25.00%)	5	(35.71%)	8	(30.77%)	0.555
No	9	(75.00%)	9	(64.29%)	18	(69.23%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Age of the patient at the time of surgery							
40 to 49 years	1	(8.33%)	1	(7.14%)	2	(7.69%)	0.997
50 to 59 years	2	(16.67%)	2	(14.29%)	4	(15.38%)	
60 to 69 years	4	(33.33%)	5	(35.71%)	9	(34.62%)	
70 to 79 years	2	(16.67%)	3	(21.43%)	5	(19.23%)	
>= 80 years	3	(25.00%)	3	(21.43%)	6	(23.08%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Date of surgery							
2012	1	(8.33%)	0	(0.00%)	1	(3.85%)	0.019*
2014	4	(33.33%)	0	(0.00%)	4	(15.38%)	
2015	3	(25.00%)	0	(0.00%)	3	(11.54%)	
2016	1	(8.33%)	0	(0.00%)	1	(3.85%)	
2017	1	(8.33%)	2	(14.29%)	3	(11.54%)	
2018	2	(16.67%)	9	(64.29%)	11	(42.31%)	
2019	0	(0.00%)	1	(7.14%)	1	(3.85%)	
2020	0	(0.00%)	2	(14.29%)	2	(7.69%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Local surgery							
COT	11	(91.67%)	10	(71.43%)	21	(80.77%)	0.192
HGG	1	(8.33%)	4	(28.57%)	5	(19.23%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Harris Hip Score before surgery							
< 70 points	12	(100.00%)	14	(100.00%)	26	(100.00%)	-
70 to 80 points	0	(0.00%)	0	(0.00%)	0	(0.00%)	
80 to 90 points	0	(0.00%)	0	(0.00%)	0	(0.00%)	
90 to 100 points	0	(0.00%)	0	(0.00%)	0	(0.00%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Harris Hip score after surgery							
< 70 points	0	(0.00%)	7	(50.00%)	7	(26.92%)	0.008*
70 to 80 points	5	(41.67%)	5	(35.71%)	10	(38.46%)	
80 to 90 points	7	(58.33%)	2	(14.29%)	9	(34.62%)	
90 to 100 points	0	(0.00%)	0	(0.00%)	0	(0.00%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	
Osteointegration time							
< 6 months	9	(75.00%)	7	(50.00%)	16	(61.54%)	0.196
>= 6 months	3	(25.00%)	4	(28.57%)	7	(26.92%)	
There was no osteointegration	0	(0.00%)	3	(21.43%)	3	(11.54%)	
Total	12	(46.15%)	14	(53.85%)	26	(100.00%)	

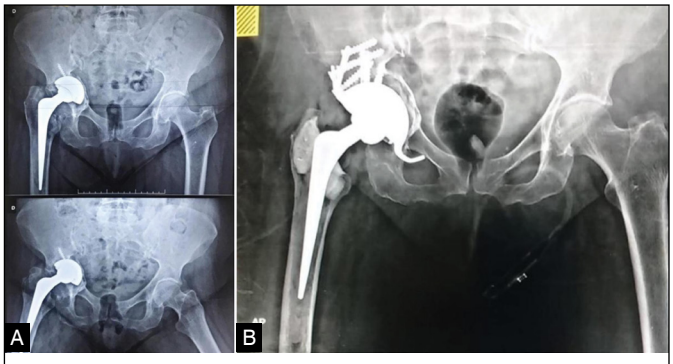
*Statistically representative difference. **Source:** Data collected by the authors.

predominance in the female sex, Harris Hip Score before surgery less than 70 points, however, only slightly more than a third of these patients had the Harris Hip Score between 70 and 80 points. Patients who used titanium had a higher predominance of Harris Hip Score after surgery proceeding below 70 points.

Patients who used titanium also demonstrated low efficacy of osteointegration, with just over a fifth of them not having osteointegration. Although the use of tantalum was most effective in osteointegration, 3/4 of patients had osteointegration before six months, and 1/4 after this period.

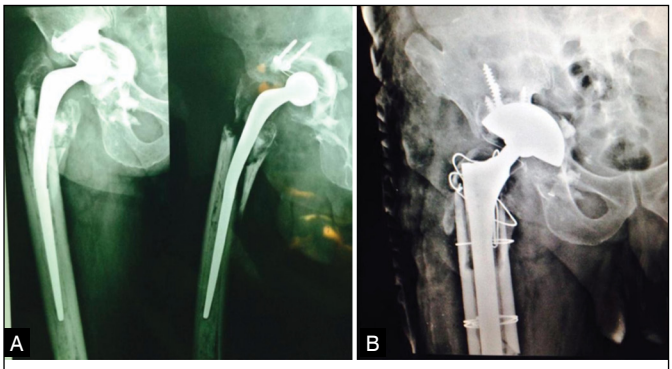
In our study, the MBP patient, 80 years old, female, white, retired, with pelvic dissociation, performed Revision of hip artroplasty on the right side with titanium material in the COT institution, developed osteointegration in four months of postoperative, with Harris Hip Score preoperative of 38 points, and in the postoperative with 92 points (Figure 1). The MRN patient, 80 years old, male, white, retired, with pelvic dissociation, performed a review of hip artroplasty on the right side with tantalum material in the COT institution, developed bone integration in six months of postoperative, with Harris Hip Score preoperative of 30 points and in the postoperative with 82 points. (Figure 2)

This osteointegration period of less than six months in patients who used tantalum demonstrates that this material corroborates the patient's prior return to their activities. Various studies in the literature have demonstrated high survival rates after two years of treatment,[13,17-20] as well as low infection rates[21] in patients who used this material.



Source: Prontuary of the patient (Service database).

Figure 1. Case 01 (Image A: Preoperative X-ray and image B: X-ray three months after surgery).



Source: Prontuary of the patient (Service database).

Figure 2. Case 02 (Image A: Preoperative X-ray and image B: X-ray six months after surgery).

Despite the high rate of non-osteointegration in our study with use of titanium even after six months of follow-up, some studies in the literature have demonstrated that titanium use leads to satisfactory clinical and radiographic results for reconstruction of the acetabular defect in primary HTA in the long term.[22] However, one study presented a case showing the risk of full and rapid wear of a ceramic femoral head through a polyethylene coating and titanium acetabular cup as well as signs of significantly elevated serum titanium ion levels.[16]

CONCLUSION

After the development of this study we can observe that tantalum has had greater efficiency in osteointegration in a period of less than six months. The use of titanium showed a higher rate of non-osteointegration even over a period of more than twelve months. In relation to the Harris Hip score after surgery, patients using tantalum had an improvement in their consideration of score, from score less than 70 points before surgery to score between 80 and 90 after surgery. Patients who used titanium had greater retention at scores lower than 70 points after surgery. Thus, we can conclude that tantalum is a highly porous material that is effective in the treatment of patients after review of total hip artroplasty in cases of pelvic dissociation.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article. RPP, LBN, GRS and LAO: design/design of the work, acquisition, analysis and interpretation of the data for the work, writing of the text and critical review of its intellectual content, in addition to the final approval of the version of the manuscript to be published.

REFERENCES

1. Villanueva M, Rios-Luna A, Pereiro De Lamo J, Fahandez-Saddi H, Böstrom MP. A review of the treatment of pelvic discontinuity. HSS J. 2008;4(2):128-37. doi: 10.1007/s11420-008-9075-6.
2. Taunton MJ, Fehring TK, Edwards P, Bernasek T, Holt GE, Christie MJ. Pelvic discontinuity treated with custom triflange component: a reliable option. Clin Orthop Relat Res. 2012;470(2):428-34. doi: 10.1007/s11999-011-2126-1.
3. Schwarzkopf R, Ihn HE, Ries MD. Pelvic discontinuity: modern techniques and outcomes for treating pelvic disassociation. Hip Int. 2015;25(4):368-74. doi: 10.5301/hipint.5000270.
4. Pulido L, Rachala SR, Cabanela ME. Cementless acetabular revision: past, present, and future. Revision total hip arthroplasty: the acetabular side using cementless implants. Int Orthop. 2011;35(2):289-98. doi: 10.1007/s00264-010-1198-y.
5. Kim WY, Greidanus NV, Duncan CP, Masri BA, Garbuz DS. Porous tantalum uncemented acetabular shells in revision total hip replacement: two to four year clinical and radiographic results. Hip Int. 2008;18(1):17-22. doi: 10.1177/112070000801800104.
6. Levine BR, Sporer S, Poggie RA, Della Valle CJ, Jacobs JJ. Experimental and clinical performance of porous tantalum in orthopedic surgery. Biomaterials. 2006;27(27):4671-81. doi: 10.1016/j.biomaterials.2006.04.041.
7. Abolghasemian M, Tangsataporn S, Sternheim A, Backstein D, Safir O, Gross AE. Combined trabecular metal acetabular shell and augment for acetabular revision with substantial bone loss: a mid-term review. Bone Joint J. 2013;95-B(2):166-72. doi: 10.1302/0301-620X.95B2.30608.
8. Amenabar T, Rahman WA, Hetaimish BM, Kuzyk PR, Safir OA, Gross AE. Promising Mid-term Results With a Cup-cage Construct for Large Acetabular Defects and Pelvic Discontinuity. Clin Orthop Relat Res. 2016;474(2):408-14. doi: 10.1007/s11999-015-4210-4.
9. Migaud H, Common H, Girard J, Huten D, Putman S. Acetabular reconstruction using porous metallic material in complex revision total hip arthroplasty: A systematic review. Orthop Traumatol Surg Res. 2019;105(1S):S53-S61. doi: 10.1016/j.otsr.2018.04.030.
10. Han Q, Wang C, Chen H, Zhao X, Wang J. Porous Tantalum and Titanium in Orthopedics: A Review. ACS Biomater Sci Eng. 2019;5(11):5798-5824. doi: 10.1021/acsbiomaterials.9b00493.

11. Matassi F, Botti A, Sirleo L, Carulli C, Innocenti M. Porous metal for orthopedics implants. Clin Cases Miner Bone Metab. 2013;10(2):111-5.
12. Wang H, Su K, Su L, Liang P, Ji P, Wang C. Comparison of 3D-printed porous tantalum and titanium scaffolds on osteointegration and osteogenesis. Mater Sci Eng C Mater Biol Appl. 2019;104:109908. doi: 10.1016/j.msec.2019.109908.
13. Konan S, Duncan CP, Masri BA, Garbuz DS. Porous tantalum uncemented acetabular components in revision total hip arthroplasty: a minimum ten-year clinical, radiological and quality of life outcome study. Bone Joint J. 2016;98-B(6):767-71. doi: 10.1302/0301-620X.98B6.37183.
14. Ramappa M, Bajwa A, Kulkarni A, McMurtry I, Port A. Early results of a new highly porous modular acetabular cup in revision arthroplasty. Hip Int. 2009;19(3):239-44. doi: 10.1177/112070000901900309.
15. Jafari SM, Bender B, Coyle C, Parvizi J, Sharkey PF, Hozack WJ. Do tantalum and titanium cups show similar results in revision hip arthroplasty? Clin Orthop Relat Res. 2010;468(2):459-65. doi: 10.1007/s11999-009-1090-5.
16. Malahias MA, De Martino I, Gu A, Baral E, Wright TM, Sculco PK. Complete wear-through of a metal-backed acetabular cup in an ambulatory patient. Arthroplast Today. 2019;5(4):394-400. doi: 10.1016/j.artd.2019.09.008.
17. Jeong M, Kim HJ, Lim SJ, Moon YW, Park YS. Revision Total Hip Arthroplasty Using Tantalum Augment in Patients with Paprosky III or IV Acetabular Bone Defects: A Minimum 2-year Follow Up Study. Hip Pelvis. 2016;28(2):98-103. doi: 10.5371/hp.2016.28.2.98.
18. Evola FR, Costarella L, Evola G, Barchitta M, Agodi A, Sessa G. Acetabular revisions using porous tantalum components: A retrospective study with 5-10 years follow-up. World J Orthop. 2017 Jul 18;8(7):553-560. doi: 10.5312/wjo.v8.i7.553.
19. Laaksonen I, Lorimer M, Gromov K, Rolfson O, Mäkelä KT, Graves SE, et al. Does the Risk of Rerevision Vary Between Porous Tantalum Cups and Other Cementless Designs After Revision Hip Arthroplasty? Clin Orthop. 2017;475(12):3015–22.
20. Huang X, Wang J, Zhang J, Kang Y, Sandeep B, Yang J. Ultrasound-guided erector spinae plane block improves analgesia after laparoscopic hepatectomy: a randomised controlled trial. Br J Anaesth. 2022;129(3):445-453. doi: 10.1016/j.bja.2022.05.013.
21. Tokarski AT, Novack TA, Parvizi J. Is tantalum protective against infection in revision total hip arthroplasty? Bone Joint J. 2015;97-B(1):45-9. doi: 10.1302/0301-620X.97B1.34236.
22. Ling FP, Chevillotte T, Leglise A, Thompson W, Bouthors C, Le Huec JC. Which parameters are relevant in sagittal balance analysis of the cervical spine? A literature review. Eur Spine J. 2018;27(Suppl 1):8-15. doi: 10.1007/s00586-018-5462-y.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290125

ASSESSMENT OF ACCURACY OF INCISIONAL AND NEEDLE BIOPSY IN SOFT-TISSUE TUMORS IN A BRAZILIAN CENTER OF REFERENCE

AVALIAÇÃO DA ACURÁCIA DA BIÓPSIA INCISIONAL E POR AGULHA NOS TUMORES DE PARTES MOLES EM UM CENTRO DE REFERÊNCIA BRASILEIRO

Bruna Canteri Delocco[1], *Bruno de Oliveira Fiorelli*[1], *Igor Borges Abrantes*[1], *Eliane dos Santos Luz*[1], *Ana Cristina de Sá Lopes*[1], *Walter Meohas*[1]

1. Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad (INTO), Centro de Oncologia Ortopédica, Rio de Janeiro, RJ, Brazil.

ABSTRACT

Objectives: To assess the accuracy of incisional biopsies (IB) and needle biopsies (NB) in soft-tissue tumors treated at a Brazilian center of reference, as well as the variables related to the demographic profile and treatment established. Methods: A retrospective, descriptive and observational study was conducted with patients with malignant soft tissue tumoral lesions, of indeterminate and intermediary malignancy, subjected to IB or NB at the institution from January 2010 to December 2019. Results: 114 biopsies were performed in soft-tissue tumors of malignant lesions, of indeterminate and intermediary malignancy; of these 90 biopsies, 61 (67.7%) were IB and 29 (25.4%) were NB. It was necessary to perform a new collection in 5 cases among the NB (17.2%) and 1 case among the IB (1.6%). The IB accuracy was 83.6, while NB was 62.1. Of the 18 patients subjected to surgical treatment with radical margin, 7 were initially subjected to NB (36.8%) and 9 to IB (17.3%). Conclusion: Despite the advantages inherent to the percutaneous procedure of NB, IB must still be considered a diagnostic option in soft tissue tumors with high heterogeneity and degree of necrosis. ***Level of Evidence III; Diagnostic Studies - Investigating a Diagnostic Test.***

Keywords: Soft Tissue Neoplasms; Biopsy; Diagnosis; Medical Oncology; Sarcoma.

RESUMO

Objetivos: Avaliar a acurácia das biópsias incisionais (BI) e biópsias por agulha (BA) nos tumores de partes moles atendidos num centro de referência brasileiro, bem como as variáveis relacionadas ao perfil demográfico e tratamento instituído. Métodos: Foi realizado um estudo retrospectivo, descritivo e observacional, com pacientes com lesões tumorais de partes moles malignas, de malignidade indeterminada e intermediárias, submetidos a BI ou BA na instituição no período de janeiro de 2010 a dezembro de 2019. Resultados: Foram realizadas 114 biópsias de tumores de partes moles de lesões malignas, de malignidade indeterminada e intermediárias, destas 90 biópsias, 61 (67,8%) foram BI e 29 (25,4%) BA. Foi necessário nova coleta em 5 casos dentre as BA (17,2%) e 1 caso das BI (1,6%). A acurácia da BI foi de 83,6, enquanto da BA foi de 62,1. Dos 18 pacientes submetidos a tratamento cirúrgico com margem radical, 7 foram inicialmente submetidos à BA (36,8%) e 9 à BI (17,3%). Conclusão: Apesar das vantagens inerentes ao procedimento percutâneo da BA, a BI deve ainda ser considerada como opção diagnóstica em tumores de partes moles com alta heterogeneidade e grau de necrose. ***Nível de Evidência III; Estudo diagnóstico – Investigação de um exame para diagnóstico.***

Descritores: *Tumores de Partes Moles; Biópsia; Diagnóstico; Oncologia; Sarcoma.*

Citation: Delocco BC, Fiorelli BO, Abrantes IB, Luz ES, Lopes ACS, Meohas W. Assessment of accuracy of incisional and needle biopsy in soft-tissue tumors in a Brazilian center of reference. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 3. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Soft-part tumors can affect people of all ages, in the case of malignant lesions - sarcomas - most occur in adults from the 5th decade of life. The diagnosis of these lesions is carried out through clinical evaluation, imaging, biopsy and pathological analysis.

Biopsy is necessary to confirm the diagnosis and pathological analysis allows to determine the type and degree of the tumor. The techniques used to perform the diagnostic procedure can vary between the use of needle biopsy (NB) and incision biopsy (IB). A metaanalysis involving 17 studies showed that needle procedure is

All authors declare no potential conflict of interest related to this article.

The study was conducted at Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad (INTO), Av. Brasil, 500, Caju, Rio de Janeiro, RJ, Brazil. 20940-070.
Correspondence: Bruna Canteri Delocco. 88, Rua Santa Amelia, Praça da Bandeira, Rio de Janeiro, RJ, Brasil. 20260-030. brunacanteri@gmail.com

Article received on 09/08/2024 approved on 02/14/2025.

not inferior to IB in terms of defining the histopathological diagnosis.[1] Both procedures have similar rates of complications, although NB causes more hematomas and equimosis, while IB is more responsible for operational wound infection and ulceration.

World literature data increasingly consolidates the NB as the gold standard in the investigation of soft-part tumors. IB has indications in precise cases, especially in places where the Jamshid needle is not available or when the heterogeneity of the tumor makes the histopathological diagnosis challenging.

For these reasons, it is important to analyze the data from a reference center in Brazil in musculoskeletal tumors to evaluate the reality in recent years in relation to incision and needle biopsies in the ability to define diagnosis and implications in the treatment of the patient with soft tissue tumors, which depend on tissue biopsy for histopathological diagnosis.[2] The analysis of the accuracy of biopsies within these morbidities is of extreme importance for documentation of the epidemiological profile, evaluation of the results and repercussions with direct impact on treatment, on the type of surgery performed,[3,4] and patient follow-up.[5,6]

Therefore, the aim of the study was to assess whether there is robust evidence regarding the best type of biopsy, in relation to diagnostic accuracy, in soft-part tumors treated in a reference center in oncological orthopedic treatment in Brazil.

MATERIALS AND METHODS

This study was approved by the Institutional Ethics Committee (CAAE): 75396923.8.0000.5273). A retrospective, descriptive and observational study was conducted with patients with tumor lesions of soft parts who underwent biopsy at the institution from January 2010 to December 2019. The inclusion criteria were patients of any sex or age, with lesions of soft parts, in any anatomical location, submitted to IB or NB whose histopathological status is compatible with malignant lesions, of indeterminate or intermediate malignancy. Patients in whom the identified lesion was defined as metastasis, pseudotumoral lesion or benign lesion were excluded.

The data was collected, from the records, through the application of a check-list as a form of guidance for the information relevant to the research. After that they were inserted into the platform *Google Forms* and *Google Tabs* for the formulation of charts and tables for statistical development. The following data were collected: age, gender, ethnicity, type of initial biopsy, need for second biopsy and change of final histopathological status.

The software SPSS version 26 was used for data analysis, descriptive statistics were performed and the data were expressed as percentages. Student's t test was used to compare the variables.

RESULTS

114 biopsies of tumors of soft parts of malignant, indeterminate and intermediate malignant lesions were performed in the period from January 2010 to December 2019 in the specialist care center in Orthopedic Oncology of a Brazilian orthopedic hospital.

The study population was predominantly male, white and older than 40 years of age (Table 1). The average diagnostic age of patients with soft-part tumor was 48.45 years, with a standard deviation of 20.94 years, the minimum being 03 years and the maximum 97 years. The sample fashion was unimodal (46 years), with a median of 50.5 years.

The anatomical location of these tumors was predominant in the lower limbs, 71.9% (n = 82), followed by the upper limbs with 22.8% (n = 26), trunk with 3.5% (n = 4), pelvis 0.9% (n = 1) and escapular waist 0.9% (n = 1).

Of the 114 biopsies performed during the study period, 10.5% (n = 12) were excisional biopsies (BE) and 10.5% (n = 12) were performed in other institutions and were therefore excluded from the study. After these initial exclusions there were 90 biopsies, 67.8% (n = 61) IB and 25.4% (n = 29) NB. Seven patients had to repeat the biopsy procedure at least once, of which one had been performed in another institution and was therefore excluded from the final accuracy analysis; five of these patients were submitted to a new IB, while the other two were submitted to BE.

In 46.5% of cases the histopathological study was sufficient to define the diagnosis, in the other 53.5% the immunohistochemistry was necessary to complete the diagnosis.

After the elaboration of the initial diagnosis, 81 patients had indication of surgical treatment as the first indication, the other 33 patients were referred to other services for some neoadjuvant therapy (radiotherapy or chemotherapy), of these patients, 14 were still undergoing surgical treatment at some point in this institution. Five patients who had a surgical proposal initially did not follow the treatment. Data on distribution, type of biopsy performed and proposed initial treatment are presented in Table 2.

Of the needle biopsies, there was a need to perform a new collection in 5 cases, which represents 17.2% of cases. Of the incisions, only one had to be repeated, representing 1.6% of cases. In the NB cases that needed a new sample, IB was performed. There was only one case of IB that needed a new sample, was carried out then BE.

Table 1. Characterization of patients.

Variable	% (n)
Sex	
Female	52.6% (n = 60)
Male	47.4% (n = 54)
Ethnicity	
White	53.5% (n = 61)
Mixed race	32.5% (n = 37)
Black	16% (n = 14)
Age group	
Less than 20 years	13.2% (n = 15)
20 – 40 years	20.2% (n = 23)
40 – 60 years	33.3% (n = 38)
More than 60 years	33.3% (n = 38)

Table 2. Distribution as to the type of biopsy, the need to repeat the biopsy and the treatment performed.

Variable	% (n)
Type of initial biopsy	
Needle	25.4% (n = 29)
Incision	67.8% (n = 61)
Excisional[1]	10.5% (n = 12)
Carried out at another institution[1]	10.5% (n = 12)
Was it necessary to repeat the biopsy?	
Yes	6.1% (n = 7)[2]
No	93.9% (n = 107)
What technique was used in the second biopsy?	
Incision	71.4% (n = 5)
Excisional	28.6% (n = 2)
Technique used to define the diagnosis	
Histopathological	46.5% (n = 53)
Immunohistochemical	53,5% (n = 61)
Proposed initial treatment	
Surgical	71.9% (n = 82)
Referred to another service[3]	28.1% (n = 32)

1. Patients referred to this service after performing the biopsy in another institution and patients undergoing BE were excluded from the study. 2. One of the biopsies that needed to be repeated was a biopsy performed in another institution and, therefore, was excluded from the final accuracy analysis. 3. Patients referred to treatment with chemotherapy or radiotherapy in another institution.

After resection of the tumor, there was a change in the final histopathological report (FHR) in 37.9% of the cases in which the first biopsy was carried out by needle, and in 16.4% of the patients in which IB was initially carried out. The results for both types of biopsies are contained in Table 3.

After the analysis of the data exposed above, the accuracy was calculated from the total of samples that did not have the modified FHR divided by the total of the sample and multiplied by 100. The IB accuracy was 83.6, higher than the NB accuracy of 62.1. The accuracy data are shown in Table 4.

Of the total of 90 biopsies evaluated in this study, 61 incision and 29 per needle, 71 were submitted to surgical treatment at some point, of which 71, 19 were NB and 52 IB. Evaluating the type of surgery proposed and the final outcome of the patient, of these 71 biopsies submitted to surgical treatment at some point, in 18 was performed radical treatment, when the entire compartment where the tumor is located is resecated, e.g. amputation or desarticulation of limb. Thus, of the 18 patients undergoing radical surgical treatment, 7 initially underwent NB, which implies that 36.8% of the NB patients undergoing surgical treatment needed surgery with radical margin. Regarding IB, 9 of the 52 biopsies undergoing surgical treatment at some point required treatment with radical margin, which corresponds to 17.3%.

Table 3. Results relating to the type of biopsy performed, the need to repeat the biopsy and change of final histopathological record.

Variable	% (n)
Type of biopsy[1]	
Incision biopsy	67.8% (n = 61)
Biopsy by needle	32.2% (n = 29)
Unconcluding biopsies that needed to be repeated	
Incision biopsy	1.6% (n = 1)
Biopsy by needle	17.2% (n = 5)
Biopsies that had initial FHR altered	
Incision biopsy	16.4% (n = 10)
Biopsy by needle	37.9% (n = 11)

1. After exclusion of excisional biopsies and biopsies performed in another institution.

Table 4. Accuracy of incision and needle biopsies performed in the period from January/2010 to December 2019.

Accuracy	%
Type of biopsy	
Incision biopsy	83.6%
Biopsy by needle	62.1%

DISCUSSION

This study showed that the accuracy of the IB was higher than of the NB, in addition, approximately 40% of the NB presented discrepancy in the final diagnosis.

Biopsy for the histological definition of soft-part tumors is a crucial part of the correct management and treatment of these patients, as an inaccurate biopsy delays the start of the optimal treatment and an incorrect biopsy compromises the entire sequential treatment proposed to the patient.

One study compared ultrasound-guided tumor biopsies of incisional and needle soft parts and found an accuracy for the IB of 100%, very similar to this study, which found 96.7%.[7] For the ultrasound-guided NB, this also found an accuracy of 100%, while in our study the accuracy for the NB was 55.2%. This significant difference between the accuracy found can be explained because in the study period we did not use any auxiliary imaging method in the NB, such as ultrasound.

Published data indicate in tumors of malignant soft parts, such as sarcomas, a rate of diagnostic inaccuracy ranging from 20 to 30%.[8,9] This is due to the large heterogeneity of these tumors. In this study, the diagnostic inaccuracy was less, about 6%.

Survival of patients with soft-part sarcoma varies considerably based on factors such as the location of the tumor and the stage of the disease at the time of diagnosis, highlighting the importance of early detection and appropriate treatment to improve survival chances in patients with soft-part sarcoma.

This study evaluated a very representative number of patients for being rare malignant tumors in an extensive period of analysis. Thus, this study shows the current scenario of a reference center in Brazil with a large volume of tumors treated per year. However, when compared with general orthopedic pathologies the number of patients evaluated is small, and there is always a limitation of this type of study. Another limitation of this study is that the biopsies that needed to be repeated were repeated as IB or BE, none per NB.

New analyses may complement the findings of this study with the comparative evaluation of the results obtained with the NB of ultrasound-guided soft parts.

CONCLUSION

Our findings show that despite the advantages inherent in the percutaneous procedure of NB, such as faster procedure, shorter hospital time and less invasion of the patient, IB should still be considered as an option, especially in tumors of soft parts with high heterogeneity and degree of necrosis inside.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article. BCD: data collection, data analysis, work drafting; BDOF: data collection and data analysis; IBA: data collection and work drafting; EDSL: data collection and data analysis; ACSL: critical review of the intellectual content of the article and approval of the final version of the article; WM: critical review of the intellectual content of the article and approval of the final version of the article.

REFERENCES

1. Birgin E, Yang C, Hetjens S, Reissfelder C, Hohenberger P, Rahbari NN. Core needle biopsy versus incisional biopsy for differentiation of soft-tissue sarcomas: A systematic review and meta-analysis. Cancer. 2020;126(9):1917-1928. doi: 10.1002/cncr.32735.
2. Agulnik M, Bui MM, Carr-Ascher J, Choy E, Dry S, Ganjoo KN, et al. NCCN. Guidelines Version 2.2022 Soft Tissue Sarcoma NCCN Evidence Blocks TM.[Internet]. Available from: www.nccn.org/patients.
3. Sbaraglia M, Bellan E, Dei Tos AP. The 2020 WHO Classification of Soft Tissue Tumours: news and perspectives. Pathologica. 2021;113(2):70-84. doi: 10.32074/1591-951X-213.
4. Steffner RJ, Jang ES. Staging of Bone and Soft-tissue Sarcomas. J Am Acad Orthop Surg. 2018;26(13):e269-e278. doi: 10.5435/JAAOS-D-17-00055.
5. Morita SY. Surgical management of truncal soft tissue sarcoma and other selected soft tissue neoplasms. Chin Clin Oncol. 2018;7(4):38. doi: 10.21037/cco.2018.08.07.
6. Alamanda VK, Crosby SN, Archer KR, Song Y, Schwartz HS, Holt GE. Predictors and clinical significance of local recurrence in extremity soft tissue sarcoma. Acta Oncol. 2013;52(4):793-802. doi: 10.3109/0284186X.2012.711953.
7. Pazourek L, StaniczkovÁ Zambo I, TomÁŠ T, Mahdal M. [Open Incisional Biopsy and Ultrasound-Guided Core Needle Biopsy of Extremity-Localized Musculoskeletal Tumors]. Acta Chir Orthop Traumatol Cech. 2020;87(6):421-428.
8. Sbaraglia M, Dei Tos AP. The pathology of soft tissue sarcomas. Radiol Med. 2019;124(4):266-281. doi: 10.1007/s11547-018-0882-7.
9. Thway K, Wang J, Mubako T, Fisher C. Histopathological diagnostic discrepancies in soft tissue tumours referred to a specialist centre: reassessment in the era of ancillary molecular diagnosis. Sarcoma. 2014;2014:686902. doi: 10.1155/2014/686902.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290194

EPIDEMIOLOGICAL PROFILE OF INJURIES IN PATIENTS WITH HIGH DIAGNOSTIC SUSPICION OF ABUSE

PERFIL EPIDEMIOLÓGICO DAS LESÕES EM PACIENTES COM ALTA SUSPEIÇÃO DIAGNÓSTICA DE MAUS TRATOS

Isaias Silva Ribeiro de Souza[1], *Victor Peyneau Poncio*[1], *Matheus Giovanni Medina Molina*[1], *Georges Akira Shigekiyo Perera*[1], *Luiz Fernando Cocco*[1], *Eiffel Tsuyoshi Dobashi*[1]

1. Universidade Federal de Sao Paulo, Escola Paulista de Medicina, Departamento de Ortopedia e Traumatologia, Sao Paulo, SP, Brazil.

ABSTRACT

Objective: This study aimed to analyze the epidemiological profile of child abuse cases treated at Hospital Geral de Pirajussara, São Paulo, and to understand the characteristics of associated injuries. Methods: A retrospective cross-sectional study was conducted by reviewing medical records of patients suspected of abuse, aged 18 years or younger, from January 2012 to December 2022. Data on sex, age, trauma mechanism, presence of fractures, and outcomes were analyzed. Results: A total of 58 records were included. Most cases involved adolescents (50%, n=29). The most common abuse mechanism was physical force (36.21%, n=21), followed by direct trauma by object (13.79%, n=8). Fractures were present in 41.38% of cases (n=24), with skull and facial fractures being the most frequent (33.33%, n=7). Brain injuries were the most common associated injuries (42.42%, n=14). Most cases (77.59%, n=45) were discharged with an average hospital stay of 9 days. Conclusions: Abuse is prevalent among young children under 1 year and adolescents (13-18 years). Identified patterns of injuries and abuse mechanisms highlight the need for stringent screening and management protocols. Continuous training and vigilance are crucial for effective prevention and intervention. ***Level of Evidence III; Cross-Sectional Retrospective Study.***

Keywords: Child Abuse; Child Maltreatment; Epidemiology; Aggression; Fractures, Bone; Child.

RESUMO

Objetivo: Analisar o perfil epidemiológico de crianças vítimas de maus-tratos atendidas no Hospital Geral de Pirajussara, São Paulo, e investigar as características das lesões associadas. Métodos: Conduzido um estudo transversal retrospectivo com revisão de prontuários dos pacientes com suspeita de maus-tratos, idade igual ou inferior a 18 anos, entre janeiro de 2012 e dezembro de 2022. Analisaram-se dados sobre sexo, idade, mecanismo de trauma, presença de fraturas e desfecho. Resultados: Dos 58 prontuários analisados, 50% (n=29) referiam-se a adolescentes. O abuso mais comum foi por força corporal (36,21%, n=21), seguido por trauma direto por objeto (13,79%, n=8). Fraturas foram encontradas em 41,38% dos casos (n=24), com maior frequência em crânio e face (33,33%, n=7). Lesões cerebrais foram mais prevalentes entre as lesões associadas (42,42%, n=14). A maioria dos pacientes (77,59%, n=45) recebeu alta apresentando internação média de 9 dias. Conclusões: Maus-tratos são prevalentes em crianças menores de 1 ano e adolescentes (13-18 anos). Os padrões de lesões e mecanismos de abuso evidenciam a necessidade de protocolos rigorosos para triagem e manejo. A capacitação contínua e a vigilância são essenciais para a prevenção e intervenção eficaz. ***Nível de Evidência: III; Estudo Transversal Retrospectivo.***

Descritores: *Abuso de Crianças; Maus-Tratos de Menores; Epidemiologia; Agressão; Fraturas Ósseas; Criança.*

Citation: Souza ISR, Poncio VP, Molina MGM, Perera GAS, Cocco LF, Dobashi ET. Epidemiological profile of injuries in patients with high diagnostic suspicion of abuse. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 6. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Child abuse and ill-treatment are defined by the Child Abuse Prevention and Treatment Act (the Child Abuse Prevention and Treatment Act, CAPTA) as emotional or physical harm, sexual abuse, exploitation and imminent risk of death inflicted on persons under the age of 18.[1] Nationally, Articles 4 and 5 of the Child and Adolescent Statute of 13 July 1990 define that every child should be assured by the public authority of the rights to life, leisure, respect, food and family and community coexistence without physical or mental discrimination, without violence, without cruelty, without oppression and without exploitation.[2] However, it is presumable that there is a subnotification of many of the cases, especially in

All authors declare no potential conflict of interest related to this article.

The study was conducted at General Hospital de Pirajussara, 1214, Av. Ibirama, Parque Industrial Daci, Taboao da Serra, Sao Paulo, SP, Brazil.
Correspondence: Eiffel Tsuyoshi. 740, Rua Botucatu, Vila Clementino, Sao Paulo, SP, Brazil. 04039-032. eiffeldobashi@uol.com.br

Article received on 09/10/2024 approved on 03/14/2025.

our environment where, countless incidents are not diagnosed. It is considered as the only criterion of confirmation of the fact, especially in child abuse, the confession of the abuser. The most commonly affected age group is children under 2 years of age, however, in children under 1 year of age, the incidence corresponds to 50% of all abuse injuries.[3]

As for beaten child syndrome, a condition in which the child is a victim of non-accidental physical trauma, by one or more of its carers, its incidence is 1 in 100 children. Among those affected, about 2 to 3% progress to death. In Toronto's Hospital for Sick Children, the incidence observed in this service was three times higher than in other conditions such as congenital impotence.[4]

The repercussions on the life of a child victim of ill-treatment are countless. When exposed to such abuse, they may develop mental health problems throughout their development. Among them we can cite anxiety, depression, sleep disorders, post-traumatic stress disorders, lack of concentration in school and hypervigilance.[5] In addition, the population when it reaches adulthood is most seen in mental health services and is more prone to self-harassment and suicide.[6]

The most commonly found lesions are those of soft tissues and fractures that are present in up to 20% of patients. Given this fact, for the assessment of a possible case of ill-treatment, orthopedists will often be required for the assessment of this population.[7]

An important fact to consider is that a single fracture cannot be considered, in isolation, to define a framework of ill-treatment. The entire clinical and social context of the patient and the family involved should be considered.

However, there are patterns of fractures that should increase suspicion and generate a warning for a possible ill-treatment injury, which are: scapula, sternum, metalizarias, posterior coastal arches and thinning processes.[8] It is important to emphasize that even when we have fractures of low specificity, but with a confusing and/or unconnected history, this injury becomes highly suspicious for ill-treatment.

