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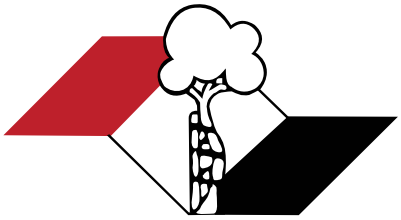

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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed January 2016)

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ACKNOWLEDGEMENTS
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Levels of Evidence for Primary Research Question[a]

(This chart was adapted from material published by the Centre for Evidence-Based Medicine, Oxford, UK. For more information, please visit www.cebm.net.)

	Types of study			
Level	**Therapeutic Studies Investigating the Results of Treatment**	**Prognostic Studies – Investigating the Effect of a Patient Characteristic on the Outcome of Disease**	**Diagnostic Studies – Investigating a Diagnostic Test**	**Economic and Decision Analyses – Developing an Economic or Decision Model**
I	High quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	High quality prospective study[d] (all patients were enrolled at the same point in their disease with ≥80% of enrolled patients)	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference ''gold'' standard)	Sensible costs and alternatives; values obtained from many studies; with multiway sensitivity analyses
	Systematic review[b] of Level RCTs (and study results were homogenous[c])	Systematic review[b] of Level I studies	Systematic review[b] of Level I studies	Systematic review[b] of Level I studies
II	Lesser quality RCT (eg, < 80% followup, no blinding, or improper randomization)	Retrospective[f] study	Development of diagnostic criteria on consecutive patients (with universally applied reference ''gold'' standard)	Sensible costs and alternatives; values obtained from limited studies; with multiway sensitivity analyses
	Prospective[d] comparative study[e]	Untreated controls from an RCT	Systematic review[b] of Level II studies	Systematic review[b] of Level II studies
	Systematic review[b] of Level II studies or Level I studies with inconsis tent results	Lesser quality prospective study (eg, patients enrolled at different points in their disease or <80% followup)		
		Systematic review[b] of Level II studies		
III	Case control study[g]	Case control study[g]	Study of non consecutive patients; without consistently applied reference ''gold'' standard	Analyses based on limited alternatives and costs; and poor estimates
	Retrospective[f] comparative study[e]		Systematic review[b] of Level III studies	Systematic review[b] of Level III studies
	Systematic review[b] of Level III studies		Case-control study	
			Poor reference standard	
IV	Case series[h]	Case series		Analyses with no sensitivity analyses
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion

[a] A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.
[b] A combination of results from two or more prior studies.
[c] Studies provided consistent results.
[d] Study was started before the first patient enrolled.
[e] Patients treated one way (eg, cemented hip arthroplasty) compared with a group of patients treated in another way (eg, uncemented hip arthroplasty) at the same institution.
[f] The study was started after the first patient enrolled.
[g] Patients identified for the study based on their outcome, called "cases" eg, failed total arthroplasty, are compared with patients who did not have outcome, called ''controls'' eg, successful total hip arthroplasty.
[h] Patients treated one way with no comparison group of patients treated in another way.

SUMMARY

VOLUME 28–Nº 1–2020

Original Articles

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<< SUMÁRIO

DOI: http://dx.doi.org/10.1590/1413-785220202801227402
ORIGINAL ARTICLE

EFFECTIVENESS OF SHOCKWAVE THERAPY IN THE TREATMENT OF PLANTAR FASCIITIS

EFICÁCIA DA TERAPIA POR ONDAS DE CHOQUE NO TRATAMENTO DE FASCIÍTE PLANTAR

Renan Gonçalves Leão[1], Marina Mayumi Azuma[1], Gustavo Henrique Carillo Ambrosio[1], Flavio Faloppa[1], Eduardo Shoiti Takimoto[1], Marcel Jun Sugawara Tamaoki[1]

1. Universidade Federal de São Paulo, Paulista School of Medicine, Department of Orthopedics and Traumatology, São Paulo, SP, Brazil.