In addition, in the suspicion of child abuse, we should consider some differential diagnoses such as rachitis or imperfect osteogenesis that may present similar radiographic signs. Considering the fractures of the ribs, in bone fragility, these occur more frequently in its lateral portion, however in the normal skeleton the involvement is postromedial which increases the suspicion of a non-accidental trauma.[9] Therefore, it is of extreme importance that requests for radiographies should be standardized for determination of cases follow strict protocols to perform the screening of possible other fractures at the same time or in previous periods. The fractures that have moderate specificity are the epiphyse separations, fractures of the phalanges and vertebral bodies. The fractures of low specificity, or more likely to be accidental, are the diaphysic fractures of long bones (at less than 1 year old), clavicular fractures and linear fractures of the skull.[10] Due to the difficult diagnosis and high clinical repercussions in the cases, more factors should be established to strengthen suspected fractures by ill-treatment, in order to avoid possible adverse outcomes for patients.

Therefore, this work was developed to establish the epidemiological profile of patients victims of ill-treatment in a reference hospital in São Paulo. A better understanding of injuries in this population may be useful in developing protocols for care and protection of the children involved. The conduct of this research was motivated by the scarcity of articles from the national orthopedic literature.

MATERIAL AND METHODS

The study was approved by the Research Ethics Committee (CEP) of the General Hospital of Pirajussara with the Certificate of Presentation of Ethical Appreciation number 74005723.8.0000.5450 issued by the Institute of Gastroenterology of São Paulo - IGESP, through the Brazil platform. The procedures followed the standards of the aforementioned Ethical Committee on Human Experiences of the Federal University of São Paulo and are in accordance with the 1995 Helsinki Declaration.

Design of the study

A cross-sectional retrospective study was conducted based on the descriptive review of data collected from electronic records of patients suspected of ill-treatment aged 18 or less treated at the General Hospital of Pirajussara, which comprises the municipalities of Embu das Artes and Taboão da Serra – SP, from January 2012 to December 2022.

With respect to the Terms of Free and Informed Consent (TCLE), a waiver and exemption from the application of this tool was requested, as this study used only secondary data obtained from the study of material already collected for assistance purposes and the review of medical records with information concerning patients.

Population

The population composition was obtained by selecting all the cases notified to the Epidemiological Surveillance by the medical or social care team, considering the suspected or confirmed cases of ill-treatment treated at the General Hospital of Pirajussara.

We included all patients followed between January 2012 and December 2022, of both sexes, aged under 18, with positive notification from the Protection Council for Abuse and signature of the Free Informed Consent Terms that contained data in electronic medical records. The cases that did not meet the inclusion criteria were not selected for sampling.

Procedures

Data were collected regarding gender, age, origin, mechanism of trauma, presence of fracture, laterality (where applicable), presence of associated injuries, time of hospitalization and outcome. An epidemiological analysis of the data obtained was carried out with the aim of establishing the profile of the studied sample and comparing it with available literature data on the subject.

Gathering and obtaining data

The data was obtained through the review of electronic logs and the information relevant to the database composition was tabulated in Microsoft Excel® 2010 Software spreadsheet (Microsoft Corporation®, San Diego, USA).

Statistical analysis

The data obtained was analyzed using Microsoft Excel® 2010 Software (Microsoft Corporation®, San Diego, USA). The categorial data were presented in the form of frequency and percentage and the continuous numerical data in the form of sample average and standard deviation. The analyses were carried out to characterize the sample and establish an epidemiological profile.

RESULTS

Having met the eligibility criteria for sample composition, 58 records were included for analysis. Our study included patients from the municipalities of Taboão da Serra (41.38%), Embu das Artes (36.21%) and São Paulo (10.34%). Table 1 shows the other municipalities considered by our sample.

Of the total of our sample, 31 (53.45%) were male and 27 (46.55%) female, whose average age was 10.2 years (1 day as minimum age and 18 years as maximum age); lower for boys (9.72 X 10.75 and 1 day X 1 month, respectively) and maximum age of 18 years for both sexes. The age distribution is concentrated among younger

children, from early childhood, 18 present age from 0 to 6 years (20.69%) and adolescence, 29 present age between 13 to 18 years (50%). The cases studied occurred mainly from 2015 to 2018, with 18 cases occurring in 2015 (31.03%), in 2016 were 12 cases (20.69%), in 2017 with 7 cases (12.07%) and 2018 also with 7 cases (12.07%), with the least occurrence from 2019. In the years when there was a higher incidence of cases of ill-treatment, the prevalence was higher in male individuals and in the 4 years of lower incidence, there was a higher prevalence in female. (Table 2)

According to Table 3, the most frequent mechanism of abuse was physical force, accounting for 20 cases (34.49%). The minimum age was 1 month, the maximum age was 18 years, and the average age was 10.51 years; however, the ages were widely dispersed (SD = 6.55). The distribution of boys and girls was similar (N = 10 and 11, respectively). Direct traumas per object occupied the second place in prevalence with 8 occurrences (13.79%) and beating, the third with 6 cases (10.34%), and this was most common in older children (average age 15.17 years, SD = 2.32). The lowest age was observed for the abandonment mechanism (1 day and 2 months) and the highest for white gun injury (average 15.5 years). Drowning and bite were the mechanisms of lowest prevalence, with only 1 case. Sexual abuse was observed in 2 cases (3.45%), only in female patients, aged 14 and 16.

In 34 cases (58.62%) there was no fracture, and among the cases with bone injury, the skull and the bones of the face accounted for one third of the occurrences with 7 cases (33.33%). The youngest was 4 months old, with occipital fractures from falling neck. Upper limb fractures were most observed in girls, 4 cases (19.05%), lower limb fractures in boys, 4 cases (19.05%), and hand fractures in older boys with 3 cases (14.29%) with an average of 15.5 years.

Traumatic head lesions with impaired central nervous system were the most prevalent among the associated lesions, and were observed in 14 patients (42.42%) of the 33 cases. Thorax injuries occupied the second place, representing 15.15% of associated injuries and were mainly related to the use of guns in older patients: of the 5 cases, 2 were for white gun (18 and 13 years old) and 1 for firearm (18 years old).

In our study, 45 (77.59%) of the cases developed with medical or hospital discharge, with an average duration of 9 days of hospitalization, but with large dispersion, ranging from 1 day to 3 months (SD = 16.31). Mechanism by beating and the presence of associated skull and face fractures showed longer hospitalization times (average 33.8 and 16.57 days, respectively).

Table 1. Characterization of the sample according to municipalities of origin of patients (N=58).

	N (%)
Barueri	1 (1.72)
Carapicuiba	1 (1.72)
Cotia	1 (1.72)
Embu of the Arts	21 (36.21)
Ibiuna	1 (1.72)
Itaberada	1 (1.72)
Itapecerica da Serra	1 (1.72)
Itapevi	1 (1.72)
São Paulo	6 (10.34)
Taboão da Serra	24 (41.38)

Table 2. Characterization of the sample by age and cases per year according to sex (N=58).

		Total	Male	Female
N (%)		58	31 (53.45)	27 (46.55)
Average age (years) (SD)		10.20 (6.55)	9.72 (6.8)	10.75 (6.33)
Min-Max		1 day - 18 years	1 day - 18 years	1 month - 18 years
Division by age group N(%)	< 1 year	12 (20.69)	7 (12.07)	5 (8.62)
	1-6 years	6 (10.34)	4 (6.9)	2 (3.44)
	7-12 years	11 (18.96)	7 (12.07)	4 (6.89)
	13-18 years	29 (50)	13 (22.41)	16 (27.59)
Cases per year N(%)	2015	18 (31.03)	14 (24.14)	4 (6.9)
	2016	12 (20.69)	4 (6.9)	8 (13.79)
	2017	7 (12.07)	4 (6.9)	3 (5.17)
	2018	7 (12.07)	4 (6.9)	3 (5.17)
	2019	4 (6.9)	1 (1.72)	3 (5.17)
	2020	4 (6.9)	1 (1.72)	3 (5.17)
	2021	4 (6.9)	2 (3.45)	2 (3.44)
	2022	2 (3.45)	1 (1.72)	1 (1.72)

DISCUSSION

The main data of this survey are arranged in Tables 1, 2 and 3 which revealed worrying patterns with notable peaks among children under 1 year and adolescents older than 14 years, compromising both sexes. The results indicate that individuals under the age of 1 year often experience severe physical abuse. Such observations have been evidenced by other studies that point to a high incidence of fractures associated with abuse in infants.[1,11] These fractures are often diagnosed in paediatric emergencies, where collaboration with child protection services is essential to identify and conduct these cases effectively.[7] The complexity of the signs of abuse in infants are often confused with other medical conditions. We therefore emphasize that an appropriate multidisciplinary approach can ensure an adequate response and the necessary protection for these vulnerable children.

On the other hand, among adolescents over the age of 14, cases of abuse reveal a pattern of violence that may be related to different factors such as psychological pressure and exacerbated family conflicts during adolescence.[5] Some studies show that there may be more complex forms of abuse in this age group, including psychological abuse and negligence that often result in psychiatric disorders and self-destructive behaviors.[6] There are research reports that show that mental health interventions and support programs for adolescents are crucial to mitigate the long-term impacts of abuse.[3] In addition, the implementation of public policies that promote education and awareness about child abuse and its suspicion can help detect and prevent these cases.

The data found in our study demonstrate consistent patterns that corroborate the evidence and recommendations found in the literature on child abuse. According to Weinstein and Flynn[1] and the review of Kemp et al.,[8] the prevalence of fractures in child abuse victims is a significant indicator of non-accidental trauma. Our research shows that early childhood had the highest rate of fractures (36.21%), with the highest incidence in the skull and face, which is consistent with the findings that young children are especially vulnerable to severe fractures from physical abuse.[1]

In addition, the traumatic mechanisms identified, such as the application of body force and beating, reflect the most common forms of physical abuse described in the literature.[3,7] In second childhood and adolescence, the prevalence of beating and white gun injuries, as well as associated injuries, such as cranial trauma, corroborate the observations that adolescents often face more severe and varied abuses.[5,12] Hospitalization discharge as the predominant outcome, although the most frequent, highlights the need to carry out continuous surveillance, as the literature points to the importance of early interventions and follow-up to minimize long-term complications.[6]

Table 3. Age, gender and time of admission according to abuse mechanism, fracture, associated injuries and outcome (N=58).

					Male		Female		Internation		
		N (%)	Min-max	Middle Age (SD)	N (%)	Age Mean (SD)	N (%)	Middle Age (SD)	Yes N(%)	No N(%)	Duration (days) Mean (SD)
Mechanism of abuse	Abandonment of incapable	2 (3.45)	1 day - 2 months	0.09 (0.12)	2 (3.45)	0.09 (0.12)	0		2 (3.45)	0	3.5 (3.54)
	Sexual abuse	2 (3.45)	14 - 16 years	15 (1.41)	0		2 (3.45)	15 (1.41)	2 (3.45)	0	2.5 (2.12)
	Affecting	1 (1.72)	9 years	9	1 (1.72)	9	0		1 (1.72)	0	7
	Spaning	6 (10.34)	12 - 18 years	15.17 (2.32)	4 (6.9)	14.5 (2.65)	2 (3.45)	16.5 (0.71)	5 (8.62)	1 (1.72)	33.8 (39.19)
	White gun injury	4 (6.9)	13 - 18 years	15.5 (3.54)	1 (1.72)	18	3 (5.17)	16.33 (2.89)	4 (6.9)	0	5 (2.94)
	Fire gun injury	4 (6.9)	5 - 18 years	11.5 (6.95)	3 (5.17)	13.33 (7.23)	1 (1.72)	6	2 (3.45)	2 (3.45)	4 (4.24)
	Body strength	21 (36.21)	1 month - 18 years	10.51 (6.55)	10 (17.24)	9.85 (7.32)	11 (18.97)	11.10 (6.07)	15 (25.86)	6 (10.34)	4.13 (3.44)
	Human bite	1 (1.72)	15 years	15	0		1 (1.72)	15	0	1 (1.72)	
	Negligence	2 (3.45)	5 months - 11 years	5.71 (7.48)	1 (1.72)	11	1 (1.72)	0.42	2 (3.45)	0	6 (0)
	Direct Trauma by Object	8 (13.79)	3 - 18 years	10.88 (5.54)	5 (8.62)	9.8 (6.83)	3 (5.17)	12.67 (2.52)	5 (8.62)	3 (5.17)	4 (3.67)
	Fall	5 (8.62)	1 month - 12 years	3.6 (5.12)	3 (5.17)	5.78 (5.87)	2 (3.45)	0.33 (0.35)	5 (8.62)	0	17.8 (19.77)
	No data	3 (5.17)	2 months - 14 years	4.78 (7.98)	1 (1.72)	0.17	2 (3.45)	7.09 (9.78)	1 (1.72)	2 (3.45)	3
Fraud	Yes*	21 (36.21)	1 month - 18 years	9.66 (7.13)	14 (24.14)	9.49 (7.48)	7 (12.07)	10.01 (6.91)	20 (34.48)	1 (1.72)	9.45 (19.54)
	No	34 (58.62)	1 day - 18 years	10.66 (6.28)	15 (25.86)	10.34 (6.28)	19 (32.76)	10.91 (6.44)	21 (36.21)	13 (22.41)	7.14 (10.50)
	No data	3 (5.17)	2 months - 13 years	8.72 (7.41)	2 (3.45)	6.59 (9.07)	1 (1.72)	13	2 (3.45)	1 (1.72)	30.5 (41.72)
*Yes	Hand	4 (19.05)	15 - 17 years	15.5 (1)	3 (14.29)	15.67 (1.15)	1 (4.76)	15	3 (5.17)	1 (1.72)	3 (1)
	Lower members	5 (23.81)	1 month - 17 years	4.85 (7.08)	4 (19.05)	5.56 (7.96)	1 (4.76)	2	5 (8.62)	0	6 (5.15)
	Superior members	5 (23.81)	1 month - 15 years	7.82 (6.59)	1 (4.76)	3	4 (19.05)	9.02 (6.94)	5 (8.62)	0	3.6 (1.67)
	Crane and face	7 (33.33)	4 months - 18 years	9.8 (8.25)	6 (28.57)	8.6 (8.34)	1 (4.76)	17	7 (12.07)	0	16.57 (32.42)
Associated injuries	Yes**	33 (56.9)	1 day - 18 years	9.49 (7.15)	16 (27.59)	8.86 (7.03)	17 (29.31)	10.08 (7.42)	27 (46.55)	6 (10.34)	7.07 (9.72)
	No	23 (39.66)	1 month - 18 years	11.53 (5.42)	13 (22.41)	11.25 (6.47)	10 (17.24)	11.9 (3.96)	15 (25.86)	8 (13.79)	9.93 (22.4)
	No data	2 (3.45)	2 months - 13 years	6.59 (9.07)	2 (3.45)	6.59 (9.07)	0		1 (1.72)	1 (1.72)	60
**Yes	Brain	14 (42.42)	1 day - 18 years	6.28 (7.33)	8 (24.24)	6.57 (7.1)	6 (18.18)	5.89 (8.3)	8 (13.79)	6 (10.34)	6 (6.26)
	Torax	5 (15.15)	2 months - 18 years	10.83 (7.99)	4 (12.12)	10.29 (9.12)	1 (3.03)	13	5 (8.62)	0	7.2 (0.84)
	Abdomen	3 (9.09)	10 - 18 years	14.33 (4.04)	2 (6.06)	14 (5.66)	1 (3.03)	15	3 (5.17)	0	6 (4.58)
	Nerves and tendons	2 (6.06)	14 - 18 years	16 (2.83)	0		2 (6.06)	16 (2.83)	2 (3.45)	0	3 (0)
Outcome	Altab	45 (77.59)	1 month - 18 years	10.64 (6.19)	22 (37.93)	9.94 (6.5)	23 (39.66)	11.31 (5.93)	36 (62.07)	9 (15.52)	9 (16.31)
	Death	6 (10.34)	1 day - 18 years	3.91 (7.17)	4 (6.9)	5.79 (8.46)	2 (3.45)	0.14 (0.04)	1 (1.72)	5 (8.62)	1
	Judicial transfer	1 (1.72)	11 years	11	1 (1.72)	11	0		1 (1.72)	0	8
	Escape	1 (1.72)	4 months	0.33	1 (1.72)	0.33	0		1 (1.72)	0	4
	Ambulatory route	1 (1.72)	18 years	18	1 (1.72)	18	0		1 (1.72)	0	1
	No data	4 (6.9)	13 - 17 years	15 (1.63)	2 (3.45)	15 (2.83)	2 (3.45)	15 (0)	3 (5.17)	1 (1.72)	20.67 (34.06)

The prevalence of hospitalization and non-hospitalization was calculated compared to the general sample (N=58). The prevalence of fractures and associated lesions was calculated compared to the general sample (N=58) and the prevalence of specific fractures and associated lesions was calculated compared to the positive fractural cases sample (N=21) and associated lesions (N=33). [a]Direct trauma per object includes contundent object (aspirator); perforating-cutting object; direct trauma by skate and direct trauma by unspecified objects. [a']Fall' includes falls from objects such as a plate, bed, or crib, as well as falls from different floor levels. [b]Includes post-surgical discharge; post-procedures; post-evaluation of social service; post-evaluation of custodial council and judicial discharge after loss of custody. *38.1% (N=8) presented laterality to the right, 33.33% (N=7) to the left and 14.29% (N=3) did not contain data. *Hand fractures include phalanges and metacarpal. *Lower limb fractures include femur and tibia. *Upper limb fractures include humerus and forearm. *Face and skull fractures include skull, occipit, orbit, jaw, and nasal fracture. ** Brain injuries include TCE, extradural hematoma, intracranial hypertension and cerebral death. ** Thoracic lesions include pneumothorax and increased mediastinum. ** Abdominal lesions include liver, kidney, splenic and unspecified lesions.

Over the course of early childhood, victims of abuse have a high prevalence of injuries associated with direct physical trauma. Table 3 shows that the average age of the victims of physical strength is 10.51 years, indicating that this form of trauma is significant in younger children. The data also reveal that neglect and abandonment are commonly observed mechanisms, although less frequent, with an average age of around 5.71 years. These findings are consistent with studies that highlight the vulnerability of young children to direct physical abuse and neglect, as indicated by research on child abuse patterns.[3,12]

In second childhood, physical abuse, especially by applying physical force and trauma directly per object, remains very prevalent. Fractures in the lower and upper limbs are common, reflecting the intensity of physical abuse. The average age for limb fractures is approximately 7.82 years for the superior and 4.85 years for the inferior, demonstrating a continuity in the pattern of physical abuse as children grow up. The results found coincide with the findings of studies such as those of Kemp et al.[8] that show a high incidence of fractures in school-age children.[8,12] In addition, abuse by excessive body force application and direct trauma per object continue to be prevalent.

In adolescence, patterns of abuse become even more complex and severe. We observed an increase in the severity and diversity of injuries, including beating, gunshot injuries and white gun injuries. The average age considering the beating was 15.17 years, indicating that severe physical abuse tends to occur in older ages. The hospitalization rate for these injuries was significantly high, with an average duration of 33.8 days for the beating. These data reflect the severity of abuses faced by adolescents and are in line with the literature that highlights an increase in the severity of injuries with age.[9,14,15] The pattern of fractures and associated injuries observed suggests the need for more rigorous approaches to identify and treat cases of abuse in adolescents.

The data compiled in this paper reveals worrying patterns of victimization throughout the different stages of childhood development.

<< SUMÁRIO

The results show that victimization is significant in four distinct age groups: first and second childhood and adolescence, with variations in the type and severity of associated lesions. In early childhood, we observe a high prevalence of severe physical abuse, especially fractures associated with non-accidental trauma. The analysis of the data indicates that the highest rate of bone lesions occurs in this age group, with a prevalence of 36.21% of these in the skull and face. These findings are consistent with the literature describing the vulnerability of young children to severe fractures due to physical abuse.[1,11]

We also note that in early childhood, direct physical abuse and neglect are predominant, while in second childhood, physical abuse persists, with emphasis on fractures. In adolescence, the pattern of abuse includes more serious and varied forms of violence, such as beating and gun injuries. These findings are consistent with the literature, which points to a progression in the severity and complexity of injuries as children age.[4,5]

Our study showed that in 17 of the 58 cases evaluated occurred in patients up to 5 years old, with 12 under 1 year and 5 positive for fracture, strengthening the idea that a series X-ray investigation is considered valid strategies of support for the establishment of proper diagnosis and management. We believe that our results point to the need for special attention to the younger population with emphasis on the investigation of hidden fractures and in cases of suspicion, and protective hospitalization may be of great value. Due to the morbidity of brain injuries from abuse, neuroimaging as screening for children under investigation of abuse is recommended by the American Academy of Pediatrics (RR). Consistently, our results indicate that four of the six deaths were observed in infants < 1 year (1 day, 41 days, 2 months and 2 months), of which 3 had associated brain injury. All cases of death, except one that presented incomplete data, presented associated brain injury (3 TCE, 1 intracranial hypertension and 1 cerebral death) and associated skull and face fractures showed to be associated with longer hospitalization time (average of 16.57 days).

Furthermore, our study observed, among the positive cases for fracture, a prevalence of 23.81% of fractures of upper and lower limbs and of 19.05% for fractures of the hand. Although skull and face fractures were more prevalent individually, long bone fractures of the appendicular skeleton represented 14 of the 21 cases.

This study demonstrates that there has been a reduction in the incidence of cases of ill-treatment since 2015, with the number of cases stable from 2019 to 2021. In 41.38% of cases of ill-treatment occurred in young people aged 14 to 18 and 66.66% of deaths occurred in children under 1 year. whose results are close to those of the national scene. In Brazil, from 2016 to 2020, of 35,000 violent deaths to 19 years old, more than 31,000 were between 15 and 19 years old. The lethal violence peaked between 2016 and 2017 and fell in subsequent years. However, the number of deaths increases in the 0 to 4 year range (EE). Similarly, in the United States, 80% of child abuse or negligence deaths occur in children under the age of 4 (RR). Although the prospect of reducing the number of cases is favourable, we believe that professional training is necessary in addressing and managing cases of ill-treatment in the younger age group.

Our study presents limitations such as having been developed in a single center and of retrospective collection, which may have limited the acquisition of important data not archived in records, in addition to the collection of text-free file information, which may have made it difficult to standardize the data. We also highlighted the great diversity of the data, with multiple cases isolated from the variables analyzed, which may have been a bias factor for the grouping of the results. Despite the collection of all the cases notified to the Council, the sample limitation, with few cases per year, made longitudinal epidemiological time evaluation difficult. We also mentioned the possible phase-out of expertise in the identification, suspecting and conducting of cases of ill-treatment, due to the usual reduced frequency of such occurrences in hospital daily life. Among the strengths of this study, we highlight its basis in a reference hospital serving approximately 570,187 residents of the municipalities of Taboão da Serra and Embu das Artes. Additionally, the cases were managed by final-year medical residents specializing in orthopedics, which conferred greater technical expertise and specialization in the orthopedic evaluation of child abuse cases. Finally, we cite the public health service as a possible factor of representativity of the results obtained on a large scale and fidelity to the national scene

In summary, the vulnerability of young children to serious fractures and direct physical abuse persists from early childhood to adolescence, although the complexity and severity of the injuries increase with age. The continuation of physical abuse patterns and the emergence of more complex forms of abuse in adolescence highlight the need for a multidisciplinary approach and public policies focused on prevention and early intervention. The literature recommendations, which emphasize the importance of continuous surveillance and education on signs of abuse, are crucial to improving the detection and treatment of these cases, as described by recent studies.[2,3,7]

CONCLUSION

Child ill-treatment is an issue of extreme importance for the healthcare community, and correct training for the identification and approach of suspected cases is essential. Our results allow us to conclude that the possible forms of presentation and associations are diverse. Body force consists of a highlighting mechanism for cases of child violence, deserving special attention for suspicion by professionals. Younger children, from 0 to 5 years old, especially those under 1 year old, are the target of greater vulnerability, and orthopedic fractures in this age group should be investigated actively and protectively. Serial X-rays and profile incidences can be interesting strategies for diagnostic optimization. Cranioencephalic and facial lesions demonstrate greater morbidity and mortality. Extreme ages (<1 year and between 13-18 years) may present suspicious age ranges due to higher prevalence in older adults and mortality in younger adults. Multicenter studies with greater sampling and uniformity of the data can provide additional information and be of great value for better understanding of the national scenario about the topic. We consider necessary educational strategies regarding medical assistance to child violence in medical schools and specialized training services as well as training teams in nursing services regarding the suspicion, identification, approach, management, conduct and follow-up of cases of ill-treatment in children and adolescents.

AUTHOR'S CONTRIBUTION: The authors declare their individual and significant contribution to the development of this article ISRS: data collection and interpretation of the data, MGMM: data analysis and tabulation of the results, VPP: article editing and data interpretation, GASP: documentary work creation and article editing and ETD: article review and intellectual concept of the article; LFC: article review and intellectual concept of the article.

REFERENCES

1. Weinstein SL, Flynn JM, Crawford HA. Lovell and winter's pediatric orthopaedics. 8th ed. Philadelphia: Wolters Kluwer; 2021.
2. Estatuto da criança e do adolescente. Lei número 8069. [Internet]. 1990. Available at: https://www.jusbrasil.com.br/legislacao/1031134/

estatuto-da-crianca-e-do-adolescente-lei-8069-90.
3. Blangis F, Allali S, Cohen JF, Vabres N, Adamsbaum C, Rey-Salmon C, et al. Variations in Guidelines for Diagnosis of Child Physical Abuse in High-Income Countries: A Systematic Review. JAMA Netw Open. 2021;4(11):e2129068. doi: 10.1001/jamanetworkopen.2021.29068.
4. Ruaro AF, Meyer AT, Aguilar JAG, Hellu JJ, Custódio MD. Síndrome da criança espancada. Rev Bras Ortop. 1997;(32):10.
5. Assis SG, Avanci JQ, Pesce RP, Ximenes LF. The situation of Brazilian children and adolescents with regard to mental health and violence. Ciênc. saúde coletiva. 2009;(14):349–61. doi: 10.1590/S1413-81232009000200002.
6. Read J. Do adult mental health services identify child abuse and neglect? A systematic review. Rev Inter Enf. 2017;(27):7-19. doi: 10.1111/inm.12369.
7. Sink EL, Hyman JE, Matheny T, Georgopoulos G, Kleinman P. Child abuse: the role of the orthopaedic surgeon in nonaccidental trauma. Clin Orthop Relat Res. 2011;469(3):790-7. doi: 10.1007/s11999-010-1610-3.
8. Kemp AM, Dunstan F, Harrison S, Morris S, Mann M, Rolfe K, et al Patterns of skeletal fractures in child abuse: systematic review. BMJ. 2008;337:a1518. doi: 10.1136/bmj.a1518.
9. Marine MB, Forbes-Amrhein MM. Fractures of child abuse. Pediatr Radiol. 2021;51(6):1003-1013. doi: 10.1007/s00247-020-04945-1.
10. Hornor G. Physical abuse: Recognition and reporting. J Pediatr Health Care. 2005;19(1):4-11. doi: 10.1016/j.pedhc.2004.06.009.
11. Banaszkiewicz PA, Scotland TR, Myerscough EJ. Fractures in children younger than age 1 year: importance of collaboration with child protection services. J Pediatr Orthop. 2002;22(6):740-4.
12. Schilling S, Christian CW. Child physical abuse and neglect. Child Adolesc Psychiatr Clin N Am. 2014;23(2):309-19, ix. doi: 10.1016/j.chc.2014.01.001.
13. da Silva Franzin LC, Olandovski M, Vettorazzi ML, Werneck RI, Moysés SJ, Kusma SZ, et al. Child and adolescent abuse and neglect in the city of Curitiba, Brazil. Child Abuse Negl. 2014;38(10):1706-14. doi: 10.1016/j.chiabu.2014.02.003.
14. Rosenfeld EH, Johnson B, Wesson DE, Shah SR, Vogel AM, Naik-Mathuria B. Understanding non-accidental trauma in the United States: A national trauma databank study. J Pediatr Surg. 2020;55(4):693-697. doi: 10.1016/j.jpedsurg.2019.03.024.
15. Sheets LK, Leach ME, Koszewski IJ, Lessmeier AM, Nugent M, Simpson P. Sentinel injuries in infants evaluated for child physical abuse. Pediatrics. 2013;131(4):701-7. doi: 10.1542/peds.2012-2780.
16. Henry MK, Wood JN. What's in a name? Sentinel injuries in abused infants. Pediatr Radiol. 2021;51(6):861-865. doi: 10.1007/s00247-020-04915-7.
17. Nimkin K, Kleinman PK. Imaging of child abuse. Radiol Clin North Am. 2001;39(4):843-64. doi: 10.1016/s0033-8389(05)70314-6.
18. Christian CW. The Evaluation of Suspected Child Physical Abuse. Pediatrics. 2015 May;(5):1337-54. doi: 10.1542/peds.2015-0356.
19. Karmazyn B, Duhn RD, Jennings SG, Wanner MR, Tahir B, Hibbard R, et al. Long bone fracture detection in suspected child abuse: contribution of lateral views. Pediatr Radiol. 2012;42(4):463-9. doi: 10.1007/s00247-011-2248-3.
20. UNICEF, Fórum Brasileiro de Segurança Pública (FBSP). O Panorama da Violência Letal e Sexual contra Crianças e Adolescentes no Brasil. Comunicado de imprensa [Internet]. 2021 [access in 2023 set 15]. Available at: https://www.unicef.org/brazil/comunicados-de-imprensa/nos-ultimos-cinco-anos-35-mil-criancas-e-adolescentes-foram-mortos-de-forma-violenta-no-brasil

DOI: http://dx.doi.org/10.1590/1413-785220253304e277810

POST-OSTEOSYNTHESIS INFECTION: EVALUATION OF A HISTORICAL COHORT AND DEVELOPMENT OF A CARE PROTOCOL

INFECÇÃO PÓS-OSTEOSSÍNTESE: AVALIAÇÃO DE COORTE HISTÓRICA E DESENVOLVIMENTO DE PROTOCOLO ASSISTENCIAL

Jair Moreira Dias Junior[1], *Pedro Henrique Ananias da Cunha*[1], *Marcos Paulo Paro*[1], *Mariana Machado Pinheiro*[1], *Ibsen Barguine Junqueira Passos*[1], *Adriano Fernando MendesJunior*[1]

1. Universidade Federal de Juiz de Fora, Servico de Ortopedia do Hospital Universitario, Juiz de Fora, Minas Gerais, MG, Brazil.

ABSTRACT

Objective: To evaluate patients with post-osteosynthesis infection (POI) in the appendicular skeleton, in a tertiary hospital, and to develop a care protocol for case management, based on cohort data and agreement between attending physicians. Method: primary, observational, retrospective and comparative study, evaluating cases of POI, from 2014 to 2019, assisted by the service. The outcomes analyzed were length of stay, readmission, fracture site, etiological agent, antibiotic therapy, number of surgeries and clinical outcome after one year (cure or failure, these considered recurrence, amputation or death). Based on this data, a protocol for diagnosing and treating POI was proposed to the institution's orthopedists, with responses assessed in terms of the content validity coefficient, in order to grade compliance with the protocol. Results: sample of 27 participants, mostly male, with infection in the lower limbs (77.8%), who underwent an average of two surgeries. The average length of stay was 48 days. The median duration of antibiotic therapy was 34 days. Patients with cure criteria used a greater amount of antibiotics compared to other cases ($p<0.05$). The responses of orthopedists to the management protocol for these cases reached a concordance of 0.91. Conclusion: The profile of patients and therapy to POI was similar to the literature and supported the development of the care protocol, with high agreement among developers. ***Level of Evidence III; Observational, Retrospective and Comparative Study.***

Keywords: Trauma; Fracture Fixation; Osteosynthesis, Fracture; Infections; Surgical Wound Infection.

RESUMO

Objetivo: Avaliar pacientes com infecção pós osteossíntese (IPO) no esqueleto apendicular, em um hospital terciário, e desenvolver um protocolo assistencial para manejo dos casos, baseado nos dados da coorte e na concordância entre médicos assistentes. Método: estudo primário, observacional, retrospectivo e comparativo, avaliando casos de IPO de 2014 a 2019, atendidos pelo serviço. Os desfechos analisados foram tempo de internação, local da fratura, agente etiológico, antibioticoterapia, número de cirurgias e desfecho clínico após um ano (cura ou falha, estes considerados recorrência, amputação ou óbito. Baseado nestes dados foi proposto aos ortopedistas da instituição um protocolo de diagnóstico e terapêutica de IPO, com respostas avaliadas quanto ao coeficiente de validade de conteúdo, para graduação da concordância ao protocolo. Resultados: amostra de 27 participantes, maioria do sexo masculino, com infecção nos membros inferiores (77,8%), submetidos em média a duas cirurgias. O tempo médio de internação foi 48 dias. A mediana do tempo antibioticoterapia foi de 34 dias. Pacientes com critérios de cura utilizaram maior quantidade de antibióticos se comparado aos demais casos ($p<0,05$). As respostas dos ortopedistas para o protocolo de manejo destes casos obtiveram concordância de 0,91. Conclusão: O perfil dos enfermos e da terapêutica à IPO foi semelhante à literatura e respaldou o desenvolvimento do protocolo assistencial, com alta concordância entre os desenvolvedores. ***Nível de Evidência III; Estudo observacional, Retrospectivo e Comparativo.***

Descritores: *Trauma; Fixação de Fratura; Osteossíntese; Infecção; Infecção de Ferida Operatória.*

Citation: Dias Junior JM, Cunha PHA, Paro MP, Pinheiro MM, Passos IBJ, Mendes Junior AF. Post-osteosynthesis infection: evaluation of a historical cohort and development of a care protocol. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 6. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Infection related to fractures is a serious complication in the management of skeletal muscle trauma, with impact on quality of life and significant socioeconomic consequences.[1] Post-osteosynthesis infection (POI) occurs in up to 5% after fixation of low-energy closed fractures and more than 50% after surgical treatment of exposed fractures.[2,3] The estimated cost is 6.5 times higher than for a patient without infection.[4] Furthermore, exposes the patient to prolonged hospitalization, the need for multiple surgeries and can result in adverse outcomes, such as recurrence of infection, amputation and even death.[5]

All authors declare no potential conflict of interest related to this article.

The study was conducted at Hospital Universitário of the Universidade Federal de Juiz de Fora (HU-UFJF), Rua Catulo Breviglieri, Santa Catarina, Juiz de Fora, MG, Brazil. Correspondence: Pedro Henrique Ananias da Cunha. Avenida Pereira Teixeira, Ibiapaba, Barbacena, Minas Gerais, MG, Brazil. 36202-000. pedrohenriqueananias@hotmail.com

Article received on 08/21/2023 approved on 03/12/2025.

There is little agreement on the best diagnostic and treatment criteria for POI, and discussing them is challenging for surgeons, microbiologists and infectologists.[5] A systematic review[1] of 3,711 POI cases, observed that nine different classifications have been described and multiple stages of treatment, most without standardization.[6] Therefore, it is necessary to evaluate the characteristics of the treatment of patients with POI and build an instrument for standardizing the diagnosis and conduct of these cases. The aim of this study is to identify and characterize patients diagnosed with POI of appendicular skeletal fractures in a tertiary hospital and develop a treatment protocol for this condition based on cohort data and agreement between the assisting physicians.

MATERIALS AND METHODS

This is a primary, observational, retrospective study of cases of post-osteosynthesis infection (POI), in a university hospital, tertiary level, and that was approved by the CEP institutional. All participants signed the Free and Informed Consent Clause – approval number of the ethics committee protocol CAAE 36755020.0.0000.5133.

The records were accessed on a digital platform and researched the records of adults admitted between January 1, 2014 and December 31, 2019, who underwent surgical treatment of fractures, with a minimum time of admission of seven days and whose codes for admission or identification corresponded to those of identified appendicular fractures or fractures of unspecified level of the upper and/or lower limb. Children under 18 years of age, those with spinal or pelvic fractures, those undergoing elective surgeries, cases of pathological fractures, those diagnosed with tumor diseases and or with prolonged hospitalization time due to clinical incidents not related to POI were excluded. The following, from this sample, evaluated as eligible participants those with diagnostic POI criteria according to Metsemakers[6] (see below).

From the sample data were cataloged such as gender, age, site of fractures, affected bone region (exclusive diaphyseal or non-exclusive diaphyseal), site of infection, number of surgeries performed, time of hospitalization, readmission, antibiotic used, total time of antibiotic therapy, etiological agents of infection, follow-up time and clinical outcome in the follow-up of at least one year. POI was categorized according to the time of onset of symptoms as acute (less than four weeks), or chronic.[7-9]

The age was divided into less than 30 years classified as young, between 30 and 59 years as adults and older than 60 years as elderly. Regarding the follow-up of fractured appendicular skeleton, they were divided into two groups: upper or lower limbs. Polyfractured individuals were defined as those presenting with more than one fracture site in the appendicular skeleton, regardless of concomitant injuries such as Traumatic brain injury (TBI) abdominal trauma, or spinal cord injury (SCI).

For the diagnosis of POI, the criteria of Metsemakers et al were used,[6] being confirmatory criteria: 1. Fistula; 2. Collection or rupture of the soft parts with exposure of the focus of the fracture or implant (medium communication with bone or implant); 3. Purulent drainage of the wound or the presence of pus during surgery; 4. Phenotypically similar pathogens, identified by culture from at least two separate bone/deep tissue fragments/implants (including sonication liquid) collected during an operational intervention or at least three tissue samples.

As suggestive POI criteria: clinical - pain (no weight support, increasing over time, new symptom), local redness, edema, temperature rise, fever (single temperature measurement of 38.3 C);[6] image - radiological signs of bone lyse (at the site of the fracture, around the implant), implant release, bone sequestration (occurring over time), failure in the progression of bone healing (not joining) and presence of periosteal bone formation (e.g., at different locations from the site of the fracture);[6] laboratory: positive culture (identification of a pathogenic organism from a tissue sample/implant, including sonication fluid evaluation); three laboratory markers, hemostasis sedimentation speed (HSS), white blood cell count (WBC) and reactive CPC.

The cure of the case was considered a good result, being defined as the resolution of the clinical signs of infection; a patient who did not evolve to amputation or death from this etiology. Already unfavorable result, one with recurrence of infection (fistulas, repeated abscesses, or radiographic sign of release of the implant), need for amputation of the affected limb or death due to the infectious cause. Rehabilitation for POI treatment was evaluated as a secondary outcome not related to cure or recurrence, as many cases received stagnant treatment in non-continuous scheduled interventions.

The data on soft parts or the degree of exposure of exposed fractures were not evaluated, as patients were referred to the reference service after primary care in another institution, where such a description was not routinely carried out by the care body. The cohort data were used in drafting a protocol for diagnostic and therapeutic POI (Annex I), proposed to nine assistant orthopedic doctors, which was answered in the period from February 2022 to March 2022.The agreement between the responses was evaluated and determined that if the agreement to the questionnaire obtained a value greater than 80%,[10] these criteria would be established as POI assistance protocol in the institution.

For descriptive statistics it was performed using the average and the standard deviation (minimum – maximum) for the continuous variables and proportions for the categorial variables. The variables hospital time and antibiotic use time were dichotomized based on the median value. The Qui-Quadrant test was used to test the association between qualitative variables, while the Pearson correlation test was used for quantitative variables. Student's t test was used to test differences between averages. The assumptions of normality and equality of variance were evaluated by the Komolgorov-Smirnov test and Levene test, respectively. The size of the effect (SE) was evaluated by Cohen's *d* and Cramer's V, adopting the classification proposed by (Cohen, 1992),[10] which is a measure of the magnitude of the difference between two averages, while Cramer's V evaluates the strength of the association between nominal variables. Cohen established criteria for interpreting these values as small, medium or large. The analyses were processed using SPSS software (IBM SPSS Statistics, version 22.0; IBM Corporation). The content validity coefficient (CVC), which is verified by the scale from 0 to 1, the following classification: less than 0.80, is considered unacceptable; from 0.80 to 0.90 as acceptable; above 0.90 as excellent the validity of content, proposed by Hernandez-Nieto (2002)[11] was used to evaluate the relevance of each item of the instrument and the instrument as a whole. The evaluators used a scale of 0 to 2 points to evaluate the level of relevance, being 0 = Disagrees, 1 = Agrees with reservations and 2 = Agrees. Items should have CVC $\geq$ 0.80.

RESULTS

Initial data were collected from 173 patients with fractures, of which those who presented a description of POI treatment and application of exclusion criteria totalized a sample of 27 patients. (Figure 1)

Participants were predominantly male, with an average age of 50 years. Most fractures (55.5%) occurred in the lower limbs. Infection sites were: femur (33.3%), tibia (33.3%), ankle/foot (11.1%), forearm/hand (11.1%), homer (7.4%) and radius (3.7%). The average hospitalization time was 48 days and each patient performed an average of two surgeries. Seventy percent of patients were readmitted, and approximately 93% had positive culture results. (Table 1)

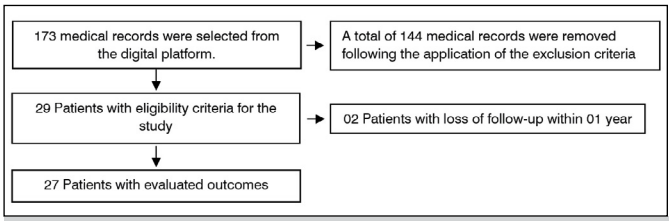


Figure 1. Summary of patient selection and follow-up.

Table 1. Sample characteristics (n = 27).

Variables	Average ± SD n	Minimum – Maximum %
Age (years)	49.7 ± 18.7	22.0 – 88.0
Sex		
Female	8	29.6%
Male	19	70.4%
Internship (days)	48.2 ± 27.6	17.0 – 123.0
Readmission (yes)	20	70.4%
fractured bone		
Arm/hand	3	11.1%
Humerus	2	7.4%
Femur	8	29.6%
Leg	2	7.4%
Foot/ankle	5	18.5%
Polytraumatized	7	25.9%
Membrane infection (yes)	10	37.0%
Location of infection		
Senior Members	6	22.2%
Lower members	21	77.8%
Germs in culture (yes)	25	92.6%
Surgery (no)	2.2 ± 2.8	0.0 – 15.0
Use of Antibiotics (days)	35.0 ± 15.1	15.0 – 74.0
Classes of antibiotics		
Cephalosporins (yes)	15	55.6%
Glycopeptides (yes)	10	37.0%
Aminoglycosides (yes)	6	22.2%
Penicillins (yes)	12	44.4%
Quinolones (yes)	10	37.0%
Other (yes)	21	77.8%
Outcome		
Cure	20	74.1%
Recurrence	4	14.8%
Amputation	2	7.4%
Death	1	3.7%

The germs found in the cultures, notably for *S. aureus* (n = 8; 29.6%), and polymicrobial infections (n = 7; 25.9%), as the most common results. The average antibiotic duration was 35 days and more than half of the patients (63.0%) used three classes of antibiotics. About 75% of patients showed good results, that is, they were cured. Seven patients had poor results (recurrence, amputation or death). Table 2 presents the variables associated with the patient's hospitalization time. The hospitalization time was longer for patients who had infection in the lower limbs. From a clinical point of view, the size of the observed effect was moderate. On the other hand, hospitalization time was not associated with the sex and age of the patient, the fracture region, the presence of germs in the culture, diaphyseal infection or even the number of classes of antibiotics used. The median time of antibiotic use was 34 days. No statistically significant explanatory variables were found for the duration of

Table 2. Variables associated with patient hospitalization time (n = 27).

Explanatory variables	Time of internation		p-value	SE
	<= 39 days	>39 days		
Sex				
Female (n=8)	50.0%	50.0%	0.71	0.07
Male (n=19)	57.9%	42.1%		
Age	46.8 ± 20.2	53.2 ± 16.8	0.38	0.34
Fracture region				
Senior Members (n=5)	100.0%	0.0%		
Lower Members (n=15)	46.7%	53.3%	0.08	0.43
Polytraumatized (n=7)	42.9%	57.1%		
Diaphyseal Infection				
No (n=17)	52.9%	47.1%	0.72	0.07
Yes (n=10)	60.0%	40.0%		
Infection site				
Lower Members (n=21)	42.9%	57.1%	0.01*	0.48
Senior Members (n=6)	100.0%	0.0%		
Germs in culture				
Yes (n=25)	56.0%	44.0%	0.87	0.03
No (n=2)	50.0%	50.0%		
Use of Classes of Antibiotics				
<=2 (n=10)	70.0%	30.0%	0.25	0.22
3 or + (n=17)	47.1%	52.9%		

SE: size of the effect;* represents values of p<0.05, by independent Student t test (quantitative variables) and by Qui-Quarter test (qualitative variables).

antibiotic use. A moderate and statistically significant positive correlation was observed between the number of days of antibiotic use and the time of hospitalization (r = 0.64; p<0.001; n = 27), suggesting that the longer the time of hospitalization, the greater the use of antibiotics.

The patients who used antibiotics for more than 34 days compared to those who used for a shorter period were those who stayed on average 60.1 ± 21.2 days interned compared to 37.2 ± 29 days interned for the rest (p = 0.03). There were no statistically significant differences between patients who were readmitted and those that were not readmitted.

When analyzed patients with cure (n=20) compared to others (recurrence, amputation or death), it was observed that the treated patients used a higher amount of cephalosporins (93.3% vs. 6.7%; p = 0.01; V = 0.49) and penicillin (100.0% vs. 0.0%; p = 0.02; V = 0.53). From a practical point of view, the size of the effect of this difference was moderate for the use of cephalosporin and large for the use of penicillin. For the other variables, age, sex, hospitalization time, antibiotic use time, fracture region, infection site, diaphyseal infection, germs in the culture and number of surgeries, no statistically significant differences were observed between the groups (p>0.05). (Table 3)

On the questionnaire (Annex I) offered to the nine orthopedists, all responded and the data of the content validity analysis are presented in Table 4. Regarding the relevance of the items, the instrument presented a content validity coefficient of 0.91, above the reference cutting point, with CVC variation of 0.83 to 1.00.

DISCUSSION

The results of the study highlighted the characteristics of the sample with post-osteosynthesis infection (POI) in the appendicular skeleton and facilitated the development of an assistance protocol, with high agreement among respondents. This initiative aims to standardize the diagnosis and treatment of POI, which is impactful after the treatment of traumatized patients, in order to decrease, after its implantation, the indicators of hospital stay and the consequent

Table 3. Variables associated with the clinical outcome of patients (n = 27).

Explanatory variables	Outcome		p-value	SE
	Healed (n = 20)	Recurrence, amputation or death (n=7)		
Sex				
Female (n=8)	62.5%	37.5%	0.63	0.17
Male (n=19)	78.9%	28.1%		
Age	46.7 ± 15.8	58.1 ± 24.7	0.17	0.
Internship (days)	43.7 ± 22.9	61.0 ± 37.2	0.16	
Surgery				
<=1 (n=15)	80.0%	20.0%	0.66	0.15
2 or + (n=12)	66.7%	33.3%		
Fracture Region				
Upper members (n=5)	60.0%	40.0%	0.60	0.19
Lower members (n=15)	73.3%	26.7%		
Polytraumatized (n=7)	85.7%	14.3%		
Diaphyseal Infection				
No (n=17)	70.6%	29.4%	0.68	0.10
Yes (n=10)	80.0%	20.0%		
Infection site				
Lower Members (n=21)	76.2%	23.8%	0.63	0.09
Senior Members (n=6)	66.7%	33.3%		
Germs in culture				
Yes (n=25)	72.0%	28.0%	0.97	0.17
No (n=2)	100.0%	0.0%		
Use of Antibiotics (days)	43.7 ± 22.9	61.0 ± 37.2	0.16	
Antibiotics class(yes)				
Cephalosporins (n=15)	93.3%	6.7%	0.01*	0.49
Glycopeptides (n=10)	70.0%	30.0%	0.71	0.07
Aminoglycosides (n=6)	83.3%	16.7%	0.56	0.11
Penicillins (n=12)	100.0%	0.0%	0.008*	0.53
Quinolones (n=10)	60.0%	40.0%	0.36	0.25
Other (n=21)	66.7%	33.3%	0.15	0.32

SE: size of the effect;* represents values of $p<0.05$, by independent Student t test (quantitative variables) and by Qui-Quarter test (qualitative variables).

Table 4. Content validity coefficient for questionnaire items for defining the infection treatment flow at the fractures fixation surgical site.

No	Items	Relevance
1	Protocol diagnostic criteria	89%
2	Classification of infections with less than 4 weeks as acute and more than 4 weeks as chronic	89%
3	Imaging evaluation with radiography for all patients	89%
4	Surgical treatment	100%
5	Empirical intravenous antibiotic therapy with vancomycin and cefepime	94%
6	Follow-up time of 1 year	83%
	CVC total scale	91%

CVC: Content validity coefficient.

economic impact on the individual and the institution. In the proper management of these patients, attention is needed to the infectious picture because it impacts on the time of hospitalization, morbidity, disability, increase in social security expenses and mortality.[12]

On the profile of patients with POI, it is noted that the sample of this study is compatible with the pattern observed in other developing and sub-developed countries, since the majority of patients correspond to adult males and the most common site of infection were the lower limbs (77.8%), mainly the femur (33.3%).[13] *S. aureus* is the main agent found in the microbiology of POI, reporting 29.6% of cases.[4] In the cohort prospectus of Kuehl et al., 229 patients with a diagnosis of osteosynthesis-associated infection (27.6%), identifying *S. aureus* as the most common pathogen in general (41.9%), while polymicrobial infections corresponded to 29.8%.[14] In addition, a similar percentage of infections caused by polymicrobial flora was observed (27.6%), consistent with the literature.

The patients who showed a good result (curation) accounted for 74.1% of the total, a lower percentage than the Swiss cohort (88.3%).[14] There was association between curation and use of two or more antibiotics in treatment, compared to other patients with poor outcome (recurrence, amputation or death), notably for cephalosporins and penicillins, which reinforces the value of combined therapy, with the goal of a broad spectrum treatment due to a high resistance rate of up to 30%.[15] Regarding readmission, it is understood that it can be used as a marker of treatment quality, but in this cohort was not considered an unfavorable outcome, since the patients were not necessarily readmitted for the treatment of the infectious background, e.g.

A statistically significant correlation between the number of days of antibiotic use and hospitalization time was expected, as venous antibiotic therapy is the main cause of hospitalization in these cases. The median hospitalization time was 48 days, the median use of antibiotics was 34 days. This data reinforces the need to optimize POI treatment, as the cost of infected cases can increase by 90% compared to uninfected cases,[15] and the costs associated with long-term hospitalization (admissions and readmissions) accounted for 62% of total POI costs in Tibia.[5]

The main aspects of the cohort result for the development of the POI assistance protocol were: criteria for confirmatory and suggestive diagnosis of the infection, classification as acute or chronic, image evaluation, surgical treatment, antibiotic therapy and total hospitalization time. Evolution time is an important aspect in the pathogenesis of POI, as the biofilm maturity occurs over weeks and determines the effectiveness of the antimicrobials; bone consolidation is crucial for the cure of infection and occurs over the course of weeks to months.[7] For standardization purposes, the time of differentiation between acute and chronic infection of the protocol was established as four weeks, despite the controversy of this temporal classification criterion and the minimum follow-up time one year. Despite the divergence of these two outcomes in the literature,[6] both achieved CVC of 89 and 83% respectively.

As a limitation of the study, we highlight the small number of patients, differentiation between closed fractures of exposed patients, absence of classification of fractures and non-evaluation of clinical comorbidities that could influence the outcome (such as diabetes mellitus and peripheral vascular diseases).[14] The main positive point was the development of a standardization to POI care. As future perspectives, the implementation of the protocol (Figure 2), resulting from the analysis of demographic results in accordance with the agreement of the assisting physicians, aims to decrease the average time of hospitalization, allowing for increased use of oral antibiotics replacing intravenous in some situations, with reduced days of hospitalization, and reduced costs.[16] This protocol will be the subject of a prospective study to be started after its implementation.

CONCLUSION

The characterization of post-osteosynthesis infection cases was similar to the literature and explained the items to be addressed in the development of the instrument. The high value of the content validity coefficient demonstrates high agreement with the proposed protocol, which was implemented in the institution.

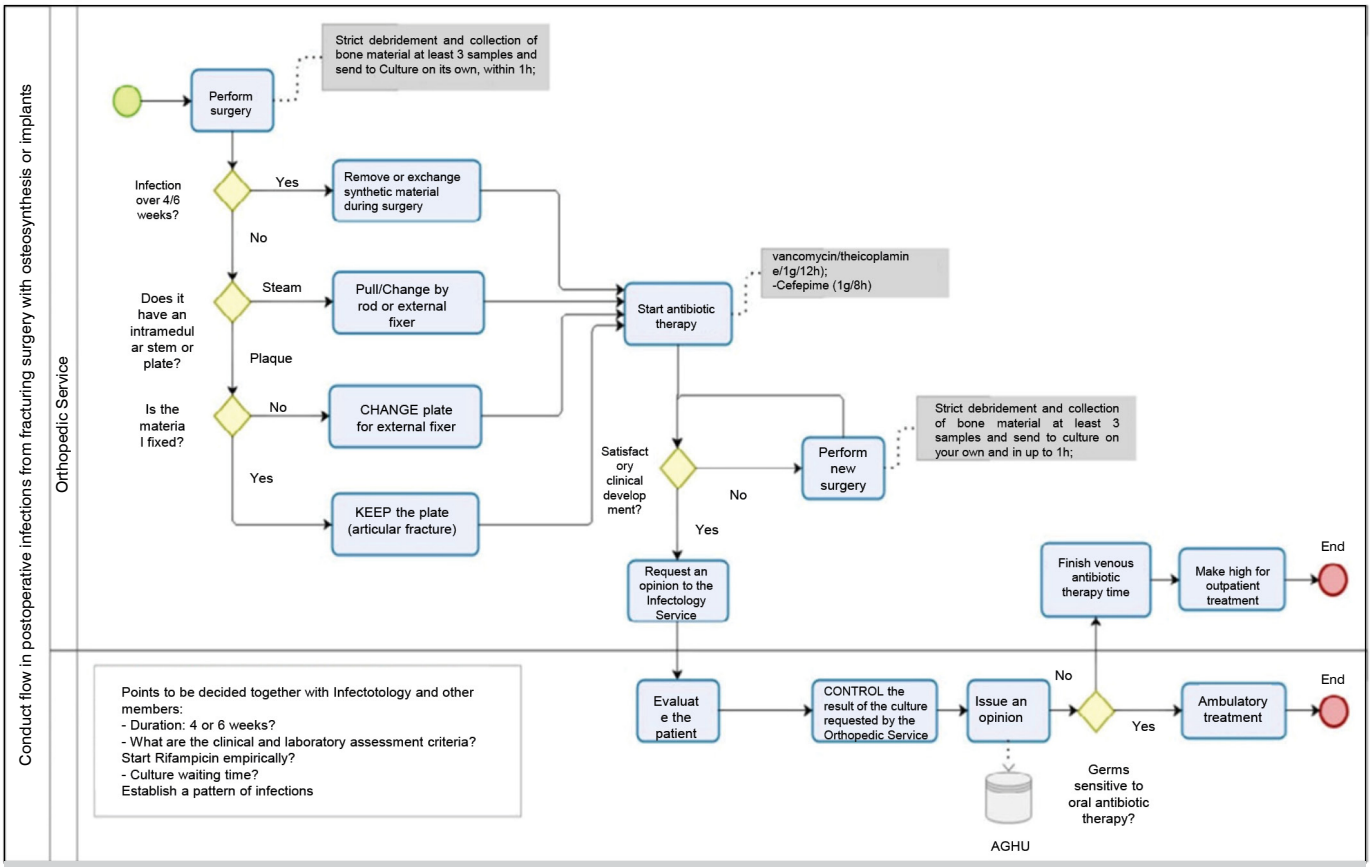


Figure 2. Fluxogram of post-osteosynthesis infections treatment protocol (POI).

AUTHOR'S CONTRIBUTION: Each author personally and significantly contributed to the development of this article: JMDJ: data collection, article writing and review; PHAC: data collection and review; MPP: data writing and review; MMP: Writing and collecting data; IBJP: writing and collecting data; AFMJ: article writing, statistical analysis and final review.

REFERENCES

1. Bezstarosti H, Van Lieshout EMM, Voskamp LW, Kortram K, Obremskey W, McNally MA, et al. Insights into treatment and outcome of fracture-related infection: a systematic literature review. Arch Orthop Trauma Surg. 2019;139(1):61-72. doi: 10.1007/s00402-018-3048-0.
2. Olesen UK, Pedersen NJ, Eckardt H, Lykke-Meyer L, Bonde CT, Singh UM, et al. The cost of infection in severe open tibial fractures treated with a free flap. Int Orthop. 2017;41(5):1049-1055. doi: 10.1007/s00264-016-3337-6.
3. Metsemakers WJ, Kuehl R, Moriarty TF, Richards RG, Verhofstad MHJ, Borens O, et al. Infection after fracture fixation: Current surgical and microbiological concepts. Injury. 2018;49(3):511-522. doi: 10.1016/j.injury.2016.09.019.
4. Metsemakers WJ, Smeets B, Nijs S, Hoekstra H. Infection after fracture fixation of the tibia: Analysis of healthcare utilization and related costs. Injury. 2017;48(6):1204-1210. doi: 10.1016/j.injury.2017.03.030.
5. Depypere M, Morgenstern M, Kuehl R, Senneville E, Moriarty TF, Obremskey WT, et al. Pathogenesis and management of fracture-related infection. Clin Microbiol Infect. 2020;26(5):572-578. doi: 10.1016/j.cmi.2019.08.006.
6. Metsemakers WJ, Morgenstern M, McNally MA, Moriarty TF, McFadyen I, Scarborough M, et al. Fracture-related infection: A consensus on definition from an international expert group. Injury. 2018;49(3):505-510. doi: 10.1016/j.injury.2017.08.040.
7. Zimmerli W, Sendi P. Orthopaedic biofilm infections. APIS. 2017;125(4):353-364. doi: 10.1111/apm.12687.
8. Willenegger H, Roth B. Treatment tactics and late results in early infection following osteosynthesis. Unfallchirurgie. 1986;12(5):241-6. German. doi: 10.1007/BF02586085.
9. Kleber C, Schaser KD, Trampuz A. KomplikationsmanagementbeiinfizierterOsteosynthese: TherapiealgorithmusbeiperiimplantärenInfektionen [Complication management of infected osteosynthesis: Therapy algorithm for peri-implant infections]. Chirurg. 2015;86(10):925-34. German. doi: 10.1007/s00104-015-0073-1.
10. Cohen J. A power primer. Psychol Bull. 1992;112(1):155-9. doi: 10.1037//0033-2909.112.1.155.
11. Hernandez-Nieto R. Contributions to Statistical Analysis.Carolina do Sul:Booksurge Publishing; 2002.
12. McQuillan TJ, Cai LZ, Corcoran-Schwartz I, Weiser TG, Forrester JD. Surgical Site Infections after Open Reduction Internal Fixation for Trauma in Low and Middle Human Development Index Countries: A Systematic Review. Surg Infect (Larchmt). 2018;19(3):254-263. doi: 10.1089/sur.2017.273.
13. Depypere M, Kuehl R, Metsemakers WJ, Senneville E, McNally MA, Obremskey WT, et al. Fracture-Related Infection (FRI) Consensus Group. Recommendations for Systemic Antimicrobial Therapy in Fracture-Related Infection: A Consensus From an International Expert Group. J Orthop Trauma. 2020;34(1):30-41. doi: 10.1097/BOT.0000000000001626.
14. Kuehl R, Tschudin-Sutter S, Morgenstern M, Dangel M, Egli A, Nowakowski A, et al. Time-dependent differences in management and microbiology of orthopaedic internal fixation-associated infections: an observational prospective study with 229 patients. Clin Microbiol Infect. 2019;25(1):76-81. doi: 10.1016/j.cmi.2018.03.040.
15. Thakore RV, Greenberg SE, Shi H, Foxx AM, Francois EL, Prablek MA, et al. Surgical site infection in orthopedic trauma: A case-control study evaluating risk factors and cost. J Clin Orthop Trauma. 2015;6(4):220-6. doi: 10.1016/j.jcot.2015.04.004.
16. Mokdad AH, Forouzanfar MH, Daoud F, Mokdad AA, El Bcheraoui C, Moradi-Lakeh M, et al. Global burden of diseases, injuries, and risk factors for young people's health during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2016;387(10036):2383-401. doi: 10.1016/S0140-6736(16)00648-6.

Annex 1. Question for defining the treatment flow of on-site infections.

Fixing fractures surgical

Confirmative criteria for post-osteosynthesis infections (1PO).
I. Fistula, collection or rupture of the soft parts with exposure of the focus of the fracture or implant (medium communication with bone or implant).
2. Purulent drainage of the wound or the presence of pus during surgery.
3. Phenotypically similar pathogens, identified by culture from at least two separate bone/deep tissue fragments/implants (including sonication liquid). Samples taken during an operational intervention. In the case of fabric, at least 3 samples must be sent, in appropriate means, each with clean instruments, do not carry out superficial harvest or fistulous route. In cases of arthritis in a joint adjacent to a fractured bone, fluid samples obtained by sterile puncture can be included for study.
4. Presence of microorganisms in deep tissues captured during the surgical intervention, confirmed by histopathology examination using specific coloring techniques for bacteria or fungi.

Suggestive 1PO criteria:
1. Clinical signs: Pain (no weight support, increasing over time, new symptom), local redness, local swelling, local temperature increase, fever (single temperature measurement of 38.3 C).
2. Radiological signs: bone lyse (at the site of fracture, around the implant), loosening of the implant, seizure (occurring over time), failure to progress bone healing (non-union), presence of periosteal bone formation (e.g., in different locations from the site of fracture)
3. A pathogenic organism identified by culture from a single tissue/implant sample (including sonication fluid), always following the proposed standards for collection and evaluation.
4. High serum inflammatory markers: in musculoskeletal trauma conditions, these should be interpreted with caution. They are included as suggestive signs in case of secondary increase (after an initial decrease) or consistent increase over a period, and after exclusion of other infectious or inflammatory focuses: Erythrocyte sedimentation rate (HSS). White Blood Cell Count (WBC), C-Reactive Protein (CRP)
5. Persistent, increasing or recent drainage beyond the first days after surgery, without other explanation.
6. Recent onset of joint stroke in patients with fracture. Surgeons should be aware that ICF may present itself as an adjacent focus for infectious arthritis in the following cases: Implant material that penetrates the joint capsule (e.g., femoral implant) and intraarticular fractures.
I agree ( )
I disagree ( )

Why?_____
_____

Pathogenesis/ Classification. [7-9]
The formation of biofilm on the surface of the implant or seizure material is crucial for the pathogenesis of infection in the presence of post-fractural implants.
The time for biofilm maturation is not yet fully established or follows a standard in the literature, so the classification of infections into acute (immature biofilm) and chronic infections (mature biofilm) is arbitrary in the treatment of POIs.
We established in our protocol that if the infection occurs within 4 weeks of surgery, we will characterize as acute and if it is more than 4 weeks, we will characterize as chronic.
I agree ( )
I disagree ( )
Why?_____
_____

Evaluation by Image: [6]
The imaging examinations, performing the conventional radiography in the routine and at the beginning of treatment, already the tomography, only in selected cases, for conducting our patients. We do not see practical applicability for the execution of magnetic resonance imaging.

I agree ( )
I disagree ( )
Why?_____
_____

Treatment: [3,10,11]
There is no treatment option for ICF without initial surgery, which aims to achieve the following: strict debridement as an essential step; collection of tissue samples for culture and histopathological examination, preferably taken directly from the bone at the fracture site; at least three samples should be collected; superficial swabs or fistulous tracts should never be evaluated.
We prioritize the time factor when deciding whether to keep, remove, or replace implant material, using 4 weeks as the cutoff point. An exception is made for intramedullary stems, which will be removed or replaced at any time due to the difficulty of debriding the medullary canal.
The use of antibiotics on site will not be used in all cases, it will be used to fill bone losses and will be done with cement with antibiotics.
I agree ( )
I disagree ( )
Why?_____
_____

Antibiotic therapy. [3,4,7,9]
After surgical debridement and obtaining tissue samples for culture, treatment should be initiated with empirical antibiotics.
As a rule, the initial empirical therapy should include an agent targeting gram-positive bacteria (such as a lipo- or glycopeptide) and an agent effective against gram-negative bacilli. The therapy should then be adapted according to the culture results as soon as possible, with ongoing support and monitoring by the infectious disease team. Maintained intravenously for at least 4 weeks, followed by oral administration, where possible, and outpatient treatment, up to a total of 6 to 12 weeks, depending on the maintenance of the implant.
I agree ( )
I disagree ( )
Why?_____
_____

Ambulatory follow-up (follow-up):
A year.
I agree ( )
I disagree ( )
Why?_____
_____

<< SUMÁRIO

DOI: http://dx.doi.org/10.1590/1413-785220253304e290649

PLATE USING CANCELLOUS GRAFT VERSUS SCREW USING CANCELLOUS CORTICAL GRAFT IN THE TREATMENT OF SCAPHOID PSEUDARTHROSIS

PLACA UTILIZANDO ENXERTO ESPONJOSO *VERSUS* PARAFUSO UTILIZANDO ENXERTO CÓRTICO ESPONJOSO NO TRATAMENTO DAS PSEUDOARTROSES DO ESCAFÓIDE

Erick Yoshio Wataya[1], *Antonio Isidoro Sousa Neto*[1], *Thales Augusto Tomé*[1], *Joao Carlos Nakamoto*[1], *Marcelo Rosa de Rezende*[1], *Rames Mattar Junior*[1]

1. Universidade de Sao Paulo, Faculdade de Medicina, Instituto de Ortopedia e Traumatologia (IOT HCFMUSP), Grupo de Cirurgia da Mao e Microcirurgia Reconstrutiva, Sao Paulo, SP, Brazil.

ABSTRACT

Objective: To make a comparative analysis of patients with scaphoid pseudarthrosis operated with screw and corticocancellous graft and patients operated with plate and cancellous graft only, in regards to consolidation, carpal stability and limb functionality. Methods: non-randomized retrospective cohort study. Nineteen patients with scaphoid pseudarthrosis without advanced collapse were included in the study, of which 9 patients operated with screw and corticocancellous graft (Group A) and 10 operated with plate using cancellous graft (Group B). The following were evaluated preoperatively and 12 weeks postoperatively: functional recovery using the visual analogue scale, range of motion, grip strength, digital pinch strength, DASH and MAYO wrist score functional scales. To assess carpal instability, the scapholunate and radiolunate angles were assessed on radiographs and the interscaphoid angle on CT. And the bone consolidation rate was assessed with CT in the 8th postoperative week. Results: group A with 90% and B with 100% consolidation rate, however the latter with a longer average time for consolidation - 9.7 weeks ($p = 0.002$). Improvement in pain intensity was achieved in both groups ($p = 0.03$). Increased pinch strength ($p=0.04$) and grip strength in group B and decreased in group A. The range of motion was superior in group B, with loss of ulnar deviation ($p=0.02$) and radial deviation ($p=0.007$) in group A. Regarding the MAYO wrist score, there was loss of function in group A and an increase in group B ($p=0.007$). There was correction of the scapholunate angle in both groups ($p=0.03$), with no difference between them. Conclusions: Patients in group B had better recovery of range of motion, pinch and grip strength, and better functionality according to the MAYO wrist score. ***Level of Evidence III; Study with an Almost-Experimental Design as a Non-Randomized Study with a Single Pre- and Post-Test Group. (Non-Randomized Retrospective Cohort).***

Keywords: Scaphoid Bone; Pseudarthrosis; Bone Plates; Bone Transplantation; Autografts.

RESUMO

Objetivo: comparar pacientes com pseudoartrose do escafóide operados com parafuso e enxerto córtico esponjoso e pacientes operados com placa e enxerto somente esponjoso em relação à consolidação, estabilidade carpal e funcionalidade do membro. Métodos: trabalho de coorte retrospectivo não-randomizado. Foram incluídos no estudo 19 pacientes com pseudoartrose do escafóide sem presença de colapso avançado, sendo 09 pacientes operados com parafuso e enxerto córtico esponjoso (Grupo A) e 10 operados com placa utilizando enxerto esponjoso (Grupo B). Foram avaliados no pré-operatório e com 12 semanas de pós-operatório: recuperação funcional através da escala visual analógica, amplitude de movimento, força de preensão, força de pinça digital, escalas funcionais de DASH e MAYO wrist score. Para avaliar a instabilidade carpal foram avaliados os ângulos escafolunar e radiolunar nas radiografias e o ângulo interescafóide na tomografia computadorizada (TC). E a taxa de consolidação óssea foi avaliada com TC na 8a semana pós-operatória. Resultados: grupo A com 90% e B com 100% de taxa de consolidação, porém este com maior média de tempo para consolidação- 9,7 semanas ($p = 0,002$). Melhora da dor em ambos os grupos ($p=0,03$). Aumento de força de pinça ($p=0,04$) e preensão no grupo B e diminuição no grupo A. O arco de movimento foi superior no grupo B, com perda de desvio ulnar ($p=0,02$) e desvio radial ($p=0,007$) no grupo A. Em relação ao MAYO wrist score, houve perda de função no grupo A e aumento no grupo B ($p=0,007$). Houve correção do ângulo escafolunar em ambos os grupos ($p=0,03$), sem diferenças entre si. Conclusões: pacientes do grupo B obtiveram melhor recuperação de arco de movimento, força de pinça e de preensão e melhor funcionalidade de acordo com o MAYO wrist score. ***Nível de Evidência III; Estudo com Delineamento quase-Experimental como Estudo sem Randomização com Grupo Único pré e Pós-Teste (Coorte Retrospectiva não-Randomizada).***

Descritores: *Osso Escafoide; Pseudoartrose; Placas Ósseas; Enxerto Ósseo; Autoenxertos.*

Citation: Wataya EY, Sousa Neto AI, Tomé TA, Nakamoto JC, Rezende MR, Mattar Junior R. Plate using cancellous graft *versus* screw using cancellous cortical graft in the treatment of scaphoid pseudarthrosis. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 8. Available from URL: http://www.scielo.br/aob.

All authors declare no potential conflict of interest related to this article.

The study was conducted at Instituto de Ortopedia e Traumatologia of the Hospital das Clinicas (HC-FMUSP), Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, SP, Brazil.
Correspondence: Erick Yoshio Wataya. 333, Rua Dr. Ovidio Pires de Campos, Sao Paulo, SP, Brazil. drerickyoshio@gmail.com

Article received on 09/27/2024 approved on 03/10/2025.

INTRODUCTION

Scapular fractures account for 60% of carpal fractures, including a high incidence in the overall rate of fractures that occur in the wrist,[1-3] being the waist region the most prevalent.[4]
Consolidation rates, when properly treated, reach almost 95%.[5] However, a neglected or not properly treated scaphoid fracture has non-consolidation rates around 5-10%.
Some factors related to the type of fracture such as: deviation, instability, proximal pole; can raise this percentage of non-union to 90%.[5]
The pseudarthrosis of the scapula represents a challenge to traumatic handles. The evolution to advanced carpal collapse (SNAC) leads to a significant decrease in wrist function as well as quality of life, as this evolution is associated with constant pain.
In terms of anatomy and biomechanics, the scaphoid tends to flex in relation to the semilunar, while the pyramid tends to extend. After scaphoid pseudarthrosis, the proximal pole tends towards extension, since it is connected to the proximal carpal row by the scapholunate (SL) and dorsal inter metacarpal (DIC) ligaments, while the distal pole tends to adopt a flexion deviation. This biomechanical imbalance leads to humpback deformity of the scaphoid and DISI deformity (Dorsal Intercalated Segment Instability).[6]
The objectives of the treatment of of the scaphoid are: to correct the normal alignment of the scaphoid to restore the biomechanical of the wrist and to obtain rigid stabilization of the fragments with osteosynthesis, using vascularized or non-vascularized graft.[6-8] If the general principles of treatment are not applied, the kinematic alteration of carpal bones can lead to arthrosis, producing pain and decreased function.[9-12]
Regarding the biomechanical aspects in the comparison between plate and screw, there is no difference between the two methods when used in bones with standard densities, however, in cases of low bone density, the plate proved superior.[13] In a study conducted on corpses, the plate also proved more effective, showing greater rigidity when load applied.[14]
In general terms, the use of the plate for the treatment of pseudarthrosis of the scaphoid has some advantages: greater rotational stability and rigidity,[15] gold standard if reoperation is needed,[16,17] and for cases with instability,[18] effective humpback correction,[19] favorable postoperative DASH score,[17] and is effective if there is focal cominution.[20]
Some disadvantages of using the plate include: longer period of post-operative immobilization due to the risk of impact of the plate with the flying surface of the radio,[21] not suitable for pseudarthrosis of the proximal pole due to the risk of impact,[19] lower amplitude of movement and grip force in the first 3 months of post-operative.[22]
In screw fixation, the tri cortical cancellous cortical graft plays a fundamental role in the correction of humpback deformity, in the maintenance of the anterior support and in the alignment of the scaphoid as described by Fernandez et. al. (1990).[23]
There is still no consensus as to whether the new method of plaque fixation using only cancellous graft is superior to the conventional method described by Fernandez et. al. (1990).[23]
This study aims to compare patients with pseudarthrosis of the scaphoid operated with screw using cancellous cortical graft with patients operated with plaque using cancellous graft only regarding:
- Consolidation time;
- Humpback correction;
- Pain, amplitude of movement, grip force, pinch strength and functional scales;
- Complications: Infection, plate impact, stiffness.