ABSTRACT

Objective: To evaluate the effectiveness of single-dose focal shockwave therapy in plantar fasciitis treatment. Methods: a primary, prospective study of a series of cases, conducted in the city of São Paulo, Brazil, by the Department of Orthopedics and Traumatology of the Universidade Federal de São Paulo, in Hospital São Paulo. All outcomes were measured at the time of inclusion of the patient in the study and at the post-intervention moments as it follows: three, six and twelve weeks. The VAS, AOFAS and SF-36 scales were applied by teams other than those who performed the SWT. Results: Data from 56 patients were collected during 2017 and 2018. There was improvement of the parameter evaluated ($p < 0.005$ and 95%CI) in all the periods in which the patients were reevaluated (3, 6 and 12 weeks), progressive improvement were observed in the three outcomes evaluated. Conclusion: Shock wave therapy was effective for plantar fasciitis treatment according to the proposed protocol considering pain, function and quality of life. ***Level of Evidence Ic, Case-series Study***.

Keywords: Fasciitis, Plantar. Shock Wave, figh-fnergy. Quality of Life.

RESUMO

Objetivo: Avaliar a eficácia da terapia de ondas de choque focais de dose única no tratamento de fasciíte plantar. Métodos: Um estudo primário e prospectivo de série de casos foi realizado na cidade de São Paulo, Brasil, pelo Departamento de Ortopedia e Traumatologia da Universidade Federal de São Paulo, no Hospital São Paulo. Todos os desfechos foram medidos no momento da inclusão do paciente no estudo e nos momentos pós-intervenção da seguinte forma: 3, 6 e 12 semanas. As escalas VAS, AOFAS e SF-36 foram aplicadas por equipes diferentes daquelas que realizaram o tratamento. Resultados: Dados de 56 pacientes foram coletados durante 2017 e 2018. Houve melhora do parâmetro avaliado ($p <$ 0,005 e IC95%) em todos os períodos de reavaliação dos pacientes (3, 6 e 12 semanas), sendo observada a melhora progressiva nos três desfechos avaliados. Conclusão: A terapia por ondas de choque foi eficaz no tratamento da fasciíte plantar de acordo com o protocolo proposto, considerando dor, função e qualidade de vida. ***Nível de evidência Ic, Estudo de série de casos.***

Descritores: *Fasciíte Plantar. Ondas de Choque, alta energia. Qualidade de vida.*

Citation: Leão RG, Azuma MM, Ambrosio GHC, Faloppa F, Takimoto ES, Tamaoki MJS. Effectiveness of shockwave therapy in the treatment of plantar fasciitis. Acta Ortop Bras. [online]. 2020;28(1):7-11. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Plantar fasciitis is a condition of pain in the lower heel region, whose most accepted etiology is the one that suggests the condition as a consequence of partial repetitive lesions and chronic inflammation in the plantar aponeurosis, in its insertion in the medial tubercle of the calcaneus.[1]

Plantar fasciitis is the most common cause of pain in the lower heel, with 10% incidence, being often seen in athletes and military personnel, as well as in sedentary individuals.[2,3] The risk factors include long time in standing position due to work activity, obesity, use of inappropriate footwear, excessive foot pronation, limited ankle dorsiflexion, and excessive running by unexperienced runners.[4,5]

It is a condition with great socioeconomic impact and it is the most prevalent to receive treatment by specialists.[6] According to a study by Tong and Furia, more than 2 million patients are treated for plantar fasciitis every year, with a treatment cost estimated between 192 and 376 million dollars a year, in 2007.[7]

The main complaint is pain under the heel that worsens when waking up in the morning or after sitting, which usually gets better after a little walk and at the end of the day with less weight bearing.[8] Pain in the inferomedial aspect of the calcaneus tuberosity is expected in the physical examination. The symptomatic heel may present erythema and a slight swelling when compared with the contralateral heel.

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

This study was performed at the Department of Orthopedics and Traumatology of the Universidade Federal de São Paulo, Hospital São Paulo.
Correspondence: Renan Gonçalves Leão. Avenida Doutor Altino Arantes, 835, apartamento 44. renangleao@gmail.com.

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The diagnosis is made clinically and by exclusion. Radiographs may show calcaneal spurs in 50% of patients.[8] Ultrasonography is a low-cost and useful exam to evaluate soft-tissue injuries to the heel. Suggestive findings for the diagnosis of plantar fasciitis include thickening of the plantar fascia greater than 4 mm and areas of hypoechogenicity.[3] Magnetic resonance imaging (MRI) is another available test that helps in the evaluation, which has diagnosed plantar fasciitis in 76% of the sample according to the literature, being also useful for diagnosing other pathological processes in the calcaneus.[9]

Patients rarely undergo surgical treatment. Clinical treatment is recommended for more than 90% of patients. Different clinical treatments have been reported such as orthoses in shoes (shims and insoles), oral anti-inflammatory agents, local infiltrations of corticosteroids, physiotherapy, and shock wave therapy. However, there is not a consensus about which is the most effective treatment in the literature.

Shock wave therapy – SWT – has been prescribed for the treatment of several musculoskeletal conditions, for being a noninvasive procedure that stimulates tissue and bone regeneration.[3,10-13]

SWT has been prescribed for the treatment of plantar fasciitis; however, there are no prospective clinical studies with a sufficient sample to show its benefits. Furthermore, there is no standardization of the form of treatment and in the measurement of the results, considering pain, function and quality of life. In our sample, a four-dose SWT protocol was described for the treatment of chronic plantar fasciitis. Thus, considering the high prevalence, consequent cost and the controversy over this treatment, our study sought to evaluate the effectiveness of shock wave therapy through questionnaires that assess pain, function and quality of life (VAS, AOFAS and SF-36) and to correlate the outcomes to epidemiological and radiographic data.

The objective is to evaluate the effectiveness of a single application of focal shock wave therapy in plantar fasciitis treatment, considering pain, function and quality of life. The secondary objective is to correlate the improvement of the primary outcomes with epidemiological data.

MATERIALS AND METHODS

All participants signed the informed consent form. This study was authorized by the Research Ethics Committee of the Universidade Federal de São Paulo, protocol CEP 0231/11.

Statistical Analysis

Data were analyzed through the ANOVA test. The Pearson correlation test was used to measure the variable interrelation, considering a 0.05 (5%) level of significance and 95%CI.

Participants

The inclusion criteria were: being older than 18 years, of both sexes, patient with unilateral chronic plantar fasciitis diagnosed by clinical, radiographic and ultrasonographic examination; symptoms of heel pain in the region of the proximal insertion of the plantar fascia for more than three weeks; physical examination with pain at palpation of the proximal insertion of the plantar fascia in the inferomedial region of the unilateral calcaneus; ultrasonographic examination of the affected foot showing an inflammatory process in the insertion region of the plantar fascia in the inferior region of the calcaneus; history of three weeks of unsuccessful conservative treatment, including one or the combination of the following therapeutic methods: NSAIDs, resting, heat, ice, ultrasound, massage, orthotics, plaster immobilization, sparking, shoe modification and use of night orthotics.

Exclusion criteria were: treatment with corticosteroid injection of less than 30 days; surgical treatment for prior plantar fasciitis; treatment in progress with anti-inflammatories, active infectious process in the region to be treated, history or documented evidence of autoimmune or peripheral vascular disease, non-palpable posterior tibial or dorsalis pedis pulses or abnormal capillary filling, history or documented evidence of peripheral neuropathy (tarsal tunnel syndrome, diabetic neuropathy), pregnancy, history or documented evidence of blood clotting disorders (treatment with anticoagulant, excluding aspirin), tumor lesions (primary or secondary tumors), trauma (fracture) or infections (osteomyelitis), use of cardiac pacemaker and allergy or known allergic sensitivity to Xylocaine®.

INTERVENTION

The patient laid down on the stretcher in supine position, without footwear, with ear protectors, with the feet towards the shock wave apparatus and with the application site marked in the medial region towards the lower tubercle of the calcaneus. Asepsis and antisepsis of the foot and ankle were performed, followed by anesthetic block with 5 ml of 2% lidocaine hydrochloride, posterior tibial nerve, medial retromalleolar region, 15 to 20 minutes before the application of the conductive gel in the heel region, where the device probe was directly positioned.