MATERIALS AND METHODS

This study was conducted at the IOT - HC/FMUSP. Non-randomized retrospective cohort work. The study included 10 patients operated with screw and cancellous cortical graft (Group A) and compared with 10 patients operated with plaque, however, using only cancellous graft (Group B). The patients were operated between January 2018 and May 2023, by different surgeons, all seniors and familiar with the surgical technique.
Inclusion criteria:
- Pseudoarthrosis of Alnot[24] type IIB and IIIA squamous collar (Table 1)
- No prior surgery
- No other injury to the upper limb
- Minimum of 6 months of development

Exclusion criteria:
- Loss of patient tracking.
- Advanced degenerative framework - SNAC type III
- Cases without all imaging tests
- Cases without functional evaluations in the scheduled time

The pre- and postoperative clinical evaluation data were evaluated for:
- Pain intensity (analog visual scale)
- Amplitude of movement (goniometry)
- Stretch force (Jamar)
- Digital pinch strength
- Functional scales of DASH and MAYO wrist score,[26] in preoperative and 12 weeks postoperative

They were also evaluated radiographically in pre and postoperative with:
- X-rays of both wrists in the incidences: front, with ulnar deviation, profile and obliques in the preoperative, with 3, 6 and 12 weeks postoperative; where the escapular and radiolunar angles were measured.
- Preoperative computed tomography (TC) to evaluate the presence of carpal collapse and measure the inter scaphoid angle
- CT with 8 weeks of postoperative to evaluate consolidation.

Presence of bone bridge between the graft and the proximal and distal poles at 8 weeks was considered a consolidation criterion in the evaluation. In the absence of this finding, the patient was re-evaluated every 4 weeks until showing signs of consolidation in CT.

Table 1. Classification of pseudarthrosis according to the Alnot system.[25]

Grade I		No linear union, no alteration of the shape of the scaphoid, instability or poor carpal alignment
Grade II	II A	No stable bond with small bone reabsorption on the fracture line, no instability or poor carpal alignment.
	II B	Non-mobile bond with anterior defect and proximal pole flexion under the tubercle of the scaphoid, with the presence of DISI
Grade III	IIIA	Non-mobile bond with carpal instability or poorly aligned redutile with radial-styloid arthrosis isolated
	III B	Non-mobile bond with deviation and instability or poorly aligned redutile, with fossa arthrosis of the scaphoid or intracarpal
Grade IV	IV A	Necrosis of the proximal fragment with poor carpal alignment
	IV B	Necrosis of proximal fragment with fossa arthrosis of the scaphoid or intra carpal

In the postoperative period, it was established the use of gessed tail or antebrachiopolegar orthesis until the presence of consolidation as a rehabilitation protocol.

Surgical technique

Patients in horizontal dorsal decubitus undergoing general anesthesia and regional blockage, inflated pneumatic tourniquet at 250 mmHg. Via volar in the wrist (via de Russe), with capsulotomy for access to the joint and the scapula, preserving ligament insertion. (Figure 1)

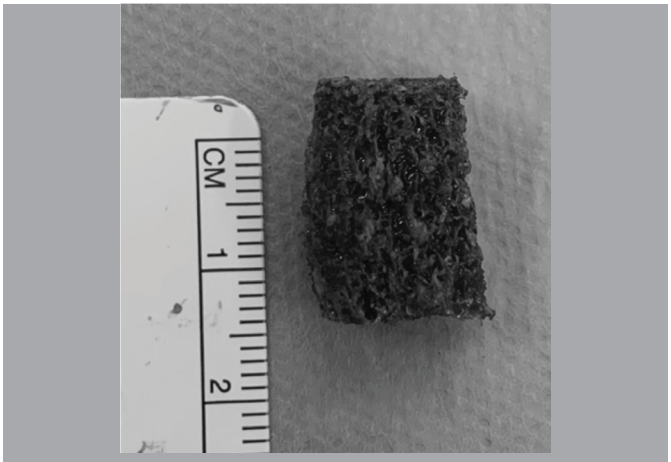
With the scaphoid exposed, the focus of pseudarthrosis was cruentized until viable bone with good vascularization was present. (Figure 2)

Performed reduction of the scaphoid and calculated the size of the graft required. Structured cancellous cortical bone graft from the iliac (Group A) was extracted. In Group B the tri cortical area was removed, remaining only the cancellous graft in a block, in a structured way. (Figure 3)

The cancellous cortical graft was inserted into the bone defect and fixed with 2.2mm Speed Tip Cannulated Compression Screws (CCS) with radioscopy. (Figure 4A and 4B)

In group B, only cancellous graft was used in the focus of pseudarthrosis (Figure 5) and the fixation with low profile Tri-lock"® plates of 1.5 mm for Medartis scaphoid. (Figure 6)

After the osteosynthesis, joint mobility test and capsuloraphia were performed on the synthesis. Disinflated the tourniquet, carried out hemostasis, cleaning and suturing by planes.

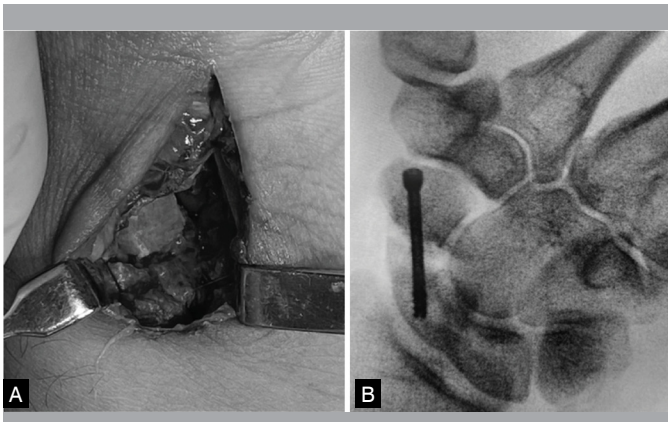


Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 3. Structured only cancellous bone graft after cortical bone resection.

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 1. Volar view showing the focus of pseudarthrosis.



Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

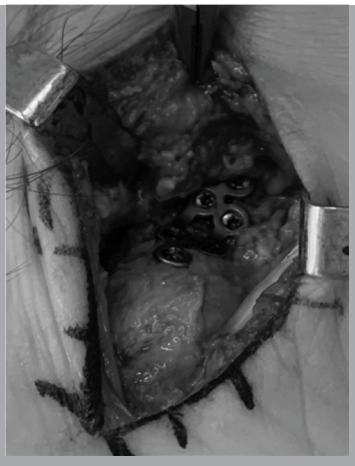
Figure 4. A) Cancellous cortical graft in the focus of pseudarthrosis (Group A). B) Fixation with canulated screw.

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 2. Resecated pseudarthrosis focus demonstrating viable bone.

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 5. Cancellous-only graft in the focus of pseudarthrosis (Group B).



Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 6. Osteosynthesis of the escafoid with blocked plate.

Statistical analysis

Based on the study by Beaton et al. (2001),[27] was defined the clinically important minimum difference (MCID – Minimum clinically important difference) for one of the following variables: obtaining consolidation, correction of deformity of the scapula and MAYO wrist score. A 5% alpha error and 80% statistical power were established. There are no prospective works of this nature, which makes the sample calculation difficult. We chose a convenience sample of 20 patients.

The quantitative data were submitted to the evaluation of normal distribution by the Shapiro-Wilk test and expressed as average, standard deviation, median, maximum and minimum values and sample size. For the comparison between quantitative data, the Student T test was used when normal (parametric) distribution and the Mann-Whitney U test for nonparametric data.

The qualitative data were demonstrated as frequencies and percentiles. For the comparison between qualitative data, we will use the qui-square test.

In the data comparison, a significance level of 5% (alpha = 0.05) was used, and the values of $p < 0.05$ were considered statistically significant.

Ethical Approval

This study was approved by the Institutional Ethics Committee under the opinion number 6.877.718 and the Terms of Free and Informed Consent was signed by all participants prior to the study.

RESULTS

19 patients were included in the study, including 09 from Group A (glass with cancellous cortical graft) and 10 from Group B (plaque with cancellous graft). One patient in Group A was excluded for loss of follow-up. The mean time from the date of the trauma to the date of surgery was 14 months for group A and 19 months for group B. 05 patients in Group A had pseudoarthrosis of the escafoid in their dominant hand, which occurred in 07 of the 10 patients in Group B. (Tables 2 and 3)

There was one case of non-consolidation in Group A due to implant failure. In the other cases, pseudoarthrosis was consolidated in CT at 08 weeks. All cases in Group B consolidated, however, in two cases, there was only evidence of consolidation in CT at 12 weeks (Figure 7 and 8) and one case at 16 weeks, with an average of 9.7 weeks, with statistical significance ($p = 0.002$).

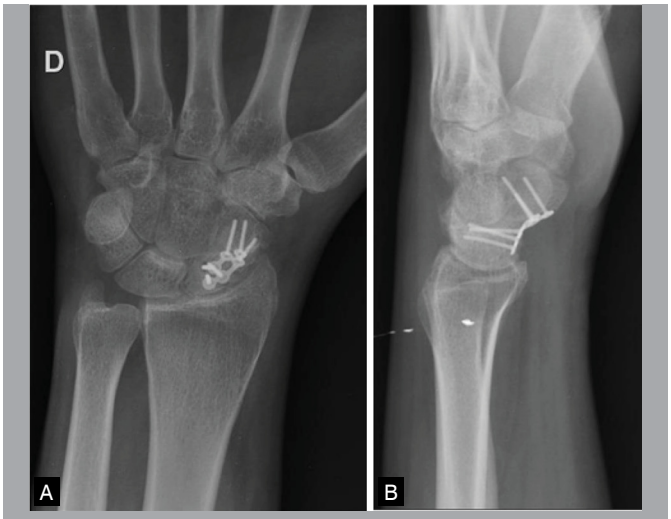
In relation to the dynamometry, the grip strength of the wrist, the digital and triple pinch strength were evaluated. In the preoperative evaluation, the initial measurements of strength were higher in Group A. Thus, the comparison was chosen in relative and non-absolute

Table 2. Epidemiological profile of the group of patients fixed with plaque + cancellous graft.

Patient	Dominance	Side Operated	Profession	Time since the trauma	Trauma mechanism
1	Right-handed	Right	Driver	8 months	Entorse of hand
2	Right-handed	Left	Manager of confectionery	6 months	Fall
3	Right-handed	Right	Mason	1 year and 6 months	Height drop (roof)
4	Right-handed	Left	Seller	2 years	Falling during sports (football)
5	Right-handed	Left	Machine Operator	1 year and 2 months	Motorcycle fall
6	Right-handed	Right	Glassman	1 year	Fall
7	Right-handed	Right	Delivery	2 years	Motorcycle fall
8	Right-handed	Right	Shelf storage	6 months	Falling during sports (basket)
9	Right-handed	Left	Unemployed	1 year and 5 months	Motorcycle fall
10	Right-handed	Left	Secretary	1 year and 8 months	Falling during sports (football)

Table 3. Epidemiological profile of the group of patients fixed with screw + cancellous cortical graft.

Patient	Dominance	Side Operated	Profession	Time since the trauma	Trauma mechanism
1	Right-handed	Right	Delivery	6 years	Motorcycle Accident
2	Right-handed	Right	Student	6 months	Motorcycle Accident
3	Right-handed	Left	Machine Operator	2 years	Fall
4	Right-handed	Right	Entrepreneur	1 year and 8 months	Motorcycle Accident
5	Right-handed	Right	Manual worker	1 year and 9 months	Fall
6	Right-handed	Left	Police	9 months	Falling during sports (football)
7	Right-handed	Left	Seller	1 year and 8 months	Fall
8	Left-handed	Left	Security	8 months	Fall
9	Right-handed	Right	Unemployed	1 year and 9 months	Motorcycle Accident
10	Right-handed	Right	Manual worker	1 year and 1 month	Fall



Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 7. Postoperative X-ray of pseudoarthrosis fixation.

values. At the end of the evaluation, the average grip and pince strength were higher in Group B (p=0.04). There was loss of grip and pinch strength in Group A in the postoperative evaluation, even after the consolidation of pseudarthrosis. Already in Group B, there was gain in all dynamometry parameters.

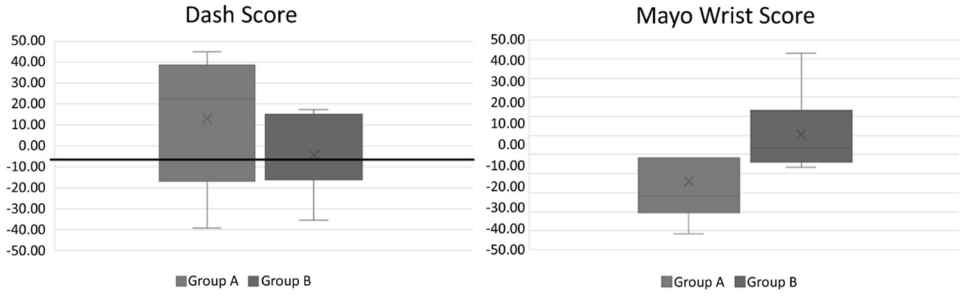
On average, there was a loss of 14% of grip strength in patients in Group A and a gain of 27% of grip strength in patients in Group B in the post-operative evaluation. Regarding pinch strength, there was a loss of 12% for Group A and a gain of 31% for Group B. There was a gain of 47% triple pinch for both groups.

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 8. Postoperative pseudoarthrosis fixation tomography with 02 months of evolution, still without signs of bone bridge. B and C: post-operative tomography of pseudoarthrosis fixation with 03 months of evolution, with presence of bone bridge in the coronal plane and flight in the sagital plane.

The goniometry was evaluated in four parameters: flexion, extension, ulnar deviation and radial deviation of the wrist, and the relative values were considered for comparison. Even after the consolidation of pseudoarthrosis, there was loss of movement arc in all criteria of Group A and gain in all criteria of Group B. In relation to Group A, there was loss of 30% of wrist extension, 16% of flexion, 14% of ulnar deviation (p=0.02) and 13% of radial deviation (p=0.007). In relation to Group B, there was an increase of 29% in the extension of the wrist, 18% in the flexion, 21% in the ulnar deviation and 75% in the radial deviation.

Patients were evaluated by MAYO wrist score in preoperative and 12 weeks postoperative. There was a 14% deterioration in Group A score and a 52% improvement in Group B score (p=0.007). In relation to the DASH score, there was improvement in the parameters in both groups, being 14% in group A and 40% in group B. (Figure 9)



Patient			Mayo Wrist Score		Dash Score						Visual Analogue Scale	Mayo Wrist Score	Dash Score
			Preop	Posop	Preop	Posop						Group H	
1H	7		55	70	25	17.24				Average	0.00	0.36	0.00
2H	3	1	65	40	32.5	48.33	-0.5	-12.14	-0.10	SD	2.43	29.62	32.14
3H	3	0	30	15	56.66	68.33	-1.5	-2.14	23.49			Group V	
4H	5	0	90	65	41.66	11.66	-3.5	-12.14	19.33	Average	-0.94	25.08	-17.29
5H	3	2	15	60	73.21	13.33	0.5	57.86	-22.34	SD	3.54	19.70	17.91
6H	5	7	50	35	30.83	55	3.5	-2.14	-52.22				
7H	4	4	75	35	35	22.4	1.5	-27.14	31.83				
8H	8		80	65	15.83	9.16							
9H	4		60		43.18								
1V	3	5	70	65	51	20.83	3.5	7.86	-35.52				
2V	6	6	55	75	70.83	15	1.5	32.86	-22.51				
3V	8	0	15	70	65.83	36.6	-6.5	67.86	-48.17				
4V	6	7	75	70	65.83	62.5	2.5	7.86	-21.57				
5V	6	0	60	90	56.66	32.25	-4.5	42.86	4.33				
6V	6	0	55	60	26.66	21.66	-4.5	17.86	-16.75				
7V	4	4	65	70	35.88	30	1.5	17.86	2.66				
9V	8	6	65	65	69.16	41.66	-0.5	12.86	1.78				
10V	7	4	65	70	60.83	25	-1.5	17.86	-19.84				

Figure 9. Comparison between groups by DASH and Mayo wrist score after 12 weeks.

There was an improvement in the intensity of pain in both groups in the Analogous Visual Scale evaluation (p=0.03), with no significant difference between the groups.

Pre- and post-operative radiographic parameters were evaluated, with emphasis on the scapular angle due to its importance for the correct reduction of the scapula and consideration for carpal stability. There were two cases in each group where the angle, even in the postoperative X-rays, was above the normal range. In relation to the overall average, in Group A there was reduction of the angle from 71° to 60° (upper limit of normality), with statistical significance (p=0,03), and in Group B reduction from 57° to 47°.

In relation to the radiolunar angle, used to evaluate the correction of deviation in DISI, there was improvement in parameters in both groups, with no significant difference. In Group A, the preoperative average angle was 17.6°, with correction to 13.75° in the postoperative period. Group B showed improvement from 22° to 19° on average in the postoperative period.

Another parameter for evaluating postoperative reduction is the interescafoid angle, measured in the sagital plane of preoperative CT and with 08 weeks of evolution. There was a significant improvement in the angle in all cases operated, with one case of Group B keeping values above the normal consideration, but with expressive improvement. In Group A, the average angle values were 52° in preoperative and 17° in postoperative. In Group B, the reduction was from 50° to 34° after surgery.

DISCUSSION

In relation to the post-operative evolution in the first 12 weeks, both for movement arc and for the evaluation of strength and function of the hand, a superiority of the plate compared to the use of the screw was observed, with better rates in functional evaluations and early return to activities. It is possible that the anterior support in the escafoid provided by the plate and the improvement in angular stability in the correction of carpal alignment angles have provided a clinical improvement in strength and mobility parameters.

The volar plates for pseudarthrosis of scaphoid were described in 1993 by Braun et al.[28] There are studies that evaluated the use of scaphoid plates in complex cases of pseudarthrosis after fixation with auto-compressive screws and cases with severe deformity of *humpback*.[16,18,29,30] Esteban-feliu et al described cases with use of volar plates with 87% consolidation rate in 15 patients.[25]

Regarding the consolidation rates in the cases of osteosynthesis with screws and cancellous cortical graft, the conventional method for primary pseudarthrosis, the literature demonstrates good consolidation rates, around 84 to 95%,[31] similar to our study, in which 90% of cases consolidated.

Ghoneim described 14 cases of plaque-treated pseudarthrosis, with an average of 16.5 months of evolution, with a 93% consolidation rate, which took an average of 3.8 months.[18] Other studies show rates ranging from 72%,[32] to 100%,[16] with plaque use. In our study, we obtained a 100% consolidation rate, similar to the data demonstrated.

When compared, the two methods show no statistical difference in consolidation rate,[32] thus being equally effective in bone consolidation, however, the cases fixed with plaque and cancellous graft showed faster consolidation and greater correction of the *humpback*.[33]

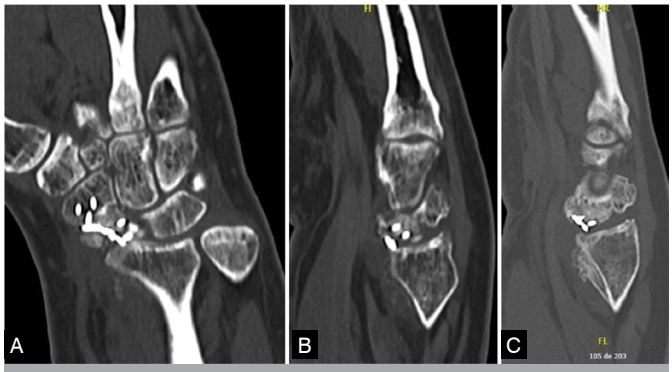
The pure cancellous graft, due to its osteogenic, osteoinductive and osteocondutory capacity,[34] showed superior consolidation rates when used with screw osteosynthesis.[35] In the cases associated with plaque osteosynthesis, in addition to the satisfactory consolidation rates, it also presented better angular correction of the scaphoid and better functional return of pinch strength and grip.[36] Putnam et al[37] presented the best consolidation rates in cases of pseudarthrosis of the scaphoid, using plaque fly with cancellous graft, with 100% consolidation rate in 26 cases, with up to 18 weeks of follow-up.

The anatomical shape of the squamous plate has been shown to be useful for the reduction of pseudarthrosis fragments, especially in the correction of the *humpback* and other deformities, in addition to allowing better support for the graft when it is not cortical. Another concern with the use of self-compressive screws is the possible rotational deviation of the escape, which can be avoided with the plate. A disadvantage described with the use of the board is the friction of the board with the flying surface of the radio. Although the low profile of the plaque mitigates this complication, the clinical experience of the study showed that if it is not properly positioned on the scapula, it can cause friction on the flying edge of the radio, especially to grip and flexion of the wrist. In cases of non-consolidation of the proximal pole of the escafoid, friction of the plate with the radio may occur in an attempt to fit the plate for fixation of the proximal pole fragment. In one case of group B, although the fracture was from the neck of the scapula, for better fixation and reduction, the plate was positioned in a more proximal topography, causing friction with the radio (Figure 10 and 11). In this case, the patient evolved with pain to the flexion of the wrist and the plaque was removed after consolidation.

There were 02 cases of plaque-related complications: 01 case of plate rupture and 01 case of plate screw release, both after pseudarthrosis consolidation (Figure 12). Esteban-feliu et al. reported 04 cases of complications associated with the plaque, including 01 cases of plaque breakage and 03 cases of release of screws from the plaque. This study followed patients for 03 years.[30]

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 10. Postoperative pseudarthrosis fixation X-ray of the scapula.



Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 11. Postoperative pseudarthrosis arthrosis fixation tomography of the proximal pole of the scaphoid with 08 weeks of evolution, evidencing the impact of the plaque on the volar surface of the radio.

Source: Photo by Erick Yoshio Wataya, Institute of Orthopaedia and Traumatology of HCFMSP, São Paulo, Brazil.

Figure 12. X-rays showing plaque C fracture: tomography with evidence of bone consolidation in the case of plaque fracture.

Other symptoms described when using the plate are pain to mobilize the wrist, stinging and cold intolerance.[19] Although there were no complaints of stinging, post-operative pain was a common complaint, although there was no statistical difference between the mean pain, taking into account the Analogous Visual Scale (p=0.03) in both groups.

The study presented limitations in relation to the short follow-up time of the patients, which may have been insufficient to define late complications, especially in relation to the use of the plate with the impact and pain when flirting the wrist. The sample was also small and insufficient to determine comparisons with statistical significance in some of the parameters used. The surgeries were performed by different surgeons, all senior and familiar with the technique, but this can also be considered a limitation of this study. However, despite the limited sample, this study was able to evaluate parameters that attest to the functionality of the limb after surgery and compare the two groups with statistical significance favorable to the use of the plaque. In addition, it is a study that compares, in an unprecedented way, clinical, functional and radiological aspects of the standard and most common technique through the use of cancellous cortical graft plus fixation with screw; with the latest technique, using cancellous graft plate.

CONCLUSION

The present study favors the use of cancellous graft plates over the screw and cancellous cortical graft technique with consolidation rates in 100% of cases, but with a higher average time for consolidation. Patients using the plate obtained better postoperative recovery, with greater movement arc, better pinch recovery and grip strength and better functionality according to MAYO wrist score.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article. EYW: performing the interventions and writing the article; AISN: analysis of the results and writing the article; TAT: collecting data and writing the article; JCN: performing the interventions and review of the article; MRR: performing the interventions and review of the article; RMJ: performing the interventions and review of the article.

REFERENCES

1. Duckworth AD, Jenkins PJ, Aitken SA, Clement ND, Court-Brown CM, McQueen MM. Scaphoid fracture epidemiology. J Trauma Acute Care Surg. 2012;72(2):E41-5. doi: 10.1097/ta.0b013e31822458e8.
2. Hove LM. Epidemiology of scaphoid fractures in Bergen, Norway. Scand J Plast Reconstr Surg Hand Surg. 1999;33(4):423-6. doi: 10.1080/02844319950159145.
3. Van Tassel DC, Owens BD, Wolf JM. Incidence estimates and demographics of scaphoid fracture in the U.S. population. J Hand Surg Am. 2010;35(8):1242-5. doi: 10.1016/j.jhsa.2010.05.017.
4. Dias J, Brealey S, Cook L, Fairhurst C, Hinde S, Leighton P, et al. Surgical fixation compared with cast immobilisation for adults with a bicortical fracture of the scaphoid waist: the SWIFFT RCT. Health Technol Assess. 2020;24(52):1-234. doi: 10.3310/hta24520.
5. Alshryda S, Shah A, Odak S, Al-Shryda J, Ilango B, Murali SR. Acute fractures of the scaphoid bone: Systematic review and meta-analysis. Surgeon. 2012;10(4):218-29. doi: 10.1016/j.surge.2012.03.004.
6. Mathoulin CL, Arianni M. Treatment of the scaphoid humpback deformity - is correction of the dorsal intercalated segment instability deformity critical? J Hand Surg Eur. 2018;43(1):13-23. doi: 10.1177/1753193417739526.
7. Nakamura R, Horii E, Watanabe K, Tsunoda K, Miura T. Scaphoid non-union: factors affecting the functional outcome of open reduction and wedge grafting with Herbert screw fixation. J Hand Surg Br. 1993;18(2):219-24. doi: 10.1016/0266-7681(93)90114-u.
8. Warren-Smith CD, Barton NJ. Non-union of the scaphoid: Russe graft vs Herbert screw. J Hand Surg Br. 1988;13(1):83-6. doi: 10.1016/0266-7681_88_90060-5.
9. Burgess RC. The effect of a simulated scaphoid malunion on wrist motion. J Hand Surg Am. 1987;12(5 Pt 1):774-6. doi: 10.1016/s0363-5023(87)80067-9.
10. Amadio PC, Berquist TH, Smith DK, Ilstrup DM, Cooney WP 3rd, Linscheid RL. Scaphoid malunion. J Hand Surg Am. 1989;14(4):679-87. doi: 10.1016/0363-5023(89)90191-3.
11. Nakamura R, Hori M, Horii E, Miura T. Reduction of the scaphoid fracture with DISI alignment. J Hand Surg Am. 1987;12(6):1000-5. doi: 10.1016/s0363-5023(87)80097-7.
12. Capito AE, Higgins JP. Scaphoid overstuffing: the effects of the dimensions of scaphoid reconstruction on scapholunate alignment. J Hand Surg Am. 2013;38(12):2419-25. doi: 10.1016/j.jhsa.2013.09.035.
13. Goodwin J, Castañeda P, Drace P, Edwards S. A Biomechanical Comparison of Screw and Plate Fixations for Scaphoid Fractures. J Wrist Surg. 2018;7(1):77-80. doi: 10.1055/s-0037-1606123.
14. Goodwin JA, Castañeda P, Shelhamer RP, Bosch LC, Edwards SG. A Comparison of Plate Versus Screw Fixation for Segmental Scaphoid Fractures: A Biomechanical Study. Hand (N Y). 2019;14(2):203-208. doi: 10.1177/1558944717732065.
15. Jurkowitsch J, Dall'Ara E, Quadlbauer S, Pezzei C, Jung I, Pahr D, et al. Rotational stability in screw-fixed scaphoid fractures compared to plate-fixed scaphoid fractures. Arch Orthop Trauma Surg. 2016;136(11):1623-1628. doi: 10.1007/s00402-016-2556-z.
16. Leixnering M, Pezzei C, Weninger P, Mayer M, Bogner R, Lederer S, et al. First experiences with a new adjustable plate for osteosynthesis of scaphoid nonunions. J Trauma. 2011;71(4):933-8. doi: 10.1097/TA.0b013e3181f65721.
17. Ansari SA, Kennedy JA, Younis F. Postoperative Outcomes of Volar Plate Fixation in Cases of Scaphoid Deformity or Nonunion: A Case Series. J Wrist Surg. 2020;9(4):304-311. doi: 10.1055/s-0040-1710383.
18. Ghoneim A. The unstable nonunited scaphoid waist fracture: results of treatment by open reduction, anterior wedge grafting, and internal fixation by volar buttress plate. J Hand Surg Am. 2011;36(1):17-24. doi: 10.1016/j.jhsa.2010.10.003.
19. Eng K, Gill S, Hoy S, Shridar V, Van Zyl N, Page R. Volar Scaphoid Plating for Nonunion: A Multicenter Case Series Study. J Wrist Surg. 2020;9(3):225-229. doi: 10.1055/s-0040-1702199.
20. Quadlbauer S, Pezzei C, Jurkowitsch J, Krimmer H, Sauerbier M, Hausner T, et al. [Palmar angular stable plate fixation of nonunions and comminuted fractures of the scaphoid]. Oper Orthop Traumatol. 2019;31(5):433-446. German. doi: 10.1007/s00064-019-00623-0.
21. Muirhead C, Talia A, Fraval A, Ross A, Thai D. Early mobilization vs delayed mobilisation following the use of a volar locking plate with non-vascularized bone graft in scaphoid non-union. A multicentred randomised controlled-trial. J Orthop. 2021;23:203-207. doi: 10.1016/j.jor.2021.01.002.
22. Burgos FH, Nakamoto JC, Nakamoto HA, Iwase FDC, Mattar R. Treatment Of Schaphoid Nonunion With Volar Locked Plate. Acta Ortop Bras. 2019;27(3):141-145. doi: 10.1590/1413-785220192703214849.
23. Fernandez DL. Anterior bone grafting and conventional lag screw fixation to treat scaphoid nonunions. J Hand Surg Am. 1990;15(1):140-7. doi: 10.1016/s0363-5023(09)91122-4.
24. Alnot JY. Fractures and pseudarthroses of the carpal scaphoid. The various stages of pseudarthrosis. Rev Chir Orthop Reparatrice Appar Mot. 1988;74(8):714-7.
25. Esteban-Feliu I, Barrera-Ochoa S, Vidal-Tarrason N, Mir-Simon B, Lluch A, Mir-Bullo X. Volar Plate Fixation to Treat Scaphoid Nonunion: A Case Series With Minimum 3 Years of Follow-Up. J Hand Surg Am. 2018;43(6):569.e1-569.e8. doi: 10.1016/j.jhsa.2017.12.004.

26. Cooney WP, Bussey R, Dobyns JH, Linscheid RL. Difficult wrist fractures. Perilunate fracture-dislocations of the wrist. Clin Orthop Relat Res. 1987;(214):136-47.
27. Beaton DE, Bombardier C, Katz JN, Wright JG, Wells G, Boers M, et al. Looking for important change/differences in studies of responsiveness. OMERACT MCID Working Group. Outcome Measures in Rheumatology. Minimal Clinically Important Difference. J Rheumatol. 2001;28(2):400-5.
28. Braun C, Gross G, Bühren V. Die Osteosynthesis using a buttress plate--a new principle for stabilizing scaphoid pseudarthroses. Unfallchirurg. 1993;96(1):9-11.
29. Dodds SD, Williams JB, Seiter M, Chen C. Lessons learned from volar plate fixation of scaphoid fracture nonunions. J Hand Surg Eur. 2018;43(1):57-65. doi: 10.1177/1753193417743636.
30. Sander AL, Sommer K, Schäf D, Braun C, Marzi I, Pohlemann T, et al. Clinical outcome after alternative treatment of scaphoid fractures and nonunions. Eur J Trauma Emerg Surg. 2018;44(1):113-118. doi: 10.1007/s00068-017-0773-y.
31. Pinder RM, Brkljac M, Rix L, Muir L, Brewster M. Treatment of Scaphoid Nonunion: A Systematic Review of the Existing Evidence. J Hand Surg Am. 2015;40(9):1797-1805.e3. doi: 10.1016/j.jhsa.2015.05.003.
32. Talia AJ, Fraval A, Halliday L, McKie G, Paiva J, Thai DM. Scaphoid specific volar locking plate and non-vascularised iliac crest bone graft in scaphoid non-union. A comparative cohort study. J Orthop. 2019;16(4):337-341. doi: 10.1016/j.jor.2019.03.005.
33. Nakamoto JC, Xavier RM, Burgos FH, Wataya EY, do Carmo Iwase F, Nakamoto HA, et al. Comparative analysis of scaphoid nonunion treatment with screw fixation and angular stable plate. Arch Orthop Trauma Surg. 2023;143(4):2247-2253. doi: 10.1007/s00402-022-04625-9.
34. Khan SN, Cammisa FP Jr, Sandhu HS, Diwan AD, Girardi FP, Lane JM. The biology of bone grafting. J Am Acad Orthop Surg. 2005;13(1):77-86.
35. Kim JK, Yoon JO, Baek H. Corticocancellous bone graft vs cancellous bone graft for the management of unstable scaphoid nonunion. Orthop Traumatol Surg Res. 2018;104(1):115-120. doi: 10.1016/j.otsr.2017.11.011.
36. Wataya EY, Meneghel GH, Mores V, Nakamoto JC, Xavier RM, Junior RM. Comparative analysis of cancellous graft and cortico-cancellous graft in osteosynthesis of scaphoid pseudoarthrosis with plate. Arch Orthop Trauma Surg. 2023;143(11):6955-6963. doi: 10.1007/s00402-023-05003-9.
37. Putnam JG, Mitchell SM, DiGiovanni RM, Stockwell EL, Edwards SG. Outcomes of Unstable Scaphoid Nonunion With Segmental Defect Treated With Plate Fixation and Autogenous Cancellous Graft. J Hand Surg Am. 2019;44(2):160.e1-160.e7. doi: 10.1016/j.jhsa.2018.05.023.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290196

USE OF PLATELET-RICH PLASMA IN THE TREATMENT OF ROTATOR CUFF INJURIES: REVIEW OF CLINICAL TRIALS

UTILIZAÇÃO DO PLASMA RICO EM PLAQUETAS NO TRATAMENTO DAS LESÕES DO MANGUITO ROTADOR: REVISÃO DE ENSAIOS CLÍNICOS

JOÃO PAULO COELHO CINTRA[1], *HUGO PINHONE RAVAGNANI*[1], *MURILLO AUGUSTO RIBEIRO DO NASCIMENTO*[1], *HENRIQUE DE PAULA RODRIGUES NISHIMURA*[1]

1. Hospital Santa Casa de Misericordia de Ribeirao Preto, Serviço de Ortopedia e Traumatologia, Ribeirao Preto, Sao Paulo, SP, Brazil.

ABSTRACT

Rotator cuff injuries occur due to overuse of the shoulder joint, trauma or age-related degeneration, and are aggravated by subacromial lesions and anatomical factors. Symptoms include persistent pain, reduced range of motion and muscle weakness, compromising patients' quality of life. Treatment can be conservative or surgical, and platelet-rich plasma (PRP) has emerged as an alternative to speed up healing and reduce inflammation. The objective was to review the literature on the use of PRP in the treatment of rotator cuff injuries. Clinical trials published in the last 5 years and available in the PUBMED database were selected, based on the following search strategy: (platelet[title] AND rich[title] AND plasma[title]) AND (rotator[title] AND cuff[title]). The 13 studies that responded to the initial search were included in the sample that made up this review. PRP has been shown to be a promising alternative for treating rotator cuff injuries, especially in terms of short-term pain and function. However, its long-term efficacy and its comparison with corticosteroids are still a matter of debate. Therefore, the choice of treatment should be personalized, taking into account the characteristics and goals of each patient. ***Level of Evidence IV; Evidence from Descriptive (Non-Experimental) Studies or with a Qualitative Approach.***

Keywords: Rotator Cuff; Platelet-Rich Plasma; Wound Healing; Regeneration; Adrenal Cortex Hormones.