A single application of 900 pulses follows, with energy around 0.13 mJ/mm^2 with frequency of 4 pulses /s with Evotron (Switch), considered as high energy, greater than 0,12 mJ/mm^2.[14]

Epidemiological data were initially recorded at the first visit, namely: sex, age, BMI, time of pain, laterality, presence of spurs in the radiography. In addition, all patients underwent X-ray examination and ultrasonography to confirm the condition.

Outcomes

Primary:

- Pain (visual analog scale – VAS)
- Function (AOFAS)
- Quality of life (SF-36)

All outcomes were measured at the time of inclusion of the patient in the study and at the post-intervention moments as it follows: three, six and twelve weeks. Outcomes were measured by physicians or physiotherapists not directly related to the study, all of them capable of measuring the outcomes.

Complication and adverse effects

Adverse effects, complications and treatment failure were evaluated, considering treatment failure as the need to another intervention besides shockwave therapy, except oral drugs. Another definition was the lack of pain improvement compared with pre intervention pain in subsequent periods (3, 6 and 12 weeks).

RESULTS

A total of 60 patients were included in the study. Of these, we had 4 patients lost to follow up who did not complete the collection of results. Thus, data from 56 patients were collected during 2017 and 2018: 44 women (78.6%) and 12 men (21.4%), with an average age of 49.1 +/- 2.9 years and an average time of symptoms of 24.3 months. Average BMI of 28.74 was observed among the selected patients. The presence of calcaneal spur was found in 78.2% of the sample, as shown in Table 1.

Table 2 shows the results obtained in the Visual Analog Pain Scale (VAS) analysis.

Table 1. Epidemiologic data.

	Mean	Media	Standard Deviation	Min	Max	N	CI
Age	49.1	49.5	11	27	75	56	2.9
Δt symptoms	24.3	12	28.8	1.5	120	56	7.7
Weight	76.7	75	16.1	49	118	56	4.2
Height	1.63	1.62	0.1	1.48	1.9	56	0.03
BMI	28.74	27.65	4.98	20.08	42.82	56	1.3

Based on the results, we conclude there was a progressive increase in the parameter evaluated in all the periods in which the patients were reevaluated (3, 6 and 12 weeks), as shown in Figure 1.

The functional evaluation obtained with the AOFAS questionnaire showed the results evidenced by Table 3.

The results obtained showed that the Pre mean (19.5) was higher when compared with all other periods, which had lower and decreasing averages. Thus, the average was 15.1 in Post 3, versus 13.6 in the Post 6 and 13.1 in the Post 12 (p-values < 0.001, as shown in Table 3). Based on these results, we concluded there was a progressive increase in the AOFAS score.

The SF-36 questionnaire was subdivided into the following parameters in the analysis: Functional capacity (FC), Pain (P), Limitation for physical aspects (LPA), General health status (GHS), Vitality (V), Social aspects (SA), Limitation for emotional aspects (LEA) and Mental health (MH); Statistical difference was observed between the periods for almost all variables, except general health status and limitation for emotional aspects.

For FC, the averages obtained were: 30.6 in the Pre, 54.0 in the post 3 weeks, 48.4 in the post 6 weeks and 49.4 in the post 12 weeks, in which $p < 0.001$. For Pain, the average were: 32.2; 46.2; 41.1 and 39.3, with $p = 0.003$. For LPA: 9.4; 28.6; 21.9 and 25.4, with $p = 0.001$. For GHS: 60.4; 62.2; 57.7 and 55.2, with $p = 0.353$. For V: 48.6; 54.0; 48.8 and 48.0, with $p = 0.043$. For SA: 50.4; 59.2; 61.6 and 62.1, with $p = 0.015$. For LEA: 20.2; 31.5; 32.1 and 32.7, with p 0.129. And for MH: 58.1; 63.3; 57.1 and 55.6, with $p = 0.036$ (Figures 2 to 9).