RESUMO

Lesões do manguito rotador ocorrem devido ao uso excessivo da articulação do ombro, traumas ou degeneração relacionada à idade, sendo agravadas por lesões subacromiais e fatores anatômicos. Os sintomas incluem dor persistente, redução da amplitude de movimento e fraqueza muscular, comprometendo a qualidade de vida dos pacientes. O tratamento pode ser conservador ou cirúrgico, e o plasma rico em plaquetas (PRP) surge como uma alternativa para acelerar a cicatrização e reduzir a inflamação. O objetivo foi revisar a literatura acerca do uso do PRP no tratamento das lesões do manguito rotador. Foram selecionados ensaios clínicos publicados nos últimos 5 anos e disponíveis na base de dados PUBMED, com base na seguinte estratégia de busca: (platelet[title] AND rich[title] AND plasma[title]) AND (rotator[title] AND cuff[title]). Os 13 estudos que responderam à busca inicial foram incluídos na amostra que constituiu a presente revisão. O PRP mostrou-se como uma alternativa promissora para tratar lesões do manguito rotador, especialmente em termos de dor e função em curto prazo. Contudo, sua eficácia em longo prazo e sua comparação com corticosteroides ainda são objeto de debate. Portanto, a escolha do tratamento deve ser personalizada, considerando as características e objetivos de cada paciente. ***Nível de Evidência IV; Evidências de Estudos Descritivos (Não Experimentais) ou com Abordagem Qualitativa.***

Descritores: *Manguito Rotador; Plasma Rico em Plaquetas; Cicatrização; Regeneração; Corticosteroides.*

Citation: Cintra JPC, Ravagnani HP, Nascimento MAR, Nishimura HPR. Use of platelet-rich plasma in the treatment of rotator cuff injuries: review of clinical trials. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 6. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

The main mechanisms that lead to injury to the rotator cuff include excessive use of the joint, such as repetitive movements, in addition to acute trauma, such as falls. Age-related degeneration is also a relevant factor, since aging especially weakens the tendons of the muscles that make up the rotator cuff. The subacromic conflict occurs when the tendons are compressed against the acromy, generating pain and inflammation. In addition, postural problems

All authors declare no potential conflict of interest related to this article.

The study was conducted at Service of Orthopaedics and Traumatology. Hospital Santa Casa de Misericordia de Ribeirao Preto, Ribeirao Preto, Sao Paulo, SP, Brazil.
Correspondence: João Paulo Coelho Cintra. Hospital Santa Casa de Misericórdia de Ribeirão Preto, 456, Av. Saudade, Campos Elisios, Ribeirao Preto Sao Paulo, SP, Brazil. 14085-000. joaopauloccintra@hotmail.com

Article received on 09/19/2024 approved on 05/12/2025.

and disalignment of the shoulder can overload the tendons, while anatomical factors, such as a more pronounced acromion, can increase the predisposition to lesions.[1]

Patients with rotator cuff injury often experience persistent shoulder pain, which gets worse with daily movements and activities. The range of movement can be reduced, making it difficult to raise the arm and reach objects above the head. Muscle weakness is also common, compromising the ability to lift and carry objects, which can affect the performance of everyday tasks, such as dressing or peeling your hair. These limitations affect participation in physical and sports activities, affecting quality of life. The severity of these functional losses varies depending on the extent of the injury and the treatment received.[2]

Treatment for lesions of the rotator cuff may involve conservative and surgical approaches. Conservative measures often include physiotherapy to strengthen and improve the range of movement, use of anti-inflammatory medications to relieve pain, and adjustments in activities to prevent the injury from worsening. Corticosteroid injections can be used to reduce inflammation and pain. In turn, treatment with platelet-rich plasma (PRP) is gaining prominence in the medical environment, and is based on the use of the patient's own blood to promote healing and regeneration of injured tissues.[3]

The use of PRP involves collecting and processing the patient's blood to concentrate the platelets, which are then injected directly into the affected area. This method aims to use the growth factors present in PRP to stimulate regeneration and healing of injured tissues, taking advantage of the natural ability of the organism to promote recovery.[4]

The justification for the use of PRP in the treatment of lesions of the rotator cuff lies in its potential ability to accelerate the healing process and reduce inflammation, in addition to improving the function of the tendon. Platelets, rich in proteins and growth factors, play a crucial role in tissue regeneration, making PRP a less invasive option compared to surgery. This treatment may be especially beneficial for patients who do not respond well to traditional conservative methods, or who wish to avoid more invasive surgical procedures.

In view of the above, the proposal of this study was to review the literature about the use of PRP in the lesions of the rotator cuff, highlighting the pros and cons of this method that has been gaining space in recent years.

MATERIAL AND METHOD

This study is set up as an integrative review of the literature, with the proposal to synthesize clinical evidence on the use of PRP in the treatment of lesions of the rotator cuff. The selection of the reviewed articles was carried out in the PUBMED database using the following search strategy: *(platelet[title] AND rich[title] AND plasma[title]) AND (rotator[title] AND cuff[title])*, including only clinical trials published in the last 5 years. The research question that guided this review was the following: "What are the effects of platelet-rich plasma when used for treatment of rotator cuff lesions?" The review process was conducted in six sequential stages, which are: a) formulation of the research question; b) identification of the relevant studies on the previously established topic; c) collection of data in the specified database; d) critical and detailed analysis of the selected studies; e) discussion of the findings of the articles; and f) elaboration and presentation of the integrative review.[5]

RESULTS

The initial search resulted in 13 articles that met the established criteria for this survey. After reviewing the titles and summaries, all identified works were selected for review. The studies were then read in full, summarized and discussed, following a chronological order based on the year they were published. A summary of the articles selected for this review is presented in Table 1.

DISCUSSION

Mohammadivahedi et al.[6] evaluated the ideal approach for partial treatment of rotator cuff rupture (PTRCT), which remains a controversial issue. According to the authors, recent studies have suggested that injection of platelet-rich plasma (PRP) could be a promising treatment option. However, the effects of the combined treatment of PRP and vitamin C, despite the recognized role of vitamin C in collagen synthesis and its antioxidant properties, were still not well understood. Thus, the study aimed to investigate the effect of the combined treatment of PRP and vitamin C in patients with PTRCT. For this, 110 patients were randomly assigned into two groups and sub-acromal injections of normal saline and PRP (Group A) or vitamin C and PRP (Group B) were given. Assessments were performed using the Constant score, the American Shoulder and Elbow Surgeons score (ASES) and the analogue visual scale, before and after 1 and 3 months of injections. Although both groups showed significant improvements in pain reduction and functional scores over time, there was no statistically significant difference between them. Both groups showed significant reductions in pain ($p < 0.001$) and increases in ASES and Constant scores ($p < 0.001$). Thus, it was concluded that both PRP injection alone and PRP combined with vitamin C led to significant improvements, suggesting that PRP may be effective as non-surgical treatment for PTRCTs over a 3-month period. However, it was stressed at the end of the study that additional research was still needed to determine whether the combination of PRP and vitamin C could offer significant advantages over PRP alone.

On the other hand, Pitsilos and collaborators[7] studied the effect of PRP on tendon metabolism, which had already been extensively studied and proven *in vitro*, but whose effects *in vivo* were still little understood. A prospective, randomized, prospective study conducted by them aimed to evaluate the effect of PRP on a broken human supra-spinal tendon. To this end, 20 patients were randomized into two groups: an experimental group that received an autologous ultrasound-guided PRP injection in the subacromal space six weeks prior to scheduled surgery, and a control group that received no injections prior to surgery. The tendon samples collected during shoulder arthroscopy showed that, in the control group, there was a mixed cell population of tenocytes within disorganized collagen and accumulations of inflammatory cells. In contrast, the experimental group presented abundant oval cells with multiple cytoplasmic processes in parallel collagen fibers and less inflammation, simulating the intact structure of the tendon. These findings indicate that PRP can induce microscopic changes that stimulate the healing process and can facilitate more effective recovery.

Rossi et al.[8], in turn, investigated whether the use of PRP as an adjuvant to the repair of the rotator cuff would improve tendon healing and functional results, a question still uncertain in clinical evidence until then. In a randomized, double-blind, controlled trial, the authors enrolled 96 patients with rotator cuff ruptures smaller than 3 cm, who were divided into two groups: a control group, submitted to double-reel suture bridge repair, and a PRP group, who received an injection of leukocyte-poor plasma (LP-PRP) during surgery. The MRI performed six months after surgery revealed that the rate of new rupture was significantly lower in the PRP group (15.2%) compared to the control group (34.1%), with a risk ratio of 0.44 ($p = 0.037$). However, despite the reduction in the rate of new ruptures, no significant differences in functional scores were observed between the groups. This suggests that while LP-PRP may reduce the rate of new ruptures, it did not show significant benefits in terms of postoperative pain or patients-reported outcomes.

Godek and colleagues,[9] when investigating the lesions of the partial thick rotator cuff (PTRCI), evaluated the potential of treatments that combine collagen and PRP, collagen isolated or PRP isolated. In

Table 1. Summary of the articles selected for this review.

Authors and Year	Original title	Type of Study	Number of Patients	Conclusion
Mohammadivahedi et al. (2024)[6]	Comparative efficacy of platelet-rich plasma (PRP) injection versus PRP combined with vitamin C injection for partial-thickness rotator cuff tears	Randomized clinical trial	110	PRP isolated and PRP with vitamin C showed similar effectiveness in reducing pain and functional improvement.
Pitsilos et al. (2024)[7]	The Biological Effect of Platelet-Rich Plasma on Rotator Cuff Tears: A Prospective Randomized In Vivo Study	Prospective randomized study	20	PRP induced beneficial microscopic changes in the healing of the supra-spinal tendon.
Rossi et al. (2024)[8]	Leukocyte-Poor Platelet-Rich Plasma as an Adjuvant to Arthroscopic Rotator Cuff Repair Reduces the Retear Rate But Does Not Improve Functional Results	Double-blind randomized clinical trial	96	PRP reduced the rate of interruption, but did not improve functional results.
Godek et al. (2022)[9]	Collagen and platelet-rich plasma in partial-thickness rotator cuff injuries	Randomized clinical trial	90	PRP and collagen showed an improvement in tendon regeneration.
Zhang et al. (2022)[10]	Injection of Leukocyte-Poor Platelet-Rich Plasma for Moderate-to-Large Rotator Cuff Tears	Prospective randomized study	104	PRP reduced relapse rate, but with no significant difference in pain and function.
Randelli et al. (2022)[11]	Platelet-Rich Plasma in Arthroscopic Rotator Cuff Repair: Clinical and Radiological Results	Randomized clinical trial	53	PRP showed no significant long-term differences.
Dyson-Hudson et al. (2022)[12]	Ultrasound-guided platelet-rich plasma injection for recalcitrant rotator cuff disease in wheelchair users	Pilot study	6	PRP was safe and reduced pain in wheelchair users.
Dadgostar et al. (2021)[13]	Corticosteroids or platelet-rich plasma injections for rotator cuff tendinopathy	Randomized clinical trial	58	PRP was more effective than corticosteroids in functional improvement.
Oudelaar et al. (2021)[14]	Efficacy of Adjuvant Application of Platelet-Rich Plasma After Needle Aspiration of Calcific Deposits	Double-blind randomized clinical trial	80	PRP showed better long-term performance than corticosteroids.
Kwong et al. (2021)[15]	Platelet-Rich Plasma in Partial-Thickness Rotator Cuff Tears Leads to Improved Short-Term Pain Relief	Randomized clinical trial	99	PRP reduced pain in the short term, but with no sustained long-term benefit.
Jo et al. (2020)[16]	Allogeneic Platelet-Rich Plasma Versus Corticosteroid Injection for Rotator Cuff Disease	Randomized clinical trial	60	PRP showed long-term functional improvements but no definitive advantage over corticosteroids.
Snow et al. (2020)[17]	The Effect of Delayed Injection of Leukocyte-Rich Platelet-Rich Plasma Following Rotator Cuff Repair	Double-blind randomized clinical trial	97	Late application of PRP did not improve function, but reduced fat infiltration.
Sari & Eroglu (2020)[18]	Comparison of ultrasound-guided PRP, prolotherapy, and corticosteroid injections in rotator cuff lesions	Randomized clinical trial	129	PRP had a longer-lasting effect than corticosteroids.

Source: Data collected by the authors.

a study involving 90 patients conducted by the researchers, the three treatments were compared in terms of pain intensity, using a numerical classification scale, and quality of life questionnaires. Although no statistically significant differences were found between the groups, there was a trend of improvement in the groups receiving collagen with PRP or PRP isolated, suggesting that these treatments may offer benefits over collagen isolated. In addition, cases of rotator cuff regeneration have been observed in all groups, suggesting that the combined treatment of collagen and PRP may have a similar efficacy to monotherapy with collagen or PRP.

Zhang et al.[10] discussed whether plasma rich in leukocyte-poor platelets (Lp-PRP) could reduce the rates of new rupture, decrease fat infiltration, and improve functional outcomes in patients with moderate to large degenerative rotator cuff ruptures. The study, conducted in a single center, involved 104 patients with such ruptures, who were randomly assigned into two groups: a control group, subjected only to arthroscopic repair of the double-reel suture bridge of the rotator cuff (n = 52), and a study group, who received the same repair followed by three injections of Lp-PRP at the site of tendon repair, on days 7 and 14 after surgery (n = 52). Patients were followed for an average of 27.2 months. The clinical evaluations were conducted using the UCLA scale, Constant score and analog visual scale (VAS). The integrity and fat infiltration of the repaired tissue were examined by MRI using Sugaya classification and Goutallier grade classification, 24 months after surgery. The study identified that while the UCLA and Constant and VAS mean scores showed clinically significant improvements in both groups, the differences between the groups were not statistically significant. However, the rate of new rupture was lower in the group receiving Lp-PRP (17.6%) compared to the control group (38.1%, p = 0.049). In addition, Goutallier's degree showed significant differences between the groups in the postoperative period (p = 0.03), although not in the preoperative period. The researchers concluded that repeated injections of Lp-PRP had a positive effect in reducing the rate of new rupture and improving the degree of Goutallier, providing clinical results that achieved the minimal clinically important difference for surgical treatment, although they did not show clinical improvements superior to the control group.

Randelli and collaborators,[11] conducted a study to compare the clinical and radiological results of the arthroscopic repair of the rotator cuff with and without the addition of PRP on the tendon-bone interface after 10 years of follow-up. Of the 53 patients recruited and randomly divided into two groups (PRP = 26; control = 27), 38 were re-evaluated at least 10 years after the procedure.

The clinical evaluation included multiple indices, such as UCLA score, VAS, *Simple Shoulder Test, Constant-Murley Score* (CMS), *Single Assessment Numerical Evaluation* (SANE), *American Shoulder and Elbow Surgeons* (ASES) and isometric strength. Musculoskeletal ultrasound was used to evaluate the integrity of the repaired rotator cuff. Of the 38 patients evaluated, satisfaction was high in both groups (90%), with no statistically significant differences between them. A good and excellent clinical performance was observed in both groups, but the statistical difference was noted only for ASES and SANE. The rate of new rupture was similar between the groups, with 6% in the PRP group and 14% in the control group ($p = 0.61$). The final conclusion of the study was that, in the long run, the clinical and radiological results were substantially uniform between the groups, and the small differences observed in 2-year follow-up did not persist.

Dyson-Hudson et al.[12] explored the use of PRP in wheelchair users with spinal cord injury (LM) and chronic shoulder pain associated with rotator cuff disease. This pilot study aimed to test the safety and potential effect of an ultrasound-guided PRP injection for shoulder pain. Six wheelchair users with chronic shoulder pain, who failed in at least six months of conservative treatment, were given a PRP injection into the supra-spinal tendon and followed for 24 weeks. Result measures included the Wheelchair User Shoulder Pain Index (WUSPI), the Numerical Scale for Pain Assessment (NRS), physical examinations and ultrasound for supra-spinal tendinopathy, as well as the overall patient change impression (PGIC). The results showed a significant reduction in pain (WUSPI and NRS) and physical examination scores after 24 weeks. In addition, the participants reported overall improvement without adverse events or changes in ultrasound markers for tendinopathy. The researchers concluded that a single ultrasound-guided PRP injection followed by an exercise program was safe and provided improvements in pain measurements, but the lack of blindness and short-term follow-up indicate the need for a larger randomized clinical trial to confirm these findings.

Dadgostar et al.[13] conducted a double-blind randomized clinical trial to compare the structural and clinical changes in the rotator cuff muscles after corticosteroid and PRP injections. The study included 58 patients with rotator cuff tendinitis randomly assigned to receive PRP (3 cc in the subacromyal joint and 3 cc at the site of tendon rupture) or corticosteroids (1 cc of Depo-medrol 40 mg and 1 cc of lidocaine 2%). The evaluation involved pain, range of motion (ROM), Western Ontario Rotator Cuff (WORC), Disability of Arm-Hand-Shoulder (DASH) and thickness of the supra-spinal. The results showed significant improvement in pain and ROM in both groups during follow-up. However, the PRP group showed a more significant improvement in pain and ROM, with more favorable clinical outcomes compared to the corticosteroid group. The conclusion was that PRP may be preferable to corticosteroid use due to its superior effectiveness in reducing pain and improving ROM, as well as avoiding the risks associated with corticosteroids, such as tendon rupture.

Oudelaar et al.[14] conducted a double-blind randomized clinical trial to compare the effects of plaque-rich plasma (PRP) versus corticosteroids after calcified deposits needle aspiration (NACD) in patients with calcified rotator cuff tendinitis (RCCT). The study included 80 patients who were assigned to receive NACD followed by PRP or NACD followed by corticosteroids. The evaluation included pain, shoulder function and quality of life (QV) at various follow-up points. The NACD+PRP group was considered no inferior to the NACD+corticosteroid group in relation to the decrease in pain scores. However, the NACD+PRP group had significantly better clinical scores in the 6-month follow-up and reduced need for additional treatments, but was associated with more complications. The conclusion was that although NACD+corticosteroids showed a favorable initial effect, NACD+PRP may be an alternative with better long-term results and less need for additional treatments, despite a higher rate of complications.

Kwong et al.[15] conducted a randomized, controlled clinical trial to compare PRP with corticosteroids in patients with partial rotator cuff rupture (PTRCTs). The study included 99 patients, and the results were evaluated based on the visual analogue scale (VAS) for pain, *American Shoulder and Elbow Surgeons* (ASES) and *Western Ontario Rotator Cuff Index* (WORC). The PRP group showed a superior improvement in pain and function compared to the corticosteroid group in the 3-month follow-up. However, there were no sustained differences in long-term follow-up (12 months), and the rate of failure and conversion to surgery was similar between the groups. The conclusion was that while PRP provided superior improvement in short-term pain and function, there was no sustained long-term benefit compared to corticosteroids.

Jo et al.[16] conducted a randomized controlled clinical trial to investigate the efficacy and safety of allogenic pure PRP injections compared to corticosteroids for the treatment of rotator cuff disease. The study included 60 patients, who were randomly assigned to receive a subacromal injection of pure allogenic PRP or a mixture of corticosteroid and lidocaine. The primary outcomes were safety and Constant score in 1 month, while the secondary outcomes included pain, amplitude of movement, muscle strength and satisfaction. There were no adverse events related to treatment. Although the Constant score at 1 month showed no significant differences between the groups, the PRP group showed significant improvements in DASH score, overall function and external rotation at 6 months. Shoulder pain and function improved slowly in the PRP group, while the corticosteroid group showed a rapid response but no further long-term improvements. The conclusion was that while PRP is safe and can offer functional benefits in terms of overall function and external rotation, it has not been shown to be definitely superior to the corticosteroid in terms of pain relief and functional improvement.

Snow et al.[17] investigated the impact of late application of leukocyte-rich PRP on the repair of the rotator cuff. The study included 97 patients with symptomatic rotator cuff rupture who were randomized to receive a PRP or normal saline solution injection between 10 and 14 days after surgery. The evaluation included patient-reported outcome scores and MRI images to evaluate the integrity of repair and fat infiltration. In 1 year, there were no significant differences between the groups in outcome scores or new break rates. However, fat infiltration was significantly lower in the PRP group compared to the control group. The conclusion was that the late application of post-repair rotator cuff PRP did not improve the function as measured by the patients' reported outcomes and Constant score, but may have a positive effect on reducing fat infiltration.

These studies suggest that while PRP may offer benefits in some aspects, such as reducing fat infiltration and improvements in certain functional parameters, its effectiveness compared to corticosteroids may vary. The decision on the use of PRP versus corticosteroids should consider both the potential benefits and clinical outcomes observed in specific studies.

Finally, Sari and Eroglu[18] conducted a study to compare the efficacy of different injection methods for rotator cuff lesions, including PRP, corticosteroids and prolotherapy. The study involved 129 patients, divided into four groups: PRP, corticosteroid (COR), prolotherapy (PRO) and lidocaine. All patients received a subacromal injection and were evaluated using the Visual Analogous Scale (VAS), the Standardized Shoulder Assessment Form of the American Shoulder and Claw Surgeons (ASES) and the Western Ontario Rotator Cuff Index (WORC) at 3, 12 and 24 weeks after injection. The results indicated that at week 3, the corticosteroid group showed a significant

reduction in pain (VAS) and a improvement in function (WORC) compared with the other groups, demonstrating a faster relief. However, over 24 weeks, the PRP group surpassed the corticosteroid group in terms of reducing pain and improving function, suggesting that PRP could provide more lasting benefits. In addition, the corticosteroid group had a significantly higher ASES score than the PRP and PRO groups at week 3, showing a faster improvement in function. In short, corticosteroid injection provides faster pain relief and short-term function improvement, while PRP stands out for its long-lasting and lasting benefits. All evaluated injection methods improved patient pain, function and quality of life, but PRP proved to be the most effective option for long-term well-being.

The analysis of the studies selected for this review revealed important convergences and divergences between the studies. In general, there is consensus that PRP provides a significant improvement in patient pain, especially in the short term,[13,15,18] in addition to contributing to the improvement of shoulder function and amplitude of movement. Some studies also indicate that this therapeutic approach reduces the rates of new tendon rupture when used as an adjuvant to surgery, suggesting a positive role in tissue healing.[8,10] Furthermore, the safety of therapy was reiterated by several authors, who did not report serious adverse events related to the use of PRP.[12,16]

Despite these agreements, there are still major differences as to the long-term effectiveness of the PRP. While some studies point to sustained benefits,[11] others did not identify significant differences between PRP and corticosteroids after a prolonged period of follow-up.[17] The comparison between these two therapies, by the way, also produced different results. Some studies also suggest that PRP provides longer functional recovery,[13,14] while others indicate that corticosteroids provide faster pain relief, but without a prolonged effect.[15,16]

Another issue discussed was the combination of PRP with other substances, such as vitamin C. Although this association has been tested, it did not demonstrate additional advantages over PRP alone.[6] Furthermore, the analysed studies showed variations in application protocols, including differences in the amount, frequency and time ideal for administration, which impacts the standardization of the technique and makes direct comparisons between the results difficult.[10,17]

Overall, there has been growing consensus on the efficacy of PRP in the treatment of rotator cuff lesions, especially for reducing pain and improving function in the short term. PRP has proven to be a promising alternative to corticosteroids, offering notable clinical benefits, such as reducing pain and improving movement amplitude. However, its efficacy combined with other substances, such as vitamin C, is still debated, with studies showing that the combination showed no significant advantages over PRP alone. In addition, while PRP can contribute to tendon healing and reduction of fatty infiltration, its long-term effects and compared to corticosteroids are varied, with some studies indicating that corticosteroids offer faster relief, while PRP can provide lasting benefits. The choice of treatment should therefore consider the individual characteristics of the patients and the specific goals of the treatment.

CONCLUSION

PRP represents a promising alternative for the treatment of rotator cuff lesions, especially for pain relief and short-term functional improvement. However, its long-term effectiveness and its comparison with other therapies still require further studies. The choice of PRP should take into account the particularities of each patient, the severity of the injury, and the goals expected with the treatment, in order to ensure the best possible therapeutic approach.

AUTHOR'S CONTRIBUTION: Each author personally and significantly contributed to the development of this article: JPCC, HPR, MARN and HPRN: design/design of the work, acquisition, analysis and interpretation of the data for the work, writing of the text and critical review of its intellectual content, in addition to the final approval of the version of the manuscript to be published.

REFERENCES

1. Fitzpatrick LA, Atinga A, White L, Henry PDG, Probyn L. Rotator Cuff Injury and Repair. Semin Musculoskelet Radiol. 2022;26(5):585-596. doi: 10.1055/s-0042-1756167.
2. Collin P, Matsumura N, Lädermann A, Denard PJ, Walch G. Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg. 2014;23(8):1195-202. doi: 10.1016/j.jse.2013.11.019.
3. Prodromos CC, Finkle S, Prodromos A, Chen JL, Schwartz A, Wathen L. Treatment of Rotator Cuff Tears with platelet rich plasma: a prospective study with 2 year follow-up. BMC Musculoskelet Disord. 2021;22(1):499. doi: 10.1186/s12891-021-04288-4.
4. Dohan Ehrenfest DM, Andia I, Zumstein MA, Zhang CQ, Pinto NR, Bielecki T. Classification of platelet concentrates (Platelet-Rich Plasma-PRP, Platelet-Rich Fibrin-PRF) for topical and infiltrative use in orthopedic and sports medicine: current consensus, clinical implications and perspectives. Muscles Ligaments Tendons J. 2014;4(1):3-9.
5. Souza MT de, Silva MD da, Carvalho R de. Revisão integrativa: o que é e como fazer. Einstein. 2010;8:102–6. doi: 10.1590/S1679-45082010RW1134.
6. Mohammadivahedi F, Sadeghifar A, Farsinejad A, Jambarsang S, Mirhosseini H. Comparative efficacy of platelet-rich plasma (PRP) injection versus PRP combined with vitamin C injection for partial-thickness rotator cuff tears: a randomized controlled trial. J Orthop Surg Res. 2024;19(1):426. doi: 10.1186/s13018-024-04917-3.
7. Pitsilos C, Karachrysafi S, Fragou A, Gigis I, Papadopoulos P, Chalidis B. The Biological Effect of Platelet-Rich Plasma on Rotator Cuff Tears: A Prospective Randomized In Vivo Study. Int J Mol Sci. 2024;25(14):7957. doi: 10.3390/ijms25147957.
8. Rossi LA, Gorodischer TD, Camino P, Brandariz RN, Tanoira I, Piuzzi NS, et al. Leukocyte-Poor Platelet-Rich Plasma as an Adjuvant to Arthroscopic Rotator Cuff Repair Reduces the Retear Rate But Does Not Improve Functional Outcomes: A Double-Blind Randomized Controlled Trial. Am J Sports Med. 2024;52(6):1403-1410. doi: 10.1177/03635465241239062.
9. Godek P, Szczepanowska-Wolowiec B, Golicki D. Collagen and platelet-rich plasma in partial-thickness rotator cuff injuries. Friends or only indifferent neighbours? Randomised controlled trial. BMC Musculoskelet Disord. 2022;23(1):1109. doi: 10.1186/s12891-022-06089-9.
10. Zhang C, Cai YZ, Wang Y. Injection of Leukocyte-Poor Platelet-Rich Plasma for Moderate-to-Large Rotator Cuff Tears Does Not Improve Clinical Outcomes but Reduces Retear Rates and Fatty Infiltration: A Prospective, Single-Blinded Randomized Study. Arthroscopy. 2022;38(8):2381-2388.e1. doi: 10.1016/j.arthro.2022.02.007.
11. Randelli PS, Stoppani CA, Santarsiero G, Nocerino E, Menon A. Platelet-Rich Plasma in Arthroscopic Rotator Cuff Repair: Clinical and Radiological Results of a Prospective Randomized Controlled Trial Study at 10-Year Follow-Up. Arthroscopy. 2022;38(1):51-61. doi: 10.1016/j.arthro.2021.05.017.
12. Dyson-Hudson TA, Hogaboom NS, Nakamura R, Terry A, Malanga GA. Ultrasound-guided platelet-rich plasma injection for the treatment of recalcitrant rotator cuff disease in wheelchair users with spinal cord injury: A pilot study. J Spinal Cord Med. 2022;45(1):42-48. doi: 10.1080/10790268.2020.
13. Dadgostar H, Fahimipour F, Pahlevan Sabagh A, Arasteh P, Razi M. Corticosteroids or platelet-rich plasma injections for rotator cuff tendinopathy: a randomized clinical trial study. J Orthop Surg Res. 2021;16(1):333. doi: 10.1186/s13018-021-02470-x.
14. Oudelaar BW, Huis In 't Veld R, Ooms EM, Schepers-Bok R, Nelissen RGHH, Vochteloo AJH. Efficacy of Adjuvant Application of Platelet-Rich Plasma After Needle Aspiration of Calcific Deposits for the Treatment of Rotator Cuff Calcific Tendinitis: A Double-Blinded, Randomized Controlled Trial With 2-Year Follow-up. Am J Sports Med. 2021;49(4):873-882. doi: 10.1177/0363546520987579.

15. Kwong CA, Woodmass JM, Gusnowski EM, Bois AJ, Leblanc J, More KD, et al. Platelet-Rich Plasma in Patients With Partial-Thickness Rotator Cuff Tears or Tendinopathy Leads to Significantly Improved Short-Term Pain Relief and Function Compared With Corticosteroid Injection: A Double-Blind Randomized Controlled Trial. Arthroscopy. 2021;37(2):510-517. doi: 10.1016/j.arthro.2020.10.037.
16. Jo CH, Lee SY, Yoon KS, Oh S, Shin S. Allogeneic Platelet-Rich Plasma Versus Corticosteroid Injection for the Treatment of Rotator Cuff Disease: A Randomized Controlled Trial. J Bone Joint Surg Am. 2020;102(24):2129-2137. doi: 10.2106/JBJS.19.01411.
17. Snow M, Hussain F, Pagkalos J, Kowalski T, Green M, Massoud S, et al. The Effect of Delayed Injection of Leukocyte-Rich Platelet-Rich Plasma Following Rotator Cuff Repair on Patient Function: A Randomized Double-Blind Controlled Trial. Arthroscopy. 2020;36(3):648-657. doi: 10.1016/j.arthro.2019.09.026.
18. Sari A, Eroglu A. Comparison of ultrasound-guided platelet-rich plasma, prolotherapy, and corticosteroid injections in rotator cuff lesions. J Back Musculoskelet Rehabil. 2020;33(3):387-396. doi: 10.3233/BMR-191519.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290571

PHYSICAL ASSESSMENT IN SURFERS: GUIDELINES FOR HEALTH PROFESSIONALS - PART 1 UPPER QUARTER

AVALIAÇÃO FÍSICA NO SURFISTA: DIRETRIZES PARA OS PROFISSIONAIS DE SAÚDE - PARTE 1 QUADRANTE SUPERIOR

Guilherme Vieira Lima[1,2,3,4], *Eduardo Takeuchi*[1,2], *Pedro Miguel Carriço de Seixas*[1,4,5], *Alexander Rehder*[1], *Marcus Vinicius Pereira Prada*[1], *Marcelo Baboghluian*[1], *Guilherme Carlos Brech*[1,2,6,7]

1. Grupo de Estudos do SID (Surf Information Data), Sao Paulo, SP, Brazil.
2. Personal Boards, Sao Paulo, SP, Brazil.
3. Faculdade de Medicina do ABC, Departamento de Ortopedia e Traumatologia, Cirurgia do Ombro e Cotovelo, Santo Andre, Sao Paulo, SP, Brazil.
4. Surfing Medicine International (SMI), Netherlands.
5. Escola Superior de Saude Atlantica, Oeiras, Portugal.
6. Universidade de Sao Paulo (USP), Faculdade de Medicina, Departamento de Ortopedia e Traumatologia, Laboratorio de Estudos do Movimento, Sao Paulo, SP, Brazil.
7. Universidade Sao Judas Tadeu, Programa de Pos-Graduacao em Ciencias do Envelhecimento, Sao Paulo, SP, Brazil.

ABSTRACT

In Brazil, surfing has gained popularity in recent decades, driven by beautiful beaches, good wave conditions and the spirit of adventure that permeates Brazilian culture, but also increasing the risk of injuries. During surfing, the surfer spends most of the time lying prone on the board while paddling, placing heavy demands on the musculoskeletal system in the cervical and lumbar spine, as well as in the shoulder region, which are important points for complaints of chronic injuries among surfers. The objective of the present study was to update musculoskeletal assessment of the upper quarter, related to physical examination and functional tests that can be applied to surfers. This is an update study based on an integrative review through a bibliographical survey in which national and international journals indexed in the scientific databases Scielo and PubMed were evaluated, developed and analyzed by a group of experts in the area of surf medicine and health composed of physical educator, physiotherapists and sports doctors. This guideline study compiled important information regarding the prevalence of upper quarter musculoskeletal injuries in surfers, guiding the surfer's outpatient assessment, considering the specificity of the sport and biomechanical gesture involved. ***Level of Evidence III; Expert opinion.***

Keyword: Practice Guideline; Water Sports; Musculoskeletal Pain; Shoulder; Spine.

RESUMO

No Brasil, o surfe tem ganhado popularidade nas últimas décadas, impulsionado pelas belas praias, boas condições de ondas e o espírito de aventura que permeia a cultura brasileira, aumentando também o risco de lesões. Durante a prática de surfe, o surfista permanece grande parte do tempo, deitado sobre a prancha remando, exigindo uma demanda acentuada do sistema musculoesquelético na região da coluna cervical e lombar, assim como na região dos ombros, pontos importantes de manifestação de queixas de lesões crônicas dos surfistas. O objetivo do presente estudo foi realizar uma atualização referente aos estudos relacionados à avaliação musculoesquelética do quadrante superior, relacionada ao exame físico e testes funcionais que possam ser aplicados ao surfista. Trata-se de estudo de atualização baseado em uma revisão integrativa através de levantamento bibliográfico no qual foram avaliados periódicos nacionais e internacionais indexados nas bases científicas Scielo e PubMed, desenvolvida e analisada por um grupo de especialistas na área de medicina e saúde do surfe composta por educador físico, fisioterapeutas e médicos do esporte. Este estudo de diretrizes compilou informações importantes referente a prevalência de lesões musculoesqueléticas do quadrante superior no surfista, norteando a avaliação ambulatorial do surfista, pensando na especificidade da modalidade e gesto biomecânico envolvido. ***Nível de Evidência III; Opinião do especialista.***

Descritores: *Guia de Prática Clínica; Esportes Aquáticos; Dor Musculoesquelética; Ombro; Coluna Vertebral.*

Citation: Lima GV, Takeuchi E, Seixas PMC, Rehder A, Prada MPV, Baboghluian M, Brech GC. Physical assessment in surfers: Guidelines for health professionals - Part 1 upper quarter. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 7. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Surfing is a sport practiced by different age groups, genders with different levels of performance (from beginners to professionals), locations and environmental conditions. This sport is in full growth, and although it is difficult to define the exact number of practitioners in the world[1] it is estimated that there are approximately 30 to 37 million surfers around the world,[2,3] with a significant increase in the number of surfers in the world and especially in Brazil, which

All authors declare no potential conflict of interest related to this article.

The study was conducted at Grupo de Estudos do SID (Surf Information Data), Sao Paulo, SP, Brazil.
Correspondence: Guilherme Carlos Brech. 333, Rua Ovídio Pires de Campos, Cerqueira César, São Paulo, Brazil. 05403-010. guibrech@gmail.com

Article received on 09/23/2024 approved on 01/31/2025.

also increases the risk of injuries.[4] In Brazil, surfing has gained significant popularity in recent decades, driven by the beautiful beaches, good wave conditions and the spirit of adventure that permeates the Brazilian culture. The popularity of surfing has grown rapidly in recent years, boosted by the sport's debut at the Tokyo Olympic Games in 2020.[5]

In the competitive "world of surfing", Brazil is a country that has been standing out, with the "Brazilian Storm" (the group of Brazilian surfers competing the world circuit) achieving expressive results in the last 10 years. In facto, the Brazilians have won 6 world titles and were the first country to win an Olympic gold in Surfing. This fact has also contributed to the growth of sport in Brazil.[6] In addition, the country today has three wave pools in full operation, with two others under construction, and it is estimated that it will soon be the country with the largest number of wave pools in the world.[7]

During the practice of surfing, the surfer spends most of the time (more than 60%), lying prone on the surfboard. This position, similar to the crawl swimming position, but relies on using a rigid surface in the ventral region (the board), which requires an increased angle of extension of the cervical and lumbar spine and movements of the upper limbs also with specifics of the sport.[8] During this time of practice there is a strong demand for the musculoskeletal system in the cervical and lumbar spine, as well as in the shoulder region, which are important points of manifestation of complaints related to surfers' chronic injuries.[5,9]

Thus, it becomes important to set guidelines that can help in the guidance of evidence-based clinical practice, for the musculoskeletal evaluation in the surfer's outpatient environment. These should involve physical examination and functional tests of the upper quarter, such training load control, evaluation of treatment and performance, as well as preventive measures to minimize injury risks.

In this sense, the aim of this study was to carry out an update regarding the studies related to musculoskeletal evaluation of the upper quarter, concerning physical examination and functional tests that can be applied to the surfer.

METHODS

This is an update study in which a bibliographic survey was conducted between June 2023 and July 2024 on Scielo and PubMed platforms, with terms related to surfing. However, as the scientific production on the topic is still quite scarce, the search has been widened to support the elaboration of a physical evaluation and functional tests guideline specific for surfers' upper quarter assessement.