Statistically significant correlations were observed, but all of them have very low values, which make them clinically not significant. The highest correlation occurred between Age and Delta t between pre and post 3 weeks SF36-V with a value of -40.1%. Since it has a negative value, it indicates that the higher the Age, the lower the value of SF36-V and vice versa. This is a Correlation classified as Regular. No statistically significant differences in sex and quality of life were observed.

Table 2. Visual analog pain scale analysis.

VAS	Pre	Post 3	Post 6	Post 12
Mean	8.31	5.9	5.74	5.08
Median	8	6	6	5
Standard Deviation	1.33	2.62	2.81	3.24
N	50	50	50	50
CI	0.37	0.73	0.78	0.9
P-value	< 0.001			

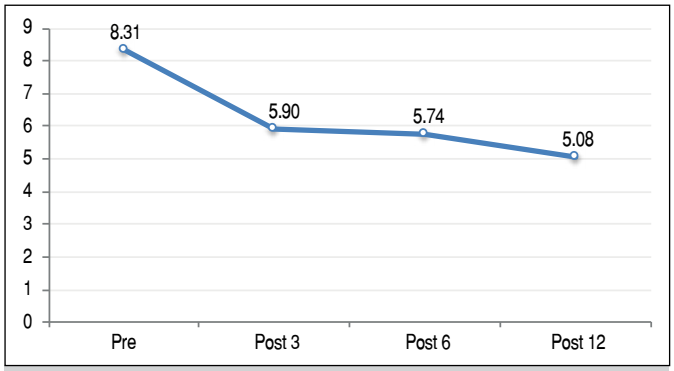

Figure 1. VAS evolution.

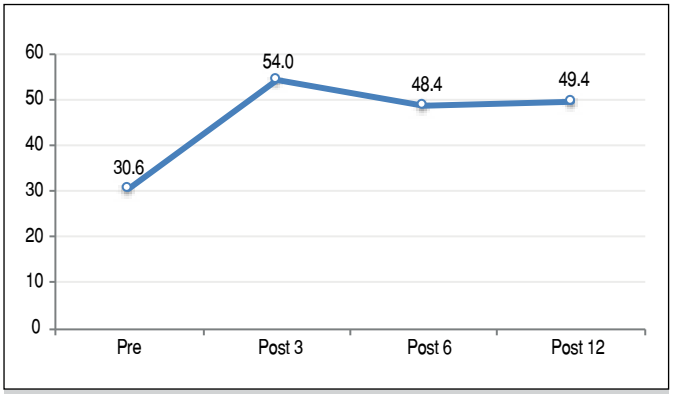

Figure 2. "SF36 – Functional capacity" evolution.

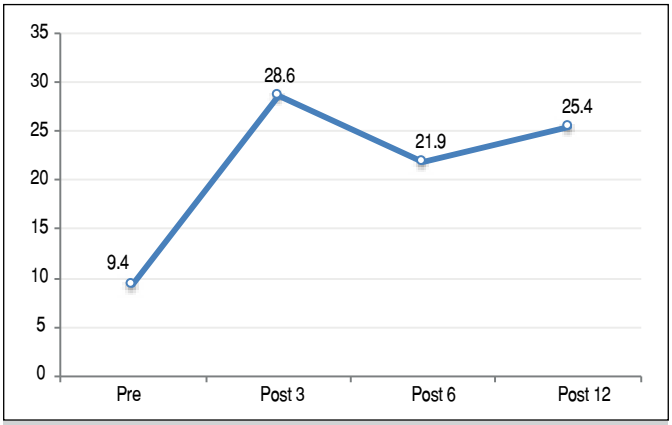

Figure 3. "SF36 – Limitation for physical aspects" evolution.

Table 3. Aofas analysis.