Surfer's musculoskeletal evaluation

Clinical Surfer Assessment

The clinical evaluation before participation in sports is the subject of long debates given the controversy of its effectiveness in detecting conditions that predispose people to diseases or injuries.[10] However, important entities recommend, and even require, the evaluation before participation.[11]

In this sense, the periodic clinical evaluation is an indispensable tool for improving performance, disease and injury prevention. When related to surfers, it becomes even more relevant since the characteristics of the practice often expose the individual to extreme weather conditions (e.g. heat, cold, wind), saltwater and long periods of dehydration.[12]

Thus, the objective of periodic clinical evaluations, at any age, should be to determine the physiological and psychological health of the practitioner, seeking to identify risk factors and opportunities for health improvement,[13,14] serving as a basis for guidance in the areas of training, nutrition and psychology.

Biomarkers are gaining evidence and being used for both professional athletes and recreational practitioners, in order to identify injury risks and improvements in training and recovery.[15,16]

For professional athletes, lung function test are important for determining maximum respiratory pressures directly linked to CO2 tolerance and fatigue.[17] In addition, clinical investigation of cardiomyopathies, valvulopathies, hypertension, diabetes, hormonal imbalances, anemias, are some of the clinical conditions that should be evaluated at all ages in identifying risk factors for injuries as well as performance improvement.[14]

Musculoskeletal evaluation of the surfer in an outpatient environment

Spine

I) Biomechanics

Postural dysfunctions of surfers in the spine are mainly associated with the biomechanical gesture of paddling, but also have a relationship with the rotational movements of the trunk involved in the manoeuvres. Paddling is responsible for about 55% of the time spent during a surfing session[18] and the prone position on the board requires a high demand from the spine.

Although surfing is a sport that demands a lot of postural control, since staying on the board in the water generates a lot of instability, there is no consensus regarding the fact that the level of the surfer presents greater postural control. Chapman's and colleagues study,[19] found that the values of postural oscillation do not provide clear evidence as to whether surfing experience facilitates adjustments in the postural control system. Even when comparing surfers and non-surfers, no evidence of changes in postural balance is found.[20] However, simultaneous findings of mental tasks illustrate that there may be systematic differences in balance skills between experienced surfers and the control group. In the study of Paillard and colleagues,[21] it was found that professional surfers present greater sensory motor domain using vision to maintain postural control when compared with amateur surfers, despite being a study with a small sample.

II) Epidemiology and evaluation of vertebral lesions

Spine injuries are common and account for 16 to 20% of all surfer chronic injuries.[22,23]

III) Structures at Risk

Structures involved in the risk of dysfunction of the spine are mainly associated with the surfer's paddling gesture, which involves an extension with rotation of the spine during paddling, with the lumbar and cervical segments being the most affected.[24]

However, Furness and colleagues[25] highlight that the thoracic spine is a key area that is overloaded, especially considering when the amplitude of movement is reduced and can result in stress in surrounding joints and potentially affect surfing performance.[25]

As for the structures that can be affected in these segments, we can highlight from muscle groups responsible for the extension of the trunk and the height of the head,[26] as well as structures related to the joint complex, disc-vertebral joints to the facetaries. These may or may not be associated with some root manifestation due to compression of nerve tissue.[24]

IV) Assessment

The postural evaluation itself is a very subjective and qualitative evaluation. It should be guided towards the evaluation of deformities, mobility tests, evaluation of overload of posterior structures/ listesis and clinically most relevant neurological tests. In this sense, the evaluation should involve other segments such as hip and shoulder, mainly due to the relationship with the disfunctions of the lumbar spine and cervical, respectively.

If the surfer shows a complaint of acute lumbar pain and/or root component, the clinical history should be collected and the clinical examination based on alarm signs ("flags") should be adopted to guide the evaluation, and consequently the treatment.[27]

The evaluation of the mobility of the spine and shoulders is extremely important in the surfer due to the paddling gesture that occurs during most of the time of practice. The flexibility of the lumbar spine can be measured using the modified Schober test (distance between the lumbosacral junction and 10 cm above), and a variation equal to or greater than 5 cm is considered normal. Intra-observer intra-class correlation coefficient (ICC) is 0.96 inter-observer 0.93, indicating high reliability.[28] Furness and colleagues[29] highlight the importance of assessing the mobility of the thoracic spine in the sagital plane, revealing excellent intra-evaluator reliability values for lumbar blockage with the thoracic rotation method. Poor mobility of the thoracic spine can be associated with increased cervical and lumbar pain[30] and shoulder dysfunction.[31]

The physical examination of the surfer's spine should take into account the investigation of possible overload and/or listesis dysfunctions. In the physical examination of these patients, lumbar hyperlordosis and shortening of the posterior musculature of the thigh might be present; in addition, pain complaints in the spine, radiating to the lower limbs may also be found, which are frequent symptoms of this dysfunction, and can also be aggravated with the extension of the lumbar spine or with extension of the lower limbs. In the palpation of the thinning processes it is possible to identify some gap, when there is the presence of some slip.[32]

In addition, neurological tests become important when a) there's a suspecting discopathy, both of the cervical and lumbar spine, which may manifest through some root symptom if positive; or b) in a preventive way to evaluate any possible manifestation of some symptom of this nature, even if in the initial stages.[33,34]

IV) Other injury to the spine

Surfers' myelopathy (SM) is a rare but associated vertebral dysfunction.[33,34] SM can be considered a severe acute injury, characterized by a rare, non-traumatic spinal cord injury associated with hyperextension of the spine. It is estimated that the incidence of MS ranges from 2.2 to 6.6 injuries per 1,000 people who surf. Myelopathy is generally defined as any neurological deficit related to spinal cord dysfunction.[33] Although little is known about this dysfunction, it is believed to occur in beginners, healthy surfers, without previous spinal or vascular problems. There is a decrease in strength and sensitivity of the lower limbs, which can affect bladder/intestinal function and walking. In most cases, this neurological deficit is transient, but it is serious and requires urgent care.[33,34]

In this sense, in addition to the lumbar and cervical hyperextension related to the surfer's posture, due to the gesture of paddling, other postural changes can be present. For example, the anterior deviation of the shoulders due to pronounced internal rotation, which may also be associated to the pectoralis minor shortening. Due to the need for hyper-extension to elevate the trunk and paddle on the board, the lumbar spine can often present an increase in the physiological curve (lordosis). Therefore, because of paddling, lumbar and cervical spine are areas of complaints for surferes.[4]

Studies point to the importance of specific exercises for the CORE muscles (trunk and spine stabilizers) in the surfer for stabilization of the lumbar spine and trunk,[35] as a strategy for the prevention of lumbalgia and cervicalgia, due to injuries associated with remade position (chronic) and maneuvers (acute) during the practice of sport.

Shoulder

I) Biomechanics

The main mechanism of injury is paddling, due to overuse, but there are many reports of acute injuries resulting in a dislocation of the glenohumeral, and in these cases, the responsible mechanism is the fall with the upper limb in abduction and external rotation with indirect trauma of the joint.[3,9,36,37]

Paddling varies greatly in terms of the frequency and intensity of the movements. However, when considering overuse injuries related to this movement, swimming is often used as a reference for analysis and treatment. Nevertheless, we must be aware of some important differences in these two sports. The first is the unpredictability of the number, frequency and intensity of paddling in surfing; another is the position adopted by the surfer, who's on a board, in a position that promotes greater trunk extension – particulary in the thoracic and cervical regions. This position results in a shorter stroke with an entry into the water early, less glide, and consequently reduced propulsion. Moreover, it limits the athlete's ability to utilize the trunk rotation (hip roll), a movement commonly employed by swimmers to facilitate a greater stroke amplitude.[8,26]

The causes of the biomechanical injuries are mainly: muscle imbalance, scapulo-thoracic dyscinesia, subacromial impact and internal impact.[8]

Testing cervical and thoracic mobility is an important ally in the evaluation of the surfer, being simple tests of movement amplitude or postural correction that have as response to the improvement in some mentioned sign or symptom. A clear example that can contribute to shoulder discomfort is the decrease in the amplitude of thoracic extension, resulting in a reduction or alteration of the expected escapular movement, increasing the risk of impact around the shoulder joint.[8,38]

Nessler and colleagues[39] conducted a study aiming to evaluate the effects of using neoprene clothing on paddling during surfing. After the analysis of kinematics data, they concluded that the use of neoprene clothing can improve the athlete's finish technique, in addition to providing improved proprioception.

II) Epidemiology

Shoulder injuries are among the most common in surfers, most often of chronic origin, with an incidence of 22.4% for both professional and recreational surfers.[25] In a study that investigated the prevalence of self-reported injuries in Australian surfers (n=685), the main shoulder injuries are highlighted: unspecific causes (6.2%); dislocation (3.6%); rotator cuff injury (1.5%); laceration (0.8%); acromioclavicular injury (0.5%) and fractures (0.5%).[40]

III) Structures at Risk

The main structures involved surf paddling are the muscles of the rotator cuff, pectoralis major, deltoid, latissimus dorsal, triceps and trapezius.[8]

The functional evaluation aims to evaluate the function or performance of a body segment, and thinking about an evaluation in the surf we have to know which muscle groups are most sought after and some combinations of movement during the remade that are most recruited in this sporting gesture, which can lead to possible overloads and dysfunctions.

The muscles that are active during remade are mainly internal rotators and shoulder flexors. Surfers with complaints in this region appear to present a decrease in the amplitude of movement and lateral shoulder rotation strength. The muscles that are involved in the internal rotation of the shoulder can be shortened, leading to aberrant scapular tilt and lateral rotation. Further research should address the potential shortening of the pectoralis minor in this dysfunction, resulting in scapular dyskinesia and subacromial pain in surfers.[8]

Testing the most active muscles during the propulsion of the remade is a good evaluation strategy, being the muscles: chest, large dorsal, brachial triceps and deltoid, specifically the deltoid exercises greater activation at the beginning of the propulsion movement.[26]

IV) Assessment

During the evaluation of the shoulder complex, it is important to address beyond the joints that are part of it, including the glenohumeral, the acromioclavicular and the sternoclavicular joints. In addition, it is also relevant to evaluate the scapulo-thoracic joint, the subacromial joint and adjacent joints such as the thoracic and cervical.[41]

Special tests

Some tests may be provocative for subacromial pain, and among them are traditional tests for subacromial impact: Jobe (empty blade); Hawkins; Neer 1 and 2; Arc Painful and Lateral Rotation with resistance. Better accuracy if 3 of these 5 tests are positive.[42]
The following combinations and test results should be considered and analyzed: Empty blade (pain) - Full blade (no pain) = cinematic conflict without involvement of the Rotor Blade;[43,44] Empty blade and full blade + (pain) Rotor blade involvement in the painful shoulder.[43,44]
For shoulder instability, the following tests should be considered: provocative - Apprehension test - Relocation test; loose - Load & Shift (previous drawer) - Sulcus sign. However, to evaluate disorders related to the brachial biceps (SLAP lesion) are indicated the tests: Speeds test; Teste O' Brien; Biceps-Load Test.[45]
A joint assessment of strength, balance and neuromuscular control is required through clinical and functional tests: Glenoumeral Internal Rotation Test (GIRD); Lesser Breast Flexibility Test; Manual Dynamometry Tests for external (lateral) and internal (medial) shoulder rotators: due to weakness findings of lateral shoulder rotators in surfers, the evaluation of this movement becomes an interesting strategy, and manual dynamometry apparatus is required.[8]
The position of the surfer that best correlates the gesture of paddling is in ventral decubitus, since it is described in the literature there is no significant difference between the positions of measurement of lateral rotation.[46]
The scapulo-humeral rhythm (SHR) should consider the movement of the scapula during shoulder flexion/abduction movements with load, considering the body weight parameters of the patient with the added load on the upper limb to be tested, being people up to 68 kg = 2kg; people >68 kg = 3kg.[47] With shoulder flexion, the changes in the SHR are more obvious. Any obvious escapular dyskinesia such as winged scapula, excessive elevation and anterior *tilt,* may be related to shoulder dysfunction. This test should always be related to other tests and patients´ characteristics. It is important to assess and classify both scapulas as: normal, subtle dyskinesia, obvious dyskinesia.[47]
Elbow

I) Epidemiology and Biomechanics

Surfing elbow and forearm injuries are uncommon and account for an incidence of 3 to 6% of all injuries. There are no specific studies for the mechanism of injury of this segment, but they are probably related to the act of paddling, riding the wave and getting up on the board.[37,48]

II) Structures at risk

The type of injury is mostly tendinopathy and the structures most commonly involved are the tendons of the muscles: triceps, finger extensors and wrist, biceps brachial.[37]

III) Assessment

According to the main complaints, it becomes important to perform palpation of the following structures: medial epicondylum; lateral epicondylum; olecrane and tendon of the triceps; and biceps tendon. In case of pain during palpation (in non-traumatic cases), probably some inflammatory process is involved. Note: in case of painful palpation associated with symptoms such as shock, tingling, it is important to investigate compressive nerve syndromes. The Tinel test is valid for these situations. In addition, other special tests can be indicated in the evaluation of the elbow such as that of Mill and Cozen and the Golfer's Elbow, and it is important to also evaluate the muscle strength of pronation/ supination/ flexion and elbow extension/ flexion and extension of the handle, for this one can use a manual dynamometer.[49]

Hand and wrist

Hand and wrist injuries are uncommon during surfing. They range from 2.4 to 4.1% of all acute injuries and are related to direct trauma against the board itself or seabed floor.[23]
The most common types of injuries are contusions, fractures, dislocations, and small wounds. The work of Rujis and colleagues [50] showed the pattern of injuries occurring in the fingers of the hands due to compression caused by the "leash" when wrapped and strained in the finger, while the board is being pulled by the wave force. Our literature research found no reports regarding surfing practice and chronic hand and wrist injuries.

Functional tests

Mobility tests

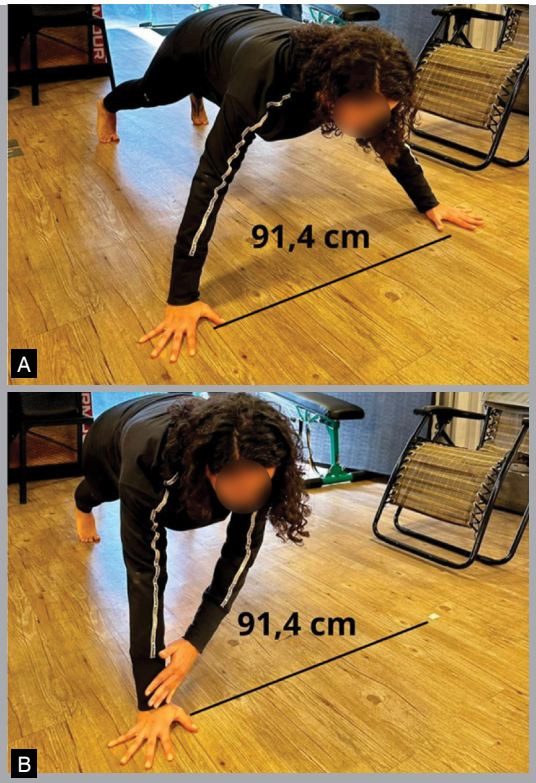
The amplitude of the shoulder's medial rotation movement is important to be evaluated as a medial rotation deficit <20% may increase the risks of injury for athletes who practice overhead sports.[51] This test has an intra-examinator correlation coefficient (ICC) of 0.85.[52]
The Leg Lateral Reach Test (LLRT) is a test used to evaluate the mobility of the toracolombar region. The test is performed with the surfer in dorsal decubitus, keeping the arms on the ground next to the trunk and raise the leg to be tested to the contralateral side seeking the greatest possible reach, without pulling the scapulas from the ground. The test has an ICC of 0.97 inter-examiners and 0.99 intra-examiners.[53]

Muscle Strength and Stability Tests

The evaluation of the isometric muscle strength of the lateral shoulder rotators is also important due to the surfer's paddling gesture. The test has an ICC of 0.88 for the non-dominant side and an ICC of 0.86 for the dominant side.[44] It is recommended to use an isometric dynamometer, evaluating with the patient in dorsal decubitus. Maximum strength should be evaluated for 5 seconds with a 30-second rest interval. 3 collections should be performed and made the average for final result.[52] (Figure 1)
The Modified Upper Quarter Y-Balance Test (mUQYBT) is a functional test that evaluates the stability and mobility of the upper limbs, unilaterally, in order to identify asymmetries that may place individuals at risk of a injury.[54] The range of the upper limbs in three directions is evaluated: medial, laterosuperior and laterosinferior. If it is necessary to normalize the length of the limb to perform the test calculation.[44] (Figure 2)
The Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) is an evaluation test for dynamic stability and muscle power of the upper limbs in closed kinetic chain, and can be used for both comparative purposes (used for treatment evolution), as well as potentially predictors of injury risk, being scores classified as bad (<21 repetitions), and good (>21 repetitions).[55] An intra-examiner intraclass correlation coefficient (ICC) of 0.92 was observed. (Figure 3)
According to Barbosa and colleagues,[56] systematic review, one can identify that the CKCUEST presented sufficient intersession and intrasession reliability, based on evidence of moderate quality.
Surfist Performance Level
When we talk about surfers, the same can be considered from a child who practices the sport in a recreational way, or even amateur (Grommets), where we need to be alert to avoid an early specialization in the modality, always seeking to the maximum development

Source: Authors.

Figure 1. Positioning for the evaluation of the isometric strength of the side rotators with dynamometer.



Legend: 91.4 cm distance between the hands; A: starting position; B: position during the execution of the hand shift. Source: Authors.

Figure 3. Closed Kinetic Chain Upper Extremity Stability test (CKCUEST).

of different motor skills/repertoires,[57] as well as adults in different age groups and levels of sporting ability. We may be dealing, in the outpatient assessment, with adult surfers or even elderly amateur (recreational), who are looking for a practice of physical activity and lifestyle, where they aim for longevity in the sport.[24] But we can also refer to the surfer, professional athlete, who is looking for better performance and in minimizing the risk of injuries.[36] In this sense, the direction of the musculoskeletal assessment of the surfer is directly related to the specificity of the modality, but also to the purpose of the surfer within the sport.

Personal and Behavioral Habits

Personal and behavioral habits in surfers at different skill levels may be related to prevention or the increased risk of musculoskeletal injury. It is well known that moderate to high intensity physical activity generates specific adaptations, and good eating habits are necessary to generate the necessary contribution for these adaptations.[58] In addition, the hydration routine is a crucial point in surfers, since it is practiced in different environmental conditions, different clothing and different degrees of intensity, and without any water replacement during the practice.[12] Adequate sleep promotes restoration in the immune, endocrine and nervous system, with direct action in reducing injury and performance.[59] The routine and periodization of training is another factor to be considered since, depending on the environmental conditions, the surfers will be exposed to the technical and tactical training of the modality in greater or smaller amount.[60]

The present study presents limitations because it is a review study based on the existing but scarce on the specific topic related to surfing. However, this group of researchers and clinicians directly

Legend: A: direction. Source: Authors.

Figure 2. Modified Upper Quarter Y Balance Test.

involved in the modality, sought to develop a guideline of clinical practices that could assist in the decision-making process for health professionals working with recreational and surfing athletes, that shows a strong growth in Brazil and the world. We highlighted, and stimulated through this study, the need for more prospective studies with better methodological quality focused on the topic of surfers physical assessment.

FINAL CONSIDERATIONS

This guideline compiled important information concerning the prevalence of musculoskeletal injuries of the upper quarter in the surfer, guiding the surfer's outpatient evaluation, considering the specificity of the sport and biomechanical gesture involved. In addition, the need for scientific studies aimed at surf medicine becomes even more obvious.

AUTHOR'S CONTRIBUTION: Each author personally and significantly contributed to the development of this article: GVL: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; ET: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; PS: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; AR: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; GCB: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published.

REFERENCES

1. Rice EL. Surfing. J Sports Med Phys Fitness. 2021;61(8):1098-1103. doi: 10.23736/S0022-4707.21.12847-6.
2. Morgan D, Ozanne-Smith J. Surf lifeguard rescues. Wilderness Environ Med. 2013;24(3):285-90. doi: 10.1016/j.wem.2013.02.001.
3. Nathanson A, Bird S, Dao L, Tam-Sing K. Competitive surfing injuries: a prospective study of surfing-related injuries among contest surfers. Am J Sports Med. 2007;35(1):113-7. doi: 10.1177/0363546506293702.
4. Bazanella NV, Garrett JGZD, Gomes ARS, Novack LF, Osiecki R, Korelo RIG. Influence of practice time on surfing injuries. Fisioter. mov. 2017;30. doi: 10.1590/1980-5918.030.S01.AO02.
5. Minasian B, Hope N. Surfing on the world stage: a narrative review of acute and overuse injuries and preventative measures for the competitive and recreational surfer. Br J Sports Med. 2022;56(1):51-60. doi: 10.1136/bjsports-2021-104307.
6. Takeuchi E, Lacerda SS, Brech GC, Kozasa EH. An Integrated Mind–Body Training Intervention on an Elite Surfing Athlete: A Case Study. Case Studies in Sport and Exercise Psychology. 2023;7(1):1–7. doi: 10.1123/cssep.2022-0006.
7. Tavares A. Surf Ranch e as piscinas de ondas. O surfe moderno também está passando por um processo de "arenização"? Esporte e Sociedade [Internet]. 2021;13(32):1–16. Available at: https://periodicos.uff.br/esportesociedade/article/view/49490/2878.
8. Langenberg LC, Vieira Lima G, Heitkamp SE, Kemps FLAM, Jones MS, Moreira MAAG, et al. The Surfer□s Shoulder: A Systematic Review of Current Literature and Potential Pathophysiological Explanations of Chronic Shoulder Complaints in Wave Surfers. Sports Med Open. 2021;7(1):2. doi: 10.1186/s40798-020-00289-0.
9. Hanchard S, Duncan A, Furness J, Simas V, Climstein M, Kemp-Smith K. Chronic and Gradual-Onset Injuries and Conditions in the Sport of Surfing: A Systematic Review. Sports (Basel). 2021;9(2):23. doi: 10.3390/sports9020023.
10. LaBotz M, Bernhardt DT. Preparticipation physical examination: Is it time to stop doing the sports physical? Br J Sports Med. 2017;51(3):151-152. doi: 10.1136/bjsports-2016-096892.
11. Farzam K, Daley SF, Akhondi H. Sports Participation Evaluation. 2024 Feb 12. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–.
12. Atencio JK, Armenta RF, Nessler JA, Schubert MM, Furness JW, Climstein M, et al. Fluid Loss in Recreational Surfers. Int J Exerc Sci. 2021;14(6):423-434. doi: 10.70252/CFEM3755.
13. Maron BJ, Thompson PD, Ackerman MJ, Balady G, Berger S, Cohen D, et al. Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. Circulation. 2007;115(12):1643-455. doi: 10.1161/CIRCULATIONAHA.107.181423.
14. Maron BJ, Friedman RA, Kligfield P, Levine BD, Viskin S, Chaitman BR, et al. Assessment of the 12-lead ECG as a screening test for detection of cardiovascular disease in healthy general populations of young people (12-25 Years of Age): a scientific statement from the American Heart Association and the American College of Cardiology. Circulation. 2014;130(15):1303-34. doi: 10.1161/CIR.0000000000000025.
15. Aldred S, Love JA, Tonks LA, Stephens E, Jones DS, Blannin AK. The effect of steady state exercise on circulating human IgE and IgG in young healthy volunteers with known allergy. J Sci Med Sport. 2010;13(1):16-9. doi: 10.1016/j.jsams.2008.07.001.
16. Apró W, Blomstrand E. Influence of supplementation with branched-chain amino acids in combination with resistance exercise on p70S6 kinase phosphorylation in resting and exercising human skeletal muscle. Acta Physiol (Oxf). 2010;200(3):237-48. doi: 10.1111/j.1748-1708.2010.02151.x.
17. HajGhanbari B, Yamabayashi C, Buna TR, Coelho JD, Freedman KD, Morton TA, et al. Effects of respiratory muscle training on performance in athletes: a systematic review with meta-analyses. J Strength Cond Res. 2013;27(6):1643-63. doi: 10.1519/JSC.0b013e318269f73f.
18. Mendez-Villanueva A, Bishop D. Physiological aspects of surfboard riding performance. Sports Med. 2005;35(1):55-70. doi: 10.2165/00007256-200535010-00005.
19. Chapman DW, Needham KJ, Allison GT, Lay B, Edwards DJ. Effects of experience in a dynamic environment on postural control. Br J Sports Med. 2008;42(1):16-21. doi: 10.1136/bjsm.2006.033688.
20. Alcantara CPA, Prado JM, Duarte M. Analysis of the balance control in surfers during the erect posture. Revista Brasileira de Medicina do Esporte. 2012;18(5):318–21.
21. Paillard T, Margnes E, Portet M, Breucq A. Postural ability reflects the athletic skill level of surfers. Eur J Appl Physiol. 2011;111(8):1619-23. doi: 10.1007/s00421-010-1782-2.
22. Nathanson A, Haynes P, Galanis D. Surfing injuries. Am J Emerg Med. 2002;20(3):155-60. doi: 10.1053/ajem.2002.32650.
23. Taylor DM, Bennett D, Carter M, Garewal D, Finch CF. Acute injury and chronic disability resulting from surfboard riding. J Sci Med Sport. 2004;7(4):429-37. doi: 10.1016/s1440-2440(04)80260-3.
24. Inada K, Matsumoto Y, Kihara T, Tsuji N, Netsu M, Kanari S, et al. Acute injuries and chronic disorders in competitive surfing: From the survey of professional surfers in Japan. Sports Orthopaedics and Traumatology. 2018;34(3):256–60. doi: 10.1016/j.orthtr.2018.03.107.
25. Furness J, Hing W, Abbott A, Walsh J, Sheppard JM, Climstein M. Retrospective analysis of chronic injuries in recreational and competitive surfers: Injury location, type, and mechanism. International Journal of Aquatic Research and Education. 2014;8(3):277–87. doi: 10.25035/ijare.08.03.06.
26. Nessler JA, Ponce-Gonzalez JG, Robles-Rodriguez C, Furr H, Warner M, Newcomer SC. Electromyographic Analysis of the Surf Paddling Stroke Across Multiple Intensities. J Strength Cond Res. 2019;33(4):1102-1110. doi: 10.1519/JSC.0000000000003070.
27. Peter VW, Anja D, Luc A, Anne B, Christophe D, Bart D, et al. Low back pain and radicular pain: evaluation and management. KCE Reports. Brussel: Belgian Health Care Knowledge Centre (KCE); 2017.
28. Macedo CSG, Souza PR, Alves PM, Cardoso JR. Study of validity and intra and inter observer reliability of modified modified schober test in subject with low-back pain. Fisioter. Pesqui. 2009;16(3):233–8.
29. Furness J, Climstein M, Sheppard JM, Abbott A, Hing W. Clinical methods to quantify trunk mobility in an elite male surfing population. Phys Ther Sport. 2016;19:28-35. doi: 10.1016/j.ptsp.2015.09.003.
30. O'gorman H, Jull G. Thoracic kyphosis and mobility: the effect of age. Physiotherapy Practice. 1987;3(4):154–62. doi: 10.3109/09593988709044180.
31. Lewis JS, Valentine RE. Clinical measurement of the thoracic kyphosis. A study of the intra-rater reliability in subjects with and without shoulder pain. BMC Musculoskelet Disord. 2010;11:39. doi: 10.1186/1471-2474-11-39.
32. Garcés GL, González-Montoro I, Rasines JL, Santonja F. Early diagnosis of stress fracture of the lumbar spine in athletes. Int Orthop. 1999;23(4):213-5. doi: 10.1007/s002640050353.
33. Gandhi J, Lee MY, Joshi G, Khan SA. Surfer□s myelopathy: A review of etiology, pathogenesis, evaluation, and management. J Spinal Cord Med. 2021;44(1):2-7. doi: 10.1080/10790268.2019.1577057.
34. Alva-Díaz C, Rodriguez-López E, López-Saavedra A, Metcalf T, Morán-Mariños C, Navarro-Flores A. et al. Is Surfer's myelopathy an acute hyperextension-induced myelopathy? A systematic synthesis of case studies and proposed diagnostic criteria. J Neurol. 2022;269(4):1776-1785. doi: 10.1007/s00415-021-10775-4.

35. Guo Z, Wang H. Influence of Core Training on the Ability of Control and Balance in Surfers. Revista Brasileira de Medicina do Esporte. 2022;28(6):723–5. doi: 10.1590/1517-8692202228062022_0042.
36. Hohn E, Robinson S, Merriman J, Parrish R, Kramer W. Orthopedic Injuries in Professional Surfers: A Retrospective Study at a Single Orthopedic Center. Clin J Sport Med. 2020;30(4):378-382. doi: 10.1097/JSM.0000000000000596.
37. Patel BJ, Heath MR, Geannette CS, Fabricant PD, Greditzer HG 4th. When the Wave Breaks You: Magnetic Resonance Imaging Findings After Surfing Injuries. Sports Health. 2020;12(1):88-93. doi: 10.1177/1941738119880863.
38. Schenk R, Donaldson M, Parent-Nichols J, Wilhelm M, Wright A, Cleland JA. Effectiveness of cervicothoracic and thoracic manual physical therapy in managing upper quarter disorders - a systematic review. J Man Manip Ther. 2022;30(1):46-55. doi: 10.1080/10669817.2021.1923313.
39. Nessler JA, Silvas M, Carpenter S, Newcomer SC. Wearing a Wetsuit Alters Upper Extremity Motion during Simulated Surfboard Paddling. PLoS One. 2015;10(11):e0142325. doi: 10.1371/journal.pone.0142325.
40. Meir R, Zhou S, Rolfe M, Gilleard W, Coutts R. An investigation of surf participation and injury prevalence in Australian surfers: a self-reported retrospective analysis. New Zealand Journal of Sports Medicine. 2012;39(2):52.
41. Rosedale R, Rastogi R, Kidd J, Lynch G, Supp G, Robbins SM. A study exploring the prevalence of Extremity Pain of Spinal Source (EXPOSS). J Man Manip Ther. 2020;28(4):222-230. doi: 10.1080/10669817.2019.1661706.
42. Hughes PC, Green RA, Taylor NF. Measurement of subacromial impingement of the rotator cuff. J Sci Med Sport. 2012;15(1):2-7. doi: 10.1016/j.jsams.2011.07.001.
43. Michener LA, Walsworth MK, Doukas WC, Murphy KP. Reliability and diagnostic accuracy of 5 physical examination tests and combination of tests for subacromial impingement. Arch Phys Med Rehabil. 2009;90(11):1898-903. doi: 10.1016/j.apmr.2009.05.015.
44. Cools AM, Maenhout AG, Vanderstukken F, Declève P, Johansson FR, Borms D. The challenge of the sporting shoulder: From injury prevention through sport-specific rehabilitation toward return to play. Ann Phys Rehabil Med. 2021;64(4):101384. doi: 10.1016/j.rehab.2020.03.009.
45. Hegedus EJ, Goode A, Campbell S, Morin A, Tamaddoni M, Moorman CT 3rd, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. Br J Sports Med. 2008;42(2):80-92; discussion 92. doi: 10.1136/bjsm.2007.038406.
46. Riemann BL, Davies GJ. Limb, Sex, and Anthropometric Factors Influencing Normative Data for the Biodex Balance System SD Athlete Single Leg Stability Test. Athl Train Sports Health Care. 2017;5(5):224-232. doi: 10.3928/19425864-20130827-02.
47. McClure P, Tate AR, Kareha S, Irwin D, Zlupko E. A clinical method for identifying scapular dyskinesis, part 1: reliability. J Athl Train. 2009;44(2):160-4. doi: 10.4085/1062-6050-44.2.160.
48. Minghelli B, Nunes C, Oliveira R. Injuries in recreational and competitive surfers: a nationwide study in Portugal. J Sports Med Phys Fitness. 2018;58(12):1831-1838. doi: 10.23736/S0022-4707.17.07773-8.
49. Pozzi F, Plummer HA, Shanley E, Thigpen CA, Bauer C, Wilson ML, et al. Preseason shoulder range of motion screening and in-season risk of shoulder and elbow injuries in overhead athletes: systematic review and meta-analysis. Br J Sports Med. 2020;54(17):1019-1027. doi: 10.1136/bjsports-2019-100698.
50. Ruijs AC, Langenberg LC, Rezzouk J. Finger Trauma Due to Surfing; A Case Series and Analysis of Fracture Patterns. J Hand Surg Asian Pac. 2017;22(1):10-13. doi: 10.1142/S0218810417500010.
51. Guney H, Harput G, Colakoglu F, Baltaci G. The Effect of Glenohumeral Internal-Rotation Deficit on Functional Rotator-Strength Ratio in Adolescent Overhead Athletes. J Sport Rehabil. 2016;25(1):52-7. doi: 10.1123/jsr.2014-0260.
52. Gillet B, Begon M, Sevrez V, Berger-Vachon C, Rogowski I. Adaptive Alterations in Shoulder Range of Motion and Strength in Young Tennis Players. J Athl Train. 2017;52(2):137-144. doi: 10.4085/1062-6050.52.1.10.
53. Kim SH, Kwon OY, Park KN, Hwang UJ. Leg lateral reach test: The reliability and correlation with thoraco-lumbo-pelvic rotation range. J Sci Med Sport. 2017;20(1):2-5. doi: 10.1016/j.jsams.2016.04.006.
54. Williamson JD, Lawson BL, Sigley D, Nasypany A, Baker RT. Intra- And Inter-Rater Reliability For Limb Length Measurement And Trial Error Assessment Of The Upper Quarter Y-Balance Test In Healthy Adults. Int J Sports Phys Ther. 2019;14(5):707-714.
55. Torabi TP, Bencke J, van den Tillaar R. The Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) Performance in Elite Team Handball Players Playing with Shoulder Pain, Previous Pain, or No Pain. Int J Sports Phys Ther. 2024;19(2):189-198. doi: 10.26603/001c.92014.
56. Barbosa GM, Calixtre LB, Fonseca Fialho HR, Locks F, Kamonseki DH. Measurement properties of upper extremity physical performance tests in athletes: a systematic review. Braz J Phys Ther. 2024;28(1):100575. doi: 10.1016/j.bjpt.2023.100575.
57. Seixas P, Oliveira R, Carita AI, Moreira M, Carita A. Musculoskeletal injuries in Portuguese junior elite surfers: an epidemiological and fitness exploratory study. IOSR Journal of Sports and Physical Education (IOSR-JSPE). 2022;9(1):32–41.
58. Reitzner SM, Emanuelsson EB, Arif M, Kaczkowski B, Kwon AT, Mardinoglu A, et al. Molecular profiling of high-level athlete skeletal muscle after acute endurance or resistance exercise - A systems biology approach. Mol Metab. 2024;79:101857. doi: 10.1016/j.molmet.2023.101857.
59. Nobari H, Banihashemi M, Saedmocheshi S, Prieto-González P, Oliveira R. Overview of the impact of sleep monitoring on optimal performance, immune system function and injury risk reduction in athletes: A narrative review. Sci Prog. 2023 Oct;106(4):368504231206265. doi: 10.1177/00368504231206265.
60. Farley OR, Secomb JL, Parsonage JR, Lundgren LE, Abbiss CR, Sheppard JM. Five Weeks of Sprint and High-Intensity Interval Training Improves Paddling Performance in Adolescent Surfers. J Strength Cond Res. 2016;30(9):2446-52. doi: 10.1519/JSC.0000000000001364.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290579

PHYSICAL ASSESSMENT IN SURFERS: GUIDELINES FOR HEALTH PROFESSIONALS - PART 2 LOWER QUARTER

AVALIAÇÃO FÍSICA NO SURFISTA: DIRETRIZES PARA OS PROFISSIONAIS DE SAÚDE - PARTE 2 QUADRANTE INFERIOR

Guilherme Carlos Brech[1,2,3,4], Eduardo Takeuchi[1,2], Pedro Miguel Carriço de Seixas[1,5,6], Alexander Rehder[1], Marcus Vinicius Pereira Prada[1], Marcelo Baboghluian[1], Guilherme Vieira Lima[1,2,5,7]

1. Grupo de Estudos do SID (Surf Information Data), Sao Paulo, SP, Brazil.
2. Personal Boards, Sao Paulo, SP, Brazil.
3. Universidade de Sao Paulo (USP), Departamento de Ortopedia e Traumatologia, Laboratorio do Estudo do Movimento, Sao Paulo, SP, Brazil.
4. Universidade Sao Judas Tadeu, Programa de Pos-Graduacao em Ciencias do Envelhecimento, Sao Paulo, SP, Brazil.
5. Surfing Medicine International (SMI), Netherlands.
6. Escola Superior de Saude Atlantica, Oeiras, Portugal.
7. Faculdade de Medicina do ABC, Departamento de Ortopedia e Traumatologia, Cirurgia de Ombro e Cotovelo, Santo Andre, Sao Paulo, SP, Brazil.

ABSTRACT

Musculoskeletal injuries in the lower quarter during surfing are primarily associated with the sport's fundamental movements. This movements occur when the surfer is standing on the board, riding the wave. The injuries are typically acute, with severity and complexity varying according to the surfer's skill level and maneuvers performed. The objective of the present study was to conduct an integrative review of studies related to the musculoskeletal assessment of the lower quarter, focusing on physical examinations and functional tests applicable to surfers. This integrative review was carried out through a literature review, evaluating and analyzing papers from national and international journals indexed in the scientific databases Scielo and PubMed. The developement and analysis involved a panel of experts in the field of medicine and surfing health composed of physical educators, physiotherapists and sports doctors. This guideline aims to complement the information presented in the upper quarter article, emphasizing the prevalence of musculoskeletal injuries in the lower quarter among surfers and guiding outpatient assessments. It considers the specificities of surfing and the biomechanical movements involved. ***Level of Evidence III; Expert opinion.***

Keyword: Practice Guideline; Water Sports; Musculoskeletal Pain; Knee; Hip; Ankle.

RESUMO

As lesões musculoesqueléticas do quadrante inferior durante a prática esportiva do surfe, estão associadas principalmente ao gesto da modalidade esportiva. Gesto este relacionado ao momento em que o surfista se encontra em pé sobre a prancha, surfando a onda. As lesões apresentam características agudas, variando sua gravidade e complexidade conforme o nível de habilidade do surfista, em função das manobras realizadas. O objetivo do presente estudo foi realizar uma atualização referente aos estudos relacionados à avaliação musculoesquelética do quadrante inferior, relacionada ao exame físico e testes funcionais que possam ser aplicados ao surfista. Trata-se de estudo de atualização baseado em uma revisão integrativa através de levantamento bibliográfico no qual foram avaliados periódicos nacionais e internacionais indexados nas bases científicas Scielo e PubMed, desenvolvida e analisada por um grupo de especialistas na área de medicina e saúde do surfe composta por educador físico, fisioterapeutas e médicos do esporte. Este estudo de diretrizes buscou complementar as informações do artigo de quadrante superior, destacando a prevalência de lesões e avaliação musculoesqueléticas do quadrante inferior no surfista, norteando a avaliação ambulatorial do surfista, pensando na especificidade da modalidade e gesto biomecânico envolvido. ***Nível de Evidência III; Opinião do especialista.***

Descritores: *Guia de Prática Clínica; Esportes Aquáticos; Dor Musculoesquelética; Joelho; Quadril; Tornozelo.*

Citation: Brech GC, Takeuchi E, Seixas PMC, Rehder A, Prada MVP, Baboghluian M, Lima GV. Physical assessment in surfers: Guidelines for health professionals - Part 2 lower quarter. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 7. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Surfing has become popular worldwide[1,2] and even more in Brazil due to the recent achievements of professional surfers. With this growth, there is an increased exposure to the risk of injuries among practitioners.[3,4]

During surfing, the surfer needs physical skills such as balance, flexibility, muscle strength and agility.[2] It is considered an intermittent activity, with the surfer spending approximately 50 to 60% of the time paddling, while lying on the board; 30 to 40% in a stationary

All authors declare no potential conflict of interest related to this article.

The study was conducted at Grupo de Estudos do SID (Surf Information Data), Sao Paulo, SP, Brazil.
Correspondence: Guilherme Carlos Brech. 333, Rua Ovídio Pires de Campos, Cerqueira César, São Paulo, Brazil. 05403-010. guibrech@gmail.com

Article received on 09/25/2024 approved on 01/31/2025.

phase, sitting on the board, and only 8 to 10% standing on the board performing maneuvers. The duration of this last phase can vary depending on the surfer's skill level [5,6]
However, when the surfer is riding the wave, the musculoskeletal system of the lower limb, experiences great demand. At this stage of the activity, the prevalence of both acute and chronic injuries is directly related to the surfer's level of performance and skill.[7-12]
When analyzing the prevalence of musculoskeletal injuries in surfers, it is known that the lower limbs present a high incidence of involvement.[10,13,14] All the demand placed on the lower limbs during surfing occurs within a closed kinetic chain.[15] The structures of the lower limbs are subject to impact forces due to the explosive effort required for the movement and maneuvering the board. Additionally, the constant posture adopted during the sport, characterized by knee flexion and *valgus*, as well as the rotation of the femur relative to the fixed tibia imposes overload on static stabilizers of the knee, such as ligaments, joint capsule and meniscus. Consequently, an increase in the number of injuries has been observed among professional surfers in recent years.
Therefore, it is important to establish guidelines that can assist in the practice of evidence-based clinical evaluation for surfers in the outpatient setting. This includes assessments of the musculoskeletal system though physical examination and functional tests for the lower quarter, such as monitoring training load control, evaluating preventive strategies to minimize injury risk, and tracking the progression of treatment and performance.

OBJECTIVE

The aim of this study is to provide an update on studies related to the evaluation of the musculoskeletal system in surfers' lower quarter, focusing on physical examinations and functional tests.

MATERIALS AND METHODS

This is an update study in which a bibliographic survey was conducted between June 2023 and July 2024 on Scielo and PubMed platforms, with terms related to surfing. However, as the scientific production on the theme is still quite scarce, the search has been expanded to support the construction of the physical evaluation guideline and functional tests in the surfer for the lower quarter.

Clinical evaluation

Periodic clinical evaluations are routine for athletes and practitioners to enhance performance and prevent injuries, as they allow identification of opportunities for improvement and risk factors[16].
As noted in the upper quarter assessment, the goal is to determine the individual's physical and psychological health, providing a foundation for guidance and targeted interventions in training, nutrition, and mental health.
As surfers are exposed to highly variable environmental conditions, these assessments become indispensable. The clinical identification of conditions such as cardiomyopathies, valvopathies, hypertension, diabetes, hormonal imbalances, anemia, and others of any age are also essential[17,18]

Hip

I) Epidemiology and Biomechanics

Scientific reports on hip injuries in surfers remain scarce. According to Hohn and colleagues[19], hip injuries account for approximately 10% of all surfer injuries. In this retrospective study, it was observed that 62% of hip injuries require surgical intervention, with the average age of athletes undergoing surgery being 33.1 years. Femoroacetabular impingement (FAI) was identified as the most common injury to this joint, representing 67% of cases.
A factor in the surfer's technique that may be associated with hip injuries could be related to the evolution of maneuvers. However, although an increase in hip injuries has been observed, this trend was not statistically significant, unlike the increase seen in ankle injuries.[19,20]

II) Structures at Risk

FAI is the most common injury mechanism, with the primary structures at risk being the femoral labrum and the acetabular rim, which may also involve cartilage defects. Additionally, injuries can occur in the bone marrow and round ligament, as well as joint impact, osteoarthritis, and loose bodies. Extra-articular structures that can also be affected by FAI related injuries include muscles and tendons, ischiofemoral impingement, trochanteric bursitis, iliopsoas tendinopathy, and strains of the hip adductors and flexors.[21]

III) Evaluation

The evaluation of surfers hip should be comprehensive, encompassing both extra-articular and intra-articular conditions. Hip mobility should be thoroughly assessed to identify potential restrictions that may predispose the athlete to injuries. Range of motion (ROM) tests are essential for determining joint flexibility and functionality.[20]
FAI is a common condition among surfers, characterized by abnormal contact between the femoral neck and the acetabulum. There are three main types of FAI: CAM, PINCER, and COMBINED. The prevalence of FAI is estimated to affect around 10 to 15% of the population, making it a primary cause of hip pain in athletes.[21,22]
The clinical presentation varies, with young men being more prone to CAM type impingement and women more commonly affected by PINCER. The pain is typically located in the groin and sometimes lateral aspect of the hip, often exacerbated by repeated or prolonged bending, internal rotation, or abduction movements.[19,20]
Fadir and Faber tests may be positive, and anterior pelvic tilt may be present.[21,22]
The strength and function of the gluteal muscles are essential for maintaining hip stability. Weakness in the gluteal medium and minimum can contribute to various painful conditions and hip dysfunctions.[22]

Extra-Articular Conditions

Pubalgia is a common condition in sports that involve repetitive, high-intensity movements, such as surfing. It is associated with hip muscle weakness (adductor strength less than 80%), abdominal weakness, reduced hip range of motion (ROM) [20], and training specificity. During physical examination, assessments should include palpation, the squeeze test, ROM evaluation, and flexibility assessment.[21,22]
Ischiofemoral Impingement Syndrome (IFI) is an injury that affects the proximal tendons of the hamstrings and common in sports involving explosive and high-intensity movements.[21,22] Assessing the strength and flexibility of the hip flexors is crucial for identifying muscle imbalances that may predispose individuals to injuries.[20]

Intra-Articular Conditions

These conditions may be associated with bone deformities that cause impact between the femur and the acetabulum, such as in FAI, or due to anomalies in hip development, like developmental dysplasia of the hip (DDH).[21,22] In these cases, structural changes in the shape of the acetabulum can affect joint congruence[20], potentially leading to micro instability either predisposed or acquired and damage to the round ligament.[21,22] Additionally, acetabular labrum injuries can cause pain and instability and may be associated with cartilage damage and osteochondral injuries.[20] Such cases may also present fragments of bone or cartilage within the joint, known as loose bodies.[21,22]

III) Clinical Assessment

The clinical evaluation of the surfer's hip should consider the demands, volume, and intensity of training.[21,22] Addionally, it is important to assess genetic predisposition to certain conditions[20] and anatomical variations that may increase the risk of injuries. Decreased range of motion of the hip, along with muscle weakness, can predispose individuals to a higher risk of injury.[21,22]

A thorough assessment and understanding of hip conditions is essential for the effective management of surfers' injuries, enabling targeted and specific treatment strategies to enhance performance and prevent future injuries.

Knee

I) Epidemiology and Biomechanics

The knee is a joint that deserves special attention among surfers, as the incidence of injuries ranges from 10 to 28%.[9,23] The increased incidence of these injuries has been observed in the last 15 years due to the change in pattern of maneuvers performed by athletes. Air maneuvers are the main responsible, especially at the time of landing, when the surfer's knee is subjected to a valgus stress force at the time of contact of the board with the feet, while landing on the unstable surface of the moving water.[19,24]

II) Structures at Risk

The main structures at risk are: medial collateral ligament (MCL), anterior cruciate ligament (ACL), and medial meniscus. Other less common are quadriceps and hamstring muscle injuries.[24,25]

The study by Hohn and colleagues[19] shows that in MCL injuries are more frequent for the lower limb positioned closer to the board's nose (63%), while for meniscal injuries the most affected limb is the one that is positioned closer to the board's tail (71% of cases).

III) Clinical evaluation

Musculoskeletal evaluation of the knee should address flexion and extension mobility for both knees. Knee extension deficits may be related to muscle shortenings, which can directly impact performance and increase the risk of injury in athletes.[26]

The static physical examination should be carried out bilaterally, initially evaluating the stability of the knee, taking into account the ligament and meniscal structure. *Valgus* and *varus* stress test to evaluate side ligaments. Previous drawer tests, Lachman or Pivot Shift, to evaluate the ACL. For meniscus evaluation, McMurray and Apley tests can be used.[27]

The dynamic evaluation of the knee should take into account the dynamic knee valgus (internal femur rotation + knee valgus), which may present weakness of hip stabilizers, and may be associated with the increased risk of knee injuries, especially the ligaments. This fact may also be aggravated by progressive maneuvers performance (e.g. aerials), which require some degree of impact and instability while landing, as well as repeated back-foot movements, with sharp valgus during the critical maneuvers. It si known that to improve the motor behavior of dynamic knee valgus, exercise programs aimed at greater muscle activation of the hip muscles are necessary,[28,29] which can facilitate strategies capable of minimizing injury risks or correction of the sporting gesture.[30]

For the clinical diagnosis of dynamic knee valgus, we can use the *Step Down* test that qualitatively evaluates the closed-chain kinetic stability of hip stabilizers. It only needs a 20 cm step. It should be observed the presence of contralateral pelvic fall or elevation, ipsilateral hip induction or internal rotation and ipsilateral knee valgus. This is a qualitative assessment that qualifies the movement in: high risk (when the patella moves inward, ending medially at the first finger of the foot); and low risk (when the patella ends in line with the first finger of the foot or laterally).[31,32] You can also use a camera to record and assist movement analysis to compare the movement. (Figure 1)

Source: Authors.

Figure 1. Step down test.

Ankle and foot

I) Epidemiology and Biomechanics

Ankle injuries are very common in general sports practice. In surfing, the incidence of injuries in this joint compared to practices such as basketball, volleyball and football is much lower. According to Furness and colleagues,[33] the incidence of acute ankle injuries was 14.6% in 1348 surfers who participated in the study, with the main mechanism being direct trauma in 54.6% of cases, followed by stumbling's caused by base maneuvers in 30.6% of cases, and by aerial maneuvers in 13.9% of cases. In this study, the authors did not demonstrate a difference between professional and recreational surfers. Taylor and colleuagues, in their study with 668 surfers, demonstrated an incidence of 17.8% ankle and foot injuries, comprised by lacerations (n=17); sprains (n=10) and fractures (n=3).[14] As for the most affected ankle in the surfer, the study of Hohn nd colleagues[19] observed that the back-foot ankle is committed in 73% of the incidents. Another problem is the repetitive wrinkle, where up to 80% of athletes will have recurrent wrinkles and up to 72% may develop chronic ankle instability.[34]

In recent years, we have observed a greater incidence of ankle injuries in surfers who are able to perform the aerial maneuver. Several authors point out the importance of the execution of this maneuver for the significant increase in the scores in competitive surf, however it is noteworthy that the success rate of aerial maneuvers in competitions is below 50%, and consequently, the risk of injury is also elevated.[35] Even if the surfer is unable to perform the aerial, surfing a wave requires continuous and relatively rapid force production and stopping, especially in the lower body.[36]

In addition to the sprain, direct trauma of the foot with the board or with the seabed, can cause fractures, being metatarsal fractures the most frequent in the practice of surfing.

II) Structures at risk

The main structures at risk in ankle injuries in surfers are the bone and stabilizing structures of the ankle and foot. The surfer may have Lisfranc joint luxation and fractures and metatarsal fractures, which are often neglected. Injuries in the ankle joint can compromise the subtalar joint, as well as more complex ligamentar ankle injuries such as syndesmosis.[24,37]

III) Clinical Assessment

The American Orthopedic Foot and Ankle Society presents an instrument called the Ankle-Hindfoot Scale (AOFAS) which is a clinical evaluation tool used primarily by health professionals to evaluate the function, pain and alignment of the foot and ankle, and is often used to evaluate the effectiveness of treatments and interventions for foot and ankle conditions, the scale has been translated and adapted with reproducibility and reliability for Portuguese.[38]

In the physical examination, physical tests should be conducted to evaluate the amplitude of movement and muscle strength, joint stability and function of the muscles and ligaments of the ankle and foot.[39] In cases of ankle sprain or instability it becomes important to evaluate the lateral ligamentary complex (mainly the anterior talofibular ligament and calcaneofibular). In cases of history of sprains with greater energy and complexity need to investigate the ankle joint syndesmosis. Balance tests are also important to evaluate the patient's ability to maintain balance and awareness of ankle and foot position.[40]

Functional tests and computerized analysis

Functional tests are mainly used for functional evaluation of the knees and ankles. Functional performance tests are useful predictors of lower extremity performance.

Localized ankle instability and chronic sprains can directly impact postural control, functional deficiencies have been identified, which can generate imbalances not only in the ankle,[34,41,42] as well as the inverse is also used (general stability) for the development of proprioceptive control, neuromuscular and balance training, which considerably reduce the risk of recurring sprains in the ankle.[43-45] During the aerial maneuver, inefficiency in the absorption of the forces generated at landing can result in acute injuries in the lower limbs.[36] A similar mechanism occurs in improper basketball landings, directly linked to patellar tendinopathy.[46]

In landing, the joints of the lower end work together to relieve the impact forces. A lower amplitude of ankle dorsiflexion movement in the landing is associated with a lower knee flexion and greater ground reaction loads, enabling greater valgus knee displacement and increasing the likelihood of injury.[47] According to Lundgren et al.,[48] ankle dorsiflexion movement amplitude can be an important factor in allowing the surfing athlete to perform an aerial landing with movement amplitude, decreasing peak force and reducing direct joint load and consequently decreasing the likelihood of injury.

Lower Quarter Y-Balance Test

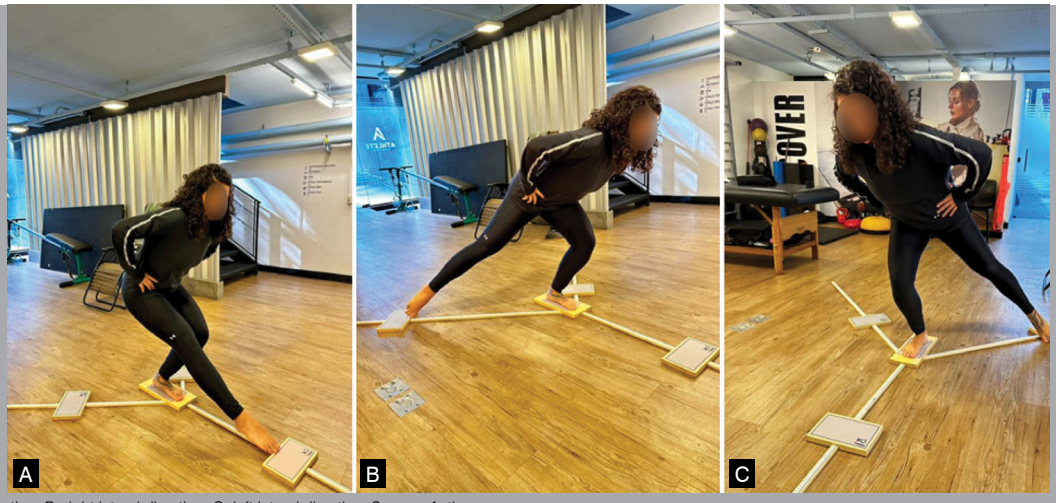
The Lower Quarter Y-Balance Test (YBT), also known as the Y-Test, is a dynamic balance test that requires strength, flexibility and proprioception. It aims to evaluate the risk of injury to the lower limbs and analyze the evolution of treatment.[49] It is a test that allows to evaluate the ankle, knee and hip, evaluating the dynamic stabilization in the three directions: anterior, posteromedial and posterolateral.[50] The goal of the test is to maintain the position on a single leg and exercise the maximum extension force of the contralateral leg seeking the greatest range while keeping the dynamic postural balance.[49] During the execution of the test the surfer should push the target over the tube as far away as possible, keeping the hands on the hip and the test calcaneum standing on the platform. Distance is computed. The values are discarded if the surfer does not maintain the posture on the platform, or loses foot contact with the target during the movement of the same or if the foot has not returned to the initial posture.[49,51] It is recommended that you make nine attempts (three for each direction), being only the first six for familiarization. For data normalization should be used the calculation of the *distance* obtained in an attempt x 100/ relative length of the limb.

To evaluate the performance of the surfer in the test should be considered the sum of the three reach directions, and the score is calculated from the total distance of the excursion dividing by three times the length of the limb (Figure 2). The length of the limb consists of the distance measured from the anterior iliac spine to the top of the external malleolus.[52] In this sense, the test parameters can be both comparative (for treatment progression) and potentially predictive of risk of injury, if interlimb difference on the anterior reach distance is $< 94\%$.

Hop e Single-Legged Hop Tests

The battery of tests called Single-Legged Hop Tests, developed by Fitzgerald et al.[53] has been widely used in clinical practice as a tool to evaluate neuromuscular control. These tests involve directional shifts and acceleration-deterioration movements, replicating the sporting demands specific to the knee and ankle of surfers.[54,55] Assess the jumps with the greatest range possible, keeping balance and stability during landing.

The Single-Legged Hop Tests comprise four types of jumps: single-leg hop, triple hop, cross-over hop, and 6-meter timed hop.[56] These tests are focused on evaluating the individual's muscle strength,



Legend: A: front direction; B: right lateral direction; C: left lateral direction. Source: Authors.

Figure 2. Lower quarter y-balance test.

stability, and ability to maintain posture during repeated and rapid side movements.[55]

The Side Hop Test aims to evaluate agility, coordination and ability to maintain ankle control and stability during movements that require rapid change of direction. Participants jump laterally, on a 5-meter course delineated by cones, forming an eight-shaped pattern. The Crossover Hop Test is designed to evaluate the individual's ability to perform fast and controlled diagonal movements, challenging lateral stability and ankle coordination. Participants jump diagonally over a 6 meters long and 15cm wide line, alternating sides along the line as quickly as possible. The Square Hop Test evaluates the agility and ability to perform fast and precise movements in various directions, in a square of 40x40 cm, for 5 repetitions as quickly as possible. The results of these tests can be expressed in two ways: the distance reached or the time spent in the case of the *6-meter timed hop*, or through an index of symmetry of the lower limbs (ISMI).[55] The ISMI reference value, which indicates significant differences in symmetry between the lower limbs, is 90%. Larger differences may indicate a deficit in neuromuscular control and early detection of possible imbalances that can lead to injuries and affect athletic performance.[55]

Weight-Bearing Lunge Test

The Weight-Bearing Lunge Test (WBLT) is a clinical test that evaluates the ROM of ankle joint dorsiflexion in closed kinetic chain. It is used to detect movement amplitude deficits in people with chronic ankle instability and monitor progress in improving movement amplitude during rehabilitation protocols.[58,59]

WBLT is performed standing, with the heel in contact with the 56th floor, the knee aligned with the second finger of the foot and the toe 10 cm away from the wall. (Figure 3)

The participant proceeds trying to touch a vertical line on the wall with his knee, keeping the heel in contact with the ground. If you can lean your knee against the wall while keeping both the heel and knee in contact with it, then move the foot 1 cm away from the wall and lean forward until reaching the maximum dorsiflexion range, the maximum ankle dorsiflexion angle can be evaluated.[59,60]

Computerized analysis

The computerized evaluation in the surfer is more relevant for professional surfers who need to improve performance, or as a thorough investigation of possible imbalances that may increase the risk of injury in the sport. In addition, it is an excellent resource for determining the return to sport after a rehabilitation process that involves the restoration of muscle capacity.[61] In this sense, we can highlight two valuable instruments for the evaluation of skeletal muscle systems. The evaluation in the isokinetic dynamometer of strength, potency and muscle endurance is excellent for quantifying possible discrepancies between muscle groups.[62] In this sense, it becomes important to conduct an annual evaluation of the professional surfer. Another important feature for evaluating the muscle strength of the limbs is the counter-movement jump, using a contact plate or force platform. The importance of evaluating the dynamic strength of the lower body is that stronger surfers appear to be able to develop a significantly greater eccentric peak speed,[63] brake more efficiently and better use the landing/excentric stage, optimizing their jump performance.[64]

Source: Authors.

Figure 3. Weight-bearing lunge test.

It is important to highlight that the risk and type of structures involved in the lesions of the lower quarter in the surf, are mainly related to the surfer's performance level. For often the acute lesions of the lower quarter of ligamentary or bone origin, are related to more complex maneuvers, such as the aeria" that are performed by more experienced and radical surfers.[24] The bone injuries caused by direct trauma with the sea floor, are often associated with less experienced surfers.

The present study presents limitations because it is a review study with a scarce literature so far on the specific topic related to the sport. In addition, sport is undergoing transformations in recent years/decades regarding changes in the style of surfing, and as to the maneuvers performed. These changes have required greater overload of the structures of the lower limbs both amateur and professional surfers. This fact is impacting on an increase in musculoskeletal lesions in these segments. Moreover, the development and evolution of surfing in a more controlled environment (i.e. wave pools) can also present changes in the profile of injuries of practitioners who have access to this type of environment, which have to be considered and subject of future studies.

FINAL CONSIDERATIONS

Surfing lacks of scientific evidence, mainly related to the orientation of surfer health and physical assessment. These assessements might be important, by offering new scopes for valid and reliable measurements, treatment progression options and injury prevention strategies . Therefore, the present study aimed to bring a direction for evidence-based clinical practice, providing guidance for the healthcare professional in ambulatory setting, for the musculoskeletal lower quarter assessment, aiming at the specificity of the level and characteristic of the surfer.

AUTHOR'S CONTRIBUTION: Each author personally and significantly contributed to the development of this article: GVL: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; ET: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; PS: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; AR: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published; GCB: editorial of the article, critical review of its intellectual content and final approval of the version of the manuscript to be published.

REFERENCES

1. Rice EL. Surfing. J Sports Med Phys Fitness. 2021;61(8):1098-1103. doi: 10.23736/S0022-4707.21.12847-6.
2. Steinman J, Vasconcellos EH, Ramos RM, Botelho JL, Nahas M V. Epidemiology of surfing accidents in Brazil. Rev Bras Med Esporte. 2000;6(1). doi: 10.1590/S1517-86922000000100004.
3. Bazanella NV, Garrett JGZD, Gomes ARS, Novack LF, Osiecki R, Korelo RIG. Influence of practice time on surfing injuries. Fisioter. mov. 2017;30. doi: 10.1590/1980-5918.030.S01.AO02.
4. Takeuchi E, Lacerda SS, Brech GC, Kozasa EH. An Integrated Mind–Body Training Intervention on an Elite Surfing Athlete: A Case Study. Case Studies in Sport and Exercise Psychology. 2023;7(1):1–7. doi: 10.1123/cssep.2022-0006.
5. Farley OR, Secomb JL, Parsonage JR, Lundgren LE, Abbiss CR, Sheppard JM. Five Weeks of Sprint and High-Intensity Interval Training Improves Paddling Performance in Adolescent Surfers. J Strength Cond Res. 2016;30(9):2446-52. doi: 10.1519/JSC.0000000000001364.
6. Secomb JL, Sheppard JM, Dascombe BJ. Reductions in Sprint Paddling Ability and Countermovement Jump Performance After Surfing Training. J Strength Cond Res. 2015;29(7):1937-42. doi: 10.1519/JSC.0000000000000843.
7. McArthur K, Jorgensen D, Climstein M, Furness J. Epidemiology of Acute Injuries in Surfing: Type, Location, Mechanism, Severity, and Incidence: A Systematic Review. Sports (Basel). 2020;8(2):25. doi: 10.3390/sports8020025.
8. Remnant D, Moran RW, Furness J, Climstein M, Hing WA, Bacon CJ. Gradual--onset surfing-related injuries in New Zealand: A cross-sectional study. J Sci Med Sport. 2020;23(11):1049-1054. doi: 10.1016/j.jsams.2020.05.010.
9. Hanchard S, Duncan A, Furness J, Simas V, Climstein M, Kemp-Smith K. Chronic and Gradual-Onset Injuries and Conditions in the Sport of Surfing: A Systematic Review. Sports (Basel). 2021;9(2):23. doi: 10.3390/sports9020023.
10. Szymski D, Achenbach L, Siebentritt M, Simoni K, Kuner N, Pfeifer C, et al. Injury Epidemiology of 626 Athletes in Surfing, Wind Surfing and Kite Surfing. Open Access J Sports Med. 2021;12:00-107. doi: 10.2147/OAJSM.S316642.
11. Seixas P, Oliveira R, Carita AI, Moreira M, Carita A. Musculoskeletal injuries in Portuguese junior elite surfers: an epidemiological and fitness exploratory study. IOSR Journal of Sports and Physical Education (IOSR-JSPE). 2022;9(1):32–41.
12. Minasian B, Hope N. Surfing on the world stage: a narrative review of acute and overuse injuries and preventative measures for the competitive and recreational surfer. Br J Sports Med. 2022;56(1):51-60. doi: 10.1136/bjsports-2021-104307.
13. Meir R, Zhou S, Rolfe M, Gilleard W, Coutts R. An investigation of surf participation and injury prevalence in Australian surfers: a self-reported retrospective analysis. New Zealand Journal of Sports Medicine. 2012;39(2):52.
14. Taylor DM, Bennett D, Carter M, Garewal D, Finch CF. Acute injury and chronic disability resulting from surfboard riding. J Sci Med Sport. 2004;7(4):429-37. doi: 10.1016/s1440-2440(04)80260-3.
15. Vaghetti CAO, Roesler H, Andrade Auditory and visual single reaction span in surfers with different ability levels: comparison of professional, amateur athletes and surf practitioners. Rev Bras Med Esporte. 2007;13(2):81–5. doi: 10.1590/S1517-86922007000200003.
16. Atencio JK, Armenta RF, Nessler JA, Schubert MM, Furness JW, Climstein M, et al. Fluid Loss in Recreational Surfers. Int J Exerc Sci. 2021;14(6):423-434. doi: 10.70252/CFEM3755.
17. Maron BJ, Thompson PD, Ackerman MJ, Balady G, Berger S, Cohen D, et al. Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. Circulation. 2007;115(12):1643-455. doi: 10.1161/CIRCULATIONAHA.107.181423.
18. Maron BJ, Friedman RA, Kligfield P, Levine BD, Viskin S, Chaitman BR, et al. Assessment of the 12-lead ECG as a screening test for detection of cardiovascular disease in healthy general populations of young people (12-25 Years of Age): a scientific statement from the American Heart Association and the American College of Cardiology. Circulation. 2014;130(15):1303-34. doi: 10.1161/CIR.0000000000000025.
19. Hohn E, Robinson S, Merriman J, Parrish R, Kramer W. Orthopedic Injuries in Professional Surfers: A Retrospective Study at a Single Orthopedic Center. Clin J Sport Med. 2020;30(4):378-382. doi: 10.1097/JSM.0000000000000596.
20. Tak I, Engelaar L, Gouttebarge V, Barendrecht M, Van den Heuvel S, Kerkhoffs G, et al. Is lower hip range of motion a risk factor for groin pain in athletes? A systematic review with clinical applications. Br J Sports Med. 2017;51(22):1611-1621. doi: 10.1136/bjsports-2016-096619.
21. Kemp J, Grimaldi A, Heerey J, Jones D, Scholes M, Lawrenson P, et al. Current trends in sport and exercise hip conditions: Intra-articular and extra-articular hip pain, with detailed focus on femoroacetabular impingement (FAI) syndrome. Best Pract Res Clin Rheumatol. 2019;33(1):66-87. doi: 10.1016/j.berh.2019.02.006.
22. Grimaldi A, Fearon A. Gluteal Tendinopathy: Integrating Pathomechanics and Clinical Features in Its Management. J Orthop Sports Phys Ther. 2015;45(11):910-22. doi: 10.2519/jospt.2015.5829.
23. Patel BJ, Heath MR, Geannette CS, Fabricant PD, Greditzer HG 4th. When the Wave Breaks You: Magnetic Resonance Imaging Findings After Surfing Injuries. Sports Health. 2020;12(1):88-93. doi: 10.1177/1941738119880863.
24. Inada K, Matsumoto Y, Kihara T, Tsuji N, Netsu M, Kanari S, et al. Acute injuries and chronic disorders in competitive surfing: From the survey of professional surfers in Japan. Sports Orthopaedics and Traumatology. 2018;34(3):256–60. doi: 10.1016/J.ORTHTR.2018.03.107.
25. Minghelli B, Nunes C, Oliveira R. Injuries in recreational and competitive surfers: a nationwide study in Portugal. J Sports Med Phys Fitness. 2018;58(12):1831-1838. doi: 10.23736/S0022-4707.17.07773-8.
26. van Dyk N, Farooq A, Bahr R, Witvrouw E. Hamstring and Ankle Flexibility Deficits Are Weak Risk Factors for Hamstring Injury in Professional Soccer Players: A Prospective Cohort Study of 438 Players Including 78 Injuries. Am J Sports Med. 2018;46(9):2203-2210. doi: 10.1177/0363546518773057.
27. Cohen M, Abdalla R. Ginástica olímpica. Em: Lesões nos esportes Diagnóstico prevenção e tratamento. São Paulo:Thieme Revinter;2002.p.776–84.
28. Rabelo NDDA, Lucareli PRG. Do hip muscle weakness and dynamic knee valgus matter for the clinical evaluation and decision-making process in patients with patellofemoral pain? Braz J Phys Ther. 2018;22(2):105-109. doi: 10.1016/j.bjpt.2017.10.002.
29. Rinaldi VG, Prill R, Jahnke S, Zaffagnini S, Becker R. The influence of gluteal muscle strength deficits on dynamic knee valgus: a scoping review. J Exp Orthop. 2022;9(1):81. doi: 10.1186/s40634-022-00513-8.
30. Wilczy□ski B, Zorena K, □I□zak D. Dynamic Knee Valgus in Single-Leg Movement Tasks. Potentially Modifiable Factors and Exercise Training Options. A Literature Review. Int J Environ Res Public Health. 2020;17(21):8208. doi: 10.3390/ijerph17218208.
31. Ortiz A, Micheo W. Biomechanical evaluation of the athlete□s knee: from basic science to clinical application. PM R. 2011;3(4):365-71. doi: 10.1016/j.pmrj.2010.12.005.
32. Lewis CL, Foch E, Luko MM, Loverro KL, Khuu A. Differences in Lower Extremity and Trunk Kinematics between Single Leg Squat and Step Down Tasks. PLoS One. 2015;10(5):e0126258. doi: 10.1371/journal.pone.0126258.
33. Furness J, Hing W, Abbott A, Walsh J, Sheppard JM, Climstein M. Retrospective analysis of chronic injuries in recreational and competitive surfers: Injury location, type, and mechanism. International Journal of Aquatic Research and Education. 2014;8(3):277–87. doi: 10.1123/ijare.2013-0032.
34. Lentell G, Katzman LL, Walters MR. The Relationship between Muscle Function and Ankle Stability. J Orthop Sports Phys Ther. 1990;11(12):605-11. doi: 10.2519/jospt.1990.11.12.605.
35. Kirialanis P, Malliou P, Beneka A, Giannakopoulos K. Occurrence of acute lower limb injuries in artistic gymnasts in relation to event and exercise phase. Br J Sports Med. 2003;37(2):137-9. doi: 10.1136/bjsm.37.2.137.
36. Forsyth JR, Riddiford-Harland DL, Whitting JW, Sheppard JM, Steele JR. Essential Skills for Superior Wave-Riding Performance: A Systematic Review. J Strength Cond Res. 2020;34(10):3003-3011. doi: 10.1519/JSC.0000000000003402.
37. Kristen KH. Foot and ankle injuries in surfing, windsurfing, Kitesurfing: A follow up study and review of the literature. Sports Orthopaedics and Traumatology [Internet]. 2018;34(3):265–70. doi: 10.1016/j.orthtr.2018.05.003.
38. Rodrigues RC, Masiero D, Mizusaki JM, Imoto AM, Peccin MS, Cohen M, et al. Translation, Cultural Adaptation And Validation Of The "American Orthopaedic Foot And Ankle Society□s (Aofas) Ankle-Hindfoot Scale". Acta ortop. bras. 2008;16(2):107-111. doi: 10.1590/S1413-78522008000200009.
39. Hale SA, Hertel J. Reliability and Sensitivity of the Foot and Ankle Disability Index in Subjects With Chronic Ankle Instability. J Athl Train. 2005 Mar;40(1):35-40.
40. Delahunt E, Bleakley CM, Bossard DS, Caulfield BM, Docherty CL, Doherty C, et al. Clinical assessment of acute lateral ankle sprain injuries (ROAST): 2019 consensus statement and recommendations of the International Ankle Consortium. Br J Sports Med. 2018;52(20):1304-1310. doi: 10.1136/bjsports-2017-098885.
41. Forkin DM, Koczur C, Battle R, Newton RA. Evaluation of kinesthetic deficits indicative of balance control in gymnasts with unilateral chronic ankle sprains. J Orthop Sports Phys Ther. 1996;23(4):245-50. doi: 10.2519/jospt.1996.23.4.245.
42. Rose A, Lee RJ, Williams RM, Thomson LC, Forsyth A. Functional instability in non-contact ankle ligament injuries. Br J Sports Med. 2000;34(5):352-8. doi: 10.1136/bjsm.34.5.352.
43. Wester JU, Jespersen SM, Nielsen KD, Neumann L. Wobble board training after partial sprains of the lateral ligaments of the ankle: a prospective randomized study. J Orthop Sports Phys Ther. 1996;23(5):332-6. doi: 10.2519/jospt.1996.23.5.332.
44. Holme E, Magnusson SP, Becher K, Bieler T, Aagaard P, Kjaer M. The effect of supervised rehabilitation on strength, postural sway, position sense and re-injury risk after acute ankle ligament sprain. Scand J Med Sci Sports. 1999;9(2):104-9. doi: 10.1111/j.1600-0838.1999.tb00217.x.

45. Verhagen EA, van Mechelen W, de Vente W. The effect of preventive measures on the incidence of ankle sprains. Clin J Sport Med. 2000;10(4):291-6. doi: 10.1097/00042752-200010000-00012.
46. Backman LJ, Danielson P. Low range of ankle dorsiflexion predisposes for patellar tendinopathy in junior elite basketball players: a 1-year prospective study. Am J Sports Med. 2011;39(12):2626-33. doi: 10.1177/0363546511420552.
47. Fong CM, Blackburn JT, Norcross MF, McGrath M, Padua DA. Ankle-dorsiflexion range of motion and landing biomechanics. J Athl Train. 2011;46(1):5-10. doi: 10.4085/1062-6050-46.1.5.
48. Lundgren LE, Tran TT, Nimphius S, Raymond E, Secomb JL, Farley OR, et al. Comparison of impact forces, accelerations and ankle range of motion in surfing-related landing tasks. J Sports Sci. 2016;34(11):1051-7. doi: 10.1080/02640414.2015.1088164.
49. Plisky P, Schwartkopf-Phifer K, Huebner B, Garner MB, Bullock G. Systematic Review and Meta-Analysis of the Y-Balance Test Lower Quarter: Reliability, Discriminant Validity, and Predictive Validity. Int J Sports Phys Ther. 2021;16(5):1190-1209. doi: 10.26603/001c.27634.
50. DeJong AF, Mangum LC, Hertel J. Ultrasound Imaging of the Gluteal Muscles During the Y-Balance Test in Individuals With or Without Chronic Ankle Instability. J Athl Train. 2020;55(1):49-57. doi: 10.4085/1062-6050-363-18.
51. Pinheiro LSP, Ocarino JM, Bittencourt NFN, Souza TR, Souza Martins SC, Bomtempo RAB, et al. Lower limb kinematics and hip extensors strengths are associated with performance of runners at high risk of injury during the modified Star Excursion Balance Test. Braz J Phys Ther. 2020;24(6):488-495. doi: 10.1016/j.bjpt.2019.07.011.
52. Westrick RB, Miller JM, Carow SD, Gerber JP. Exploration of the y-balance test for assessment of upper quarter closed kinetic chain performance. Int J Sports Phys Ther. 2012;7(2):139-47.
53. Fitzgerald GK, Lephart SM, Hwang JH, Wainner RS. Hop tests as predictors of dynamic knee stability. J Orthop Sports Phys Ther. 2001;31(10):588-97. doi: 10.2519/jospt.2001.31.10.588.
54. Logerstedt D, Grindem H, Lynch A, Eitzen I, Engebretsen L, Risberg MA, et al. Single-legged hop tests as predictors of self-reported knee function after anterior cruciate ligament reconstruction: the Delaware-Oslo ACL cohort study. Am J Sports Med. 2012;40(10):2348-56. doi: 10.1177/0363546512457551.
55. Munro AG, Herrington LC. Between-session reliability of four hop tests and the agility T-test. J Strength Cond Res. 2011;25(5):1470-7. doi: 10.1519/JSC.0b013e3181d83335.
56. Abrams GD, Harris JD, Gupta AK, McCormick FM, Bush-Joseph CA, Verma NN, et al. Functional Performance Testing After Anterior Cruciate Ligament Reconstruction: A Systematic Review. Orthop J Sports Med. 2014;2(1):2325967113518305. doi: 10.1177/2325967113518305.
57. Sawle L, Freeman J, Marsden J. INTRA-RATER RELIABILITY OF THE MULTIPLE SINGLE-LEG HOP-STABILIZATION TEST AND RELATIONSHIPS WITH AGE, LEG DOMINANCE AND TRAINING. Int J Sports Phys Ther. 2017;12(2):190-198.
58. Hoch MC, Staton GS, Medina McKeon JM, Mattacola CG, McKeon PO. Dorsiflexion and dynamic postural control deficits are present in those with chronic ankle instability. J Sci Med Sport. 2012;15(6):574-9. doi: 10.1016/j.jsams.2012.02.009.
59. Powden CJ, Hoch JM, Hoch MC. Reliability and minimal detectable change of the weight-bearing lunge test: A systematic review. Man Ther. 2015;20(4):524-32. doi: 10.1016/j.math.2015.01.004.
60. Hall EA, Docherty CL. Validity of clinical outcome measures to evaluate ankle range of motion during the weight-bearing lunge test. J Sci Med Sport. 2017;20(7):618-621. doi: 10.1016/j.jsams.2016.11.001.
61. Fontánez R, De Jesus K, Frontera WR, Micheo W. Return to Sports Following Shoulder Injury: Clinical Evaluation, Isokinetic, and Functional Testing. Curr Sports Med Rep. 2023;22(6):191-198. doi: 10.1249/JSR.0000000000001072.
62. Baltzopoulos V, Brodie DA. Isokinetic dynamometry. Applications and limitations. Sports Med. 1989;8(2):101-16. doi: 10.2165/00007256-198908020-00003.
63. Tran TT, Lundgren L, Secomb J, Farley OR, Haff GG, Seitz LB, et al. Comparison of physical capacities between nonselected and selected elite male competitive surfers for the National Junior Team. Int J Sports Physiol Perform. 2015;10(2):178-82. doi: 10.1123/ijspp.2014-0222.
64. Secomb JL, Sheppard JM, Dascombe BJ. Time-motion analysis of a 2-hour surfing training session. Int J Sports Physiol Perform. 2015;10(1):17-22. doi: 10.1123/ijspp.2014-0002.

DOI: http://dx.doi.org/10.1590/1413-785220253304e290152

QUALITY OF LIFE IN PATIENTS UNDERGOING REVERSE SHOULDER ARTHROPLASTY

QUALIDADE DE VIDA EM PACIENTES SUBMETIDOS A ARTROPLASTIA REVERSA DO OMBRO

GABRIELA REZENDE SPINI[1], *FERNANDO PASCOLAT CASTRO*[1], *GABRIEL WILLIAN BERGER MELO*[1], *PEDRO IVO SANTOS ARANAS*[1]

1. Nova Bene - Beneficencia Portuguesa de Ribeirao Preto, Sao Paulo, SP, Brazil.

ABSTRACT

Objective: To identify and review national and international articles that address the impacts on quality of life and the main clinical-functional outcomes of patients undergoing rotator cuff arthroplasty technique. Methods: A systematic literature search was conducted using the databases Lilacs, MedLine, Pubmed, Scielo, BVS and Cochrane, published in the last 05 years. Results: 623 articles were found, with 575 excluded after temporal screening, title and abstract reading. For initial registration purposes, 48 studies were selected, of which 12 were excluded for being duplicates. Of the remaining 36 studies, 31 were excluded for not meeting the inclusion criteria, resulting in 05 studies that composed the synthesized data. All classified as Evidence Level I by AHRQ. Conclusions: The results of this study suggest that individuals with rotator cuff injuries can benefit from the Reverse Shoulder Arthroplasty technique for rotator cuff treatment, where it can be observed that patients undergoing RSA had significant improvement in functional capacity and quality of life, showing improvements in both physical and emotional aspects and functional independence. ***Level of Evidence III; Systematic Review.***

Keywords: Arthroplasty, Replacement, Shoulder; Shoulder Fractures; Shoulder Injuries; Quality of Life.

RESUMO

Objetivo: Identificar e revisar artigos nacionais e internacionais que abordam os impactos na qualidade de vida e os principais resultados clínico-funcionais de pacientes submetidos à técnica de artroplastia do manguito rotador. Métodos: Foi realizada busca sistemática de literatura, a partir das bases de dados Lilacs, MedLine, Pubmed, Scielo, BVS e Cochrane, publicados nos últimos 05 anos. Resultados: Foram encontrados 623 artigos, sendo 575 excluídos após a realização de recorte temporal, leitura de títulos e resumo. Para fins de registro inicial foram selecionados 48 estudos, dos quais 12 destes foram excluídos por estarem em duplicidade. Dos 36 estudos restantes, 31 foram excluídos por não atenderem aos critérios de inclusão, resultando em 05 estudos que compuseram os dados sintetizados. Todos classificados com Nível de Evidência I pela AHRQ. Conclusões: Os resultados deste estudo sugerem que indivíduos com lesões do manguito rotador podem se beneficiar da técnica da Artroplastia Reversa do Ombro, para o tratamento do manguito rotador, onde pode-se observar que pacientes submetidos à ARO tiveram melhoria significativa na capacidade funcional e qualidade de vida, apresentando melhorias tanto no aspecto físico, quanto emocional e de independência funcional. ***Nível de Evidência III; Revisão Sistemática.***

Descritores: *Artroplastia do Ombro; Fraturas do Ombro; Lesões do Ombro; Qualidade de Vida.*

Citation: Spini GR, Castro FP, Melo GWB, Aranas PIS. Quality of life in patients undergoing Reverse Shoulder Arthroplasty. Acta Ortop Bras. [online]. 2025;33(4):Page 1 of 5. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Rotator cuff arthroplasty represents a spectrum of shoulder diseases characterized by rotator cuff insufficiency, decreased distance from the humeral head to the acromion, subacromial impingement and arthritic changes in the glenohumeral joint. The initial treatment should be conservative and the possibilities of intervention, when necessary, range from arthroscopic debridement, hemiarthroplasty, reverse arthroplasty and arthrodesis or resection arthroplasty, both in extreme cases.[1,2]

It has widely documented benefits in degenerative pathologies of the glenohumeral joint, since biomechanically it improves the functioning of the deltoid muscle, moving it distally in order to provide a greater lever arm with an increase in its perpendicular distance to the center of joint rotation, which due to the shape of the semi-constrictor remains stable and compensates for the dysfunctional rotator cuff, Reverse shoulder arthroplasty initially emerged as an alternative technique for various shoulder

All authors declare no potential conflict of interest related to this article.

The study was conducted at Nova Bene - Beneficencia Portuguesa de Ribeirao Preto, Sao Paulo, SP, Brazil.
Beneficencia Portuguesa de Ribeirao Preto, 1172, Rua Tibiriça, Ribeirão Preto, SP, Brazil. 14.010-090. gabrielaspinirs@gmail.com

Article received on 09/09/2024 approved on 02/14/2025.

conditions/injuries, becoming an option for patients with proximal humeral fractures, rheumatoid arthritis, fixed glenohumeral dislocation, tumor surgery, fracture pseudarthrosis, glenoid bone loss and/or revision arthroplasty.[2-6]

Affecting mainly women over 60 years of age, and initially intended to treat shoulder osteoarthritis with rotator cuff deficiency in elderly patients with loss of active lifting of the arm (pseudo-paralytic shoulder), this type of procedure has revolutionized the reconstructive surgery of this joint and, due to promising clinical results, has become increasingly common in the treatment of arthritic conditions, so that studies point out that in recent decades, the rotator cuff arthroplasty see presenting superior results compared to hemiartroplasty.[2,7-10]

Noting promising results in the scenario of proximal fractures of the humerus leading to fewer restrictions during the immediate postoperative period, considering that the lack of healing of tuberosity does not lead to functional disaster as seen in hemiarthroplasty and even if it requires more time and intraoperative effort on the humeral side on the glenoid can be easily exposed to allow the proper placement of the base plate and the glenosphere, resulting in better functional results.[3,11-13]

On the other hand, it is considered as the perception of the individual of his position in life in the context of the culture and system of values in which he lives and in relation to his goals, expectations, patterns and concerns and even as an ethical question, which must, primarily, be analyzed from the individual perception of each. The concept of Quality of Life (QL) has gained increasing importance in the field of healthcare since the mid-1980s, having a significant increase in medical discourse and practice.[14-17]

It is defined by the World Health Organization (WHO) as "the individual's perception of their insertion in life, in the context of the culture and values systems in which they live and in relation to their goals, expectations, patterns and concerns". QL therefore involves both spiritual, physical, mental, psychological and emotional well-being, as well as social relationships, such as family and friends and also health, education, basic sanitation housing and other life circumstances.[18]

Essential for the recovery of patients undergoing reverse shoulder arthroplasty, QL is closely linked to well-being and success in the treatment of these patients. In this sense, it becomes relevant, through this systematic review study, to identify and review national and international articles that address the impacts on their quality of life and the main clinical-functional results of patients undergoing the arthroplasty technique of the rotator cuff.

MATERIAL AND METHOD

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) methodology.[19]

According to the Oxford Centre for Evidence-Based Medicine, systematic reviews of randomized and controlled clinical trials are considered the best level of scientific evidence (A1) when therapies are evaluated.[20] This is due to the fact that randomized and controlled trials are considered with excellent level of evidence and the systematic review is a compilation of data obtained from several of these papers on the same subject.[21]

For the elaboration of this review, the following steps were considered: development of the research question; search in the databases; selection of the articles; extraction of data; evaluation of the methodological quality; synthesis of the data, evaluation of the quality of the evidence; drafting and publication of the results. Moreover, respecting what was proposed to evaluate, the guiding question was: to evaluate the main clinical-functional results of patients undergoing the technique of reverse shoulder arthroplasty, in addition to the impacts on their quality of life of these patients after surgical procedure.

Search strategy

We conducted a systematic search of literature from Latin American and Caribbean Literature in Health Sciences (Lilacs), Medical Literature Analysis and Retrieval System Online (MedLine/Pubmed), Scientific Electronic Library Online (Scielo), Virtual Library in Health (BVS) and Cochrane Library.

As a timescale, the research was based on the analysis of studies published over the past five years.

The descriptors used in the search strategy were identified based on PubMed and replicated to the other libraries and databases, using the following combinations of terms: Arthroplasty (*Arthroplasty*); Shoulder Arthroplasty (*Arthroplasty, Replacement, Shoulder*); Shoulder Fractures (*Shoulder Fractures*); Shoulder Injuries (*Shoulder Injuries*) and Quality of Life (*Quality of Life*).

All descriptors and their synonyms have been combined with each other. For the descriptors, the combinations were made using the Boolean term "AND", while for the synonyms, the Boolean term "OR" was used.

It should be noted that the above descriptors are found in the Descriptors in Health Sciences (DeCS).

Eligibility criteria

As eligibility criteria, studies available in Portuguese, English or Spanish that answered the guiding question and published in the last five years were included.

Studies conducted on animals, studies of narrative review, magazines, newspapers and/or books that did not meet the proposed study were excluded.

Selection of articles

The articles were downloaded through the Chrome browser. The files were selected individually by two distinct authors. Disagreements in the selection of articles were resolved by mutual agreement.

The research of the articles took place during the first quarter of 2024. The following variables were included in the data extraction tool: Title/Theme; Author(s); Year/ Country; Objectives; Study Design/ Evidence Level; Results and Conclusion.

These were then presented by means of tables and/or tables contemplating the main characteristics of the articles used for the purposes of this review.

RESULTS

623 articles were found, of which 575 were excluded after timing, reading titles and summary.

For initial registration purposes, 48 studies were selected for analysis, of which 12 were excluded because they were in duplicity.

Of the remaining 36 studies, 31 were excluded because they did not meet the inclusion criteria, resulting in 05 (five) studies that compiled the synthesized data (Figure 1).

For eligibility purposes and proposed results, studies of systematic review, metanalysis, randomized clinical study, cohort study, clinical trial and observational study were initially listed. Only the systematic review and metanalysis studies are retained, so that they are part of Evidence Level I, as established by the Agency for Healthcare Research and Quality (AHRQ).

The critical analysis of the studies conducted using the categorization by evidence levels by the AHRQ, covers seven levels: (I) evidence from metanalysis and systematic review; (II) evidence from clinical trials with randomization; (III) evidence from clinical trials without randomization; (IV) evidence from cohort and case-control studies; (V) evidence from systematic review of descriptive and qualitative studies; (VI) evidence based on descriptive or qualitative study and (VII) opinions from authority or expert committee.[22]

Among the selected articles, the oldest was published in 2019 and the most recent in 2024. Of the total articles included, (n=05, 100%) were available in English. As for the origin, articles with full text prevailed (n = 04, 100%).
Finally, with respect to the study design/evidence level according to the AHRQ categorization, (n=05, 100%) of these corresponded to the level of evidence Level I (Table 1).[23-27]

becomes necessary in patients with shoulder lesions. Since ARO has proved to be an excellent option for the treatment of patients with arthroplasty of the rotator cuff with satisfactory functional results.[28] Developed primarily for the treatment of rotator cuff arthroplasty, reverse shoulder arthroplasty comprises in the surgical technique for the treatment of various shoulder conditions/lesions through the replacement of the damaged cartilage surface, creating new

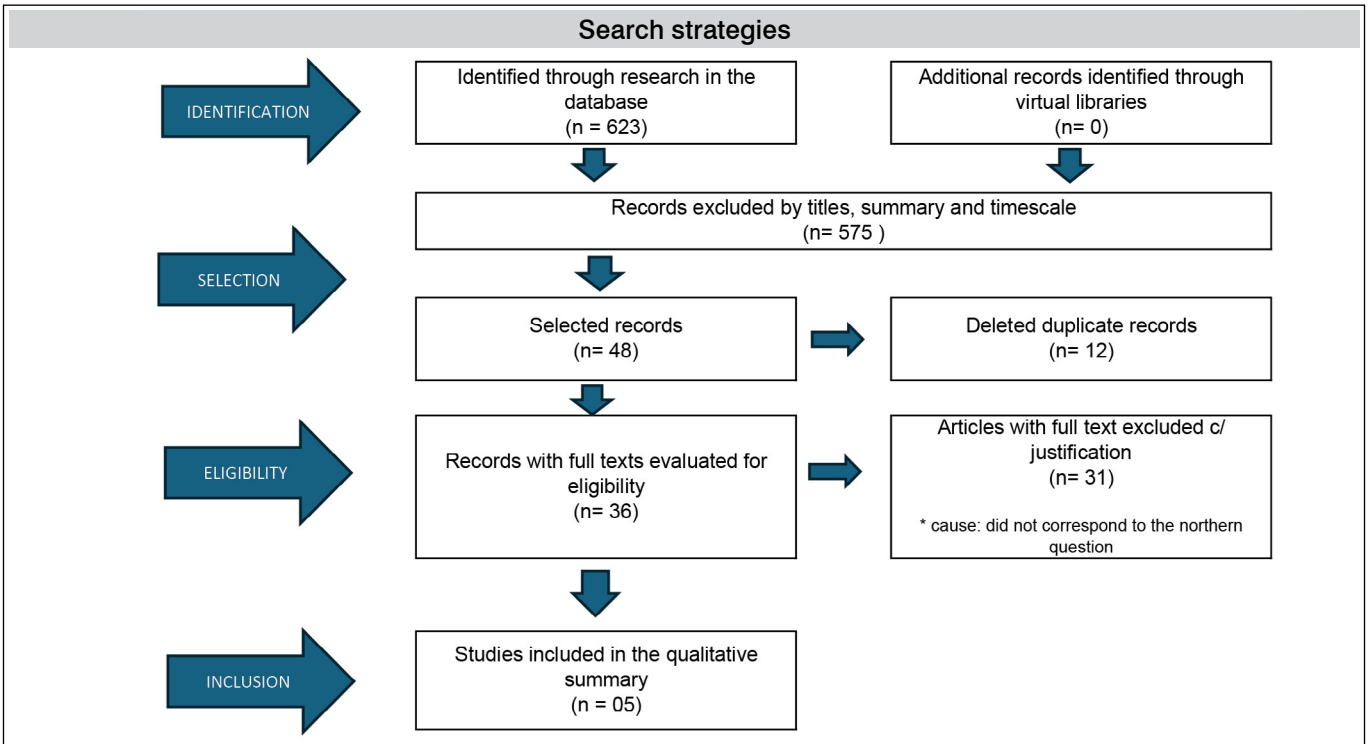


Figure 1. Flowchart of the study selection process.

Table 1. Summary of the publications used in this review.

No	Title	Author(s)	Year	Country	Language	Study Design / Evidence Level
1	The clinical impact of retears after repair of posterosuperior rotator cuff tears: a systematic review and meta-analysis	Holtedahl et al.[23]	2023	United States	English	Systematic review and metanalysis Level I
2	The Relationship of Aging and Smoking With Rotator Cuff Disease: A Systematic Review and Meta-analysis	Grusky et al.[24]	2022	United States	English	Systematic review and metanalysis Level I
3	Conservative versus surgical management for patients with rotator cuff tears: a systematic review and META-analysis	Longo et al.[25]	2021	United States	English	Systematic review and metanalysis Level I
4	Shoulder replacement surgery for osteoarthritis and rotator cuff tear arthropathy	Craig et al.[26]	2020	United States	English	Systematic review and metanalysis Level I
5	Surgery for rotator cuff tears	Karjalainen et al.[27]	2019	United States	English	Systematic review and metanalysis Level I

DISCUSSION

Mostly present in elderly patients over 60 years, studies by Grusky et al.[24] aimed at synthesizing evidence from studies that report associations between aging and smoking in relation to rotator cuff disease, point out that the increase in age is considered a strong risk factor for rotator cuff disease and that current smokers are more likely to have rotator cuff disease compared to non-smokers and/or ex-smokers.
However, the results point out that despite age, and that the initial treatment recommendation for this patient profile should always be conservative, with changes in activities, oral analgesics, physiotherapy and/or intraarticular infiltrations. Usually, surgical treatment

slippery and painless surfaces, thereby aiming to relieve pain and improve shoulder movement.[3] And this is possible through the proper balance of soft parts, the correct choice of the implant and the restoration of the articular anatomical parameters.[29]
Karjalainen et al.[27] in systematic review studies aimed at synthesizing the available evidence on the benefits and disadvantages of repairing the rotator cuff with or without subacromial decompression in the treatment of shoulder rotator cuff fractures, point out that the overall success rate evaluated by the participants was 873/1,000 after non-operative treatment and 943/1,000 after surgery, corresponding to (risk rate (RRR) 1.08, confidence interval (IC) from 95% 0.96 to 1.22; evidence of low quality (reduced by bias and inaccuracies). And that health-related quality of life was 57.5 points

(SF-36 mental component score 0 to 100, higher score indicating better quality of life) with non-operative treatment and 1.3 points worse (4.5 worse to 1.9 better) with non-operative treatment surgery (1 study; 103 participants), low-quality evidence (reduced by bias and inaccuracies). No, and it is therefore possible to estimate the risk of adverse events and serious adverse events, as only one event was recorded in the trials (very low-quality evidence; reduced once due to biases and twice due to very serious inaccuracies).

For France et al.[30] although ARO is a relatively new procedure in Brazil, it is a procedure that can be used effectively and safely in patients who previously presented themselves without therapeutic options such as arthroplasty of the rotator cuff and revisions that provide pain relief, improved function and upper limb mobility.

Corroborating with studies by Amaral et al.[31] which state that ARO consists of the procedure that restores shoulder joint function in patients who previously presented themselves without therapeutic options. And whose technique aims to provide better quality of life and mobility for patients.

For Craig et al.[26] in systematic review studies of metanalysis, aiming at determining the benefits and disadvantages of shoulder replacement surgery in adults with shoulder osteoarthritis (OA), including rotator cuff rupture arthroplasty (RCTA), according to authors, although shoulder total replacement surgery is an established procedure, no high-quality randomized trial has been conducted to determine whether shoulder replacement can be more effective than other treatments for osteoarthritis or shoulder rotator cuff rupture arthroplasty. It remains unclear, therefore, which type and/or technique of shoulder replacement surgery is most effective in different situations.

Corroborating with studies by Longo et al.[25] which, when comparing conservative versus surgical management for patients with complete rupture of CR in terms of clinical and structural results in 1 and 2 years of follow-up, report that in the follow-up of 2 years, the shoulder function evaluated in terms of CMS did not improve significantly. Where the mean value of the CMS score at 12 months follow-up was 77.6 ± 14.4 in the surgical group and 72.8 ± 16.5 in the conservative group, i.e., without statistically significant differences between the groups. High-quality, randomized, level I clinical trials with long-term follow-up are recommended to assess whether surgical and conservative treatment really provides comparable results in the long term.

Holtedahl et al.[23] in a systematic review of metanalysis aimed at analyzing the relations between postoperative rotator cuff integrity and shoulder pain and function, even stated that the negative impact of relapses on pain and function was statistically significant, but considered of less clinical importance. As such, the results indicate that most patients can expect satisfactory results despite the new ruptures.

In addition, Kim et al.[32] in studies aimed at analyzing the clinical results of reverse total shoulder arthroplasty (RTSA), according to the primary diagnosis, highlight that based on excellent RTSA results in patients with arthroplasty for rotator cuff tear, the indications for this treatment method were broadened as implants are improved and surgeons gain more experience, and RTSA has been used for treatment and review of other diseases and fractures.

Corroborating with Maia et al.[33] which state that considering that the main indication for reverse arthroplasty is for the patient with rotator cuff arthroplasty presenting pain and loss of shoulder movement arc and due to the good results obtained in the treatment of this pathology, the indications for the use of reverse arthroplasty have gradually expanded to include other conditions that were previously difficult to treat successfully and predictably.

On the other hand, being approached by many authors, as a synonym for health, and by others as a more comprehensive concept, in which health conditions would be one of the aspects to be considered.[34,35] The QV, is therefore a multidimensional concept, which includes economic issues, lifestyle, health conditions, housing, personal satisfaction and social environment, among others, and is often used as a synonym for health.[36,37]

And in patients undergoing reverse shoulder arthroplasty (ARO), according to studies by Leite et al.[38] with 35 patients undergoing ARO, the results showed good quality of life related to the health of these patients, considering both the mental and physical scores they were undergoing.

Studies by Ribeiro et al.[39] involving 28 patients in clinical evaluation after undergoing ARO, indicate that reverse shoulder arthroplasty presents, in the short and medium term, satisfactory functional results, which are influenced by sex, age to the procedure, follow-up time and pathology that led to the indication.

Corroborating with studies from Figueira et al.[40] that in a systematic review of metanalysis aimed at evaluating the results of ARO in QV of elderly patients, the results highlighted that functional capacity, ability to fully carry out their daily life activities, autonomy and functional independence is closely linked to QV of these patients.

FINAL CONSIDERATIONS

The results of this study suggest that individuals with rotator cuff lesions can benefit from the reverse shoulder arthroplasty technique for the treatment of the rotator cuff, where it can be observed that patients undergoing ARO had significant improvements in functional capacity and quality of life, showing improvements in both physical, emotional and functional independence.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article: GRS with database research, validation, visualization, written - original draft, written - revision and editing. FPCV and GWBM in Conceptualization, Data Curatorial, Formal Analysis, Research, Methodology, Validation, Visualization, Written - Original Draft, Written - Review and Editing. PISA in Review and Final Edition.

REFERENCES

1. Nascimento AT, Claudio GK, Rocha PB. Reverse Shoulder Arthroplasty: Functional Results in Rotator Cuff Arthropathy. Rev Bras Ortop 2020;55(1):106–111.
2. Narvani AA, Imam MA, Godenèche A, Calvo E, Corbett S, Wallace AL, et al. Degenerative rotator cuff tear, repair or not repair? A review of current evidence. Ann R Coll Surg Engl. 2020;102(4):248-255. doi: 10.1308/rcsann.2019.0173.
3. Hernandez NM, Chalmers BP, Wagner ER, Sperling JW, Cofield RH, Sanchez-Sotelo J. Revision to Reverse Total Shoulder Arthroplasty Restores Stability for Patients With Unstable Shoulder Prostheses. Clin Orthop Relat Res. 2017;475(11):2716-2722. doi: 10.1007/s11999-017-5429-z.
4. Patel DN, Young B, Onyekwelu I, Zuckerman JD, Kwon YW. Reverse total shoulder arthroplasty for failed shoulder arthroplasty. J Shoulder Elbow Surg 2012;21(11):1478–1483.
5. Sanchez-Sotelo J, Sperling JW, Rowland CM, Cofield RH. Instability after shoulder arthroplasty: results of surgical treatment. J Bone Joint Surg Am. 2003;85(4):622-31.
6. Schairer WW, Nwachukwu BU, Lyman S, Craig EV, Gulotta LV. National utilization of reverse total shoulder arthroplasty in the United States. J Shoulder Elbow Surg. 2015;24(1):91-7. doi: 10.1016/j.jse.2014.08.026.
7. Kiet TK, Feeley BT, Naimark M, Gajiu T, Hall SL, Chung TT, et al. Outcomes after shoulder replacement: comparison between reverse and anatomic total shoulder arthroplasty. J Shoulder Elbow Surg. 2015;24(2):179-85. doi: 10.1016/j.jse.2014.06.039.
8. Coscia AC, Matar RN, Espinal EE, Shah NS, Grawe BM. Does preoperative diagnosis impact patient outcomes following reverse total shoulder arthroplasty? A systematic review. J Shoulder Elbow Surg. 2021;30(6):1458-1470. doi: 10.1016/j.jse.2020.10.003.

9. Boileau P, Melis B, Duperron D, Moineau G, Rumian AP, Han Y. Revision surgery of reverse shoulder arthroplasty. J Shoulder Elbow Surg. 2013;22(10):1359-70. doi: 10.1016/j.jse.2013.02.004.
10. Ferreira Neto AA, Malavolta EA, Assunção JH, Trindade EM, Gracitelli MEC. Reverse shoulder arthroplasty: clinical results and quality of life evaluation. Rev Bras Ortop. 2017;52(3):298-302. doi: 10.1016/j.rboe.2017.04.007.
11. Roberson TA, Bentley JC, Griscom JT, Kissenberth MJ, Tolan SJ, Hawkins RJ, et al. Outcomes of total shoulder arthroplasty in patients younger than 65 years: a systematic review. J Shoulder Elbow Surg. 2017;26(7):1298-1306. doi: 10.1016/j.jse.2016.12.069.
12. Rasmussen JV, Olsen BS. Previous surgery for instability is a risk factor for a worse patient-reported outcome after anatomical shoulder arthroplasty for osteoarthritis: a Danish nationwide cohort study of 3,743 arthroplasties. Acta Orthop. 2022;93:588-592. doi: 10.2340/17453674.2022.3419.
13. Otte RS, Naylor AJ, Blanchard KN, Cancienne JM, Chan W, Romeo AA, et al. Salvage reverse total shoulder arthroplasty for failed anatomic total shoulder arthroplasty: a cohort analysis. J Shoulder Elbow Surg. 2020;29(7S):S134-S138. doi: 10.1016/j.jse.2020.04.013.
14. The WHOQOL Group. The Development of the World Health Organization Quality of Life Assessment Instrument (the WHOQOL). In: Orley J, Kuyken W, editors. Quality of Life Assessment: International Perspectives. Berlin, Heidelberg: Springer Verlag; 1994.
15. Gill TM, Feinstein AR. A critical appraisal of the quality of quality-of-life measurements. JAMA. 1994;272(8):619-26.
16. Santin S. Cultura corporal e qualidade de vida. Kinesis 2002;27. doi:10.5902/231654647008.
17. Canavarro MC, Pereira M, Moreira H, Paredes T. Qualidade de vida e saúde: Aplicações do WHOQOL [Internet]. 2007 [access in 2024 jun 12]; Available at: https://repositorio.ipl.pt/bitstream/10400.21/770/1/Qualidade%20de%20vida%20e%20sa%C3%BAde.pdf.
18. BVS MS. Biblioteca Virtual em Saúde. Ministério da Saúde. Qualidade de vida em 5 passos [Internet]. 2013 [access in 2024 jun 12]; Available at: https://bvsms.saude.gov.br/bvs/dicas/260_qualidade_de_vida.html.
19. Page MJ, McKenzie JE, Bossuyt PM, Bossuyt PM, Boutron I, Hoffmann TC. et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Rev Panam Salud Publica. 2022;46:1. doi:10.26633/rpsp.2022.112
20. Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence. Cebm.net. 2023. [access in 2024 jun 12]; Available at: https://www.cebm.net/wp-content/uploads/2014/06/CEBM-Levels-of-Evidence-2.1.pdf
21. Cebm. Oxford Centre for Evidence-based Medicine: levels of evidence 2009. 2009. [access in 2023s27]; Available at: http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidencemarch-2009.
22. Kronick R. AHRQ□s Role in Improving Quality, Safety, and Health System Performance. Public Health Rep. 2016;131(2):229-32. doi: 10.1177/003335491613100205.
23. Holtedahl R, Bøe B, Brox JI. The clinical impact of retears after repair of postero-superior rotator cuff tears: a systematic review and meta-analysis. J Shoulder Elbow Surg. 2023;32(6):1333-1346. doi: 10.1016/j.jse.2023.01.014.
24. Grusky AZ, Giri A, O□Hanlon D, Jain NB. The Relationship of Aging and Smoking With Rotator Cuff Disease: A Systematic Review and Meta-analysis. Am J Phys Med Rehabil. 2022;101(4):331-340. doi: 10.1097/PHM.0000000000001820.
25. Longo UG, Ambrogioni LR, Candela V, Berton A, Carnevale A, Schena E, et al. Correction to: Conservative versus surgical management for patients with rotator cuff tears: a systematic review and META-analysis. BMC Musculoskelet Disord. 2021;22(1):752. doi: 10.1186/s12891-021-04525-w.
26. Craig RS, Goodier H, Singh JA, Hopewell S, Rees JL. Shoulder replacement surgery for osteoarthritis and rotator cuff tear arthropathy. Cochrane Database Syst Rev. 2020;4(4):CD012879. doi: 10.1002/14651858.CD012879.pub2.
27. Karjalainen TV, Jain NB, Heikkinen J, Johnston RV, Page CM, Buchbinder R. Surgery for rotator cuff tears. Cochrane Database Syst Rev. 2019;12(12):CD013502. doi: 10.1002/14651858.CD013502.
28. Fávaro RC, Abdulahad M, Filho SM, Valério R, Superti MJ. Rotator cuff arthropathy: what functional results can be expected from reverse arthroplasty? Rev Bras Ortop. 2015;50(5):523-9. doi: 10.1016/j.rboe.2015.08.005.
29. Luz GD, Cavalcanti AS, Ferreira J, Godoy E, Amaral MVG, Motta Filho GR. Correlation between Implant Positioning and Functional Outcomes in Partial Shoulder Resurfacing. Rev Bras Ortop. 2022;57(03):480–487.
30. França FO, Freitas JMA, Godinho PC, Gonçalves DM, Vieira T, Pereira US. Clinical and functional evaluation of patients submitted to reverse arthroplasty with minimum one year of follow-up. Rev Bras Ortop. 2018;53(6):714-720. doi: 10.1016/j.rboe.2017.10.012.
31. Amaral MVG, Faria JLR, Siqueira G, Cohen M, Brandão B, Moraes R, et al. Artroplastia reversa do ombro no tratamento da artroplastia do manguito rotador. Rev Bras Ortop 2014;49(3):279–285.
32. Kim JY, Rhee YG, Rhee SM. Clinical Outcomes after Reverse Total Shoulder Arthroplasty According to Primary Diagnosis. Clin Orthop Surg. 2020;12(4):521-528. doi: 10.4055/cios19164.
33. Maia RB, Barros RM, Silva LF, Santos MVS. Artroplastia Reversa do Ombro: Indicações Emergentes e Resultados. Rev Cient HSI. 2020;3(3):78–85. doi: 10.35753/rchsi.v3i2.23.
34. Fleck MPA, Lousada S, Xavier M, Chachamovich E, Vieira E, Santos L, et al. Application of the portuguese version of the instrument for the assessment of the quality of life of the World Health Organization (WHOQOL-100). Rev Saude Publica. 1999;33(2):198–205. doi: 10.1590/S0034-89101999000200012.
35. Pereira EF, Teixeira CS, Santos A. Quality of life: approaches, concepts and assessment. Rev Bras Educ Fis Esporte. 2012;26(2):241–250. doi: 10.1590/S1807-55092012000200007.
36. Tavares FDMB. Apontamentos sobre o conceito de qualidade de vida: revisões, cruzamentos e possibilidades críticas. Rev Bras Qual Vida. 2011;3(2):23-32.
37. Oliveira BM, Mininel VA, Felli VEA. Qualidade de vida de graduandos de enfermagem. Rev Bras Enferm 2011;64(1):130–135.
38. Leite LMB, Lins-Kusterer L, Belangero PS, Patriota G, Ejnisman B. QUALITY OF LIFE IN PATIENTS WHO HAVE UNDERGONE REVERSE SHOULDER ARTHROPLASTY. Acta Ortop Bras. 2019;27(5):269-272. doi: 10.1590/1413-785220192705222929.
39. Ribeiro T, Oliveira M, Storti T. Avaliação clínica dos pacientes submetidos à artroplastia reversa de ombro. PIC/UniCEUB. 2018;(3). doi:10.5102/pic.n3.2017.5832
40. Figueira AA, Figueira HA, Figueira JA, Sganzerla A. Systematic review of the results of reverse shoulder arthroplasty on the quality of life of the elderly: a bioethical perspective. Res Soc Develop 2022;11(5): e55111528795.