AOFAS	Pre	Post 3	Post 6	Post 12
Mean	19.5	15.1	13.6	13.1
Median	20	14	14	14
Standard Deviation	2.7	3.4	4.9	5.7
N	56	56	56	56
CI	0.7	0.9	1.3	1.5
P-value	< 0.001			

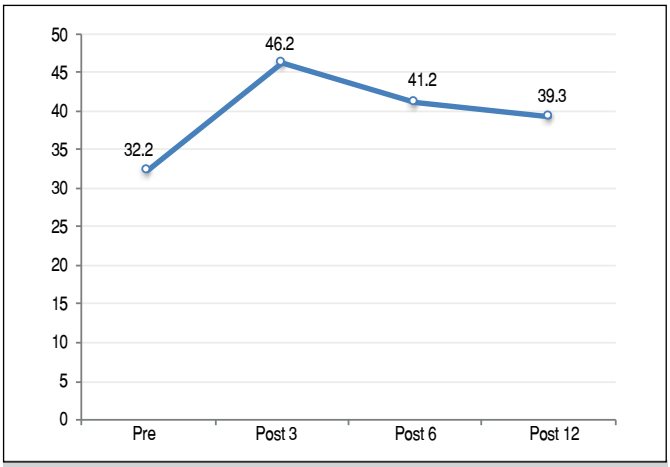

Figure 4. "SF36 – Pain" evolution.

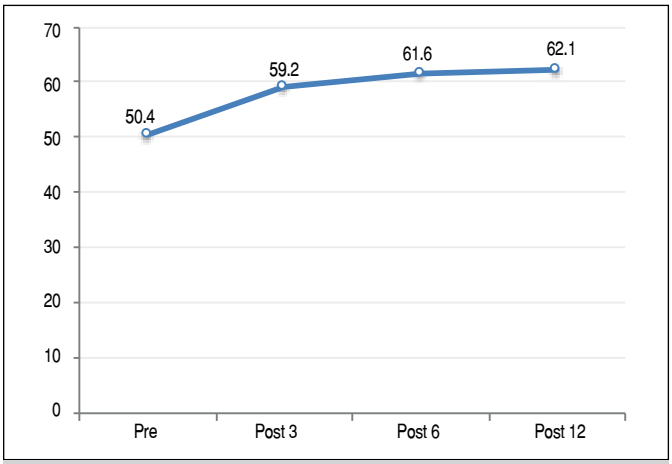

Figure 7. "SF36 – Social aspects" evolution.

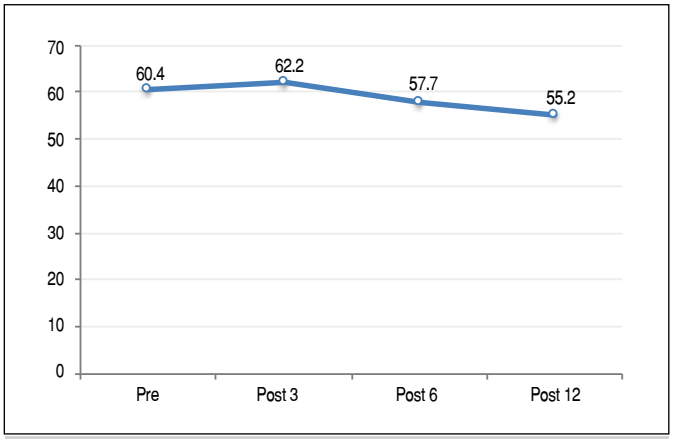

Figure 5. "SF36 – General health status" evolution.

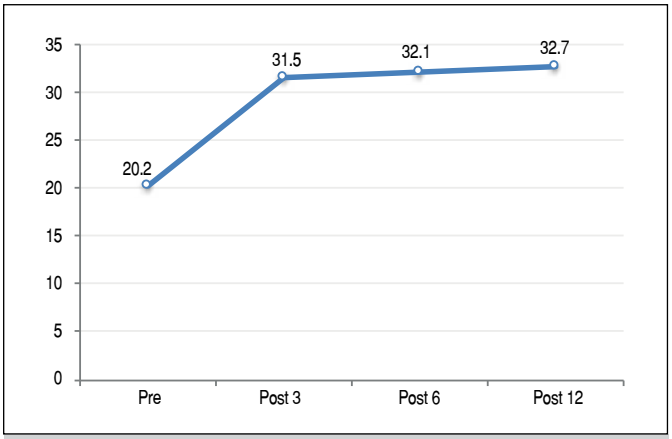

Figure 8. "SF36 – Limitation for emotional aspects" evolution.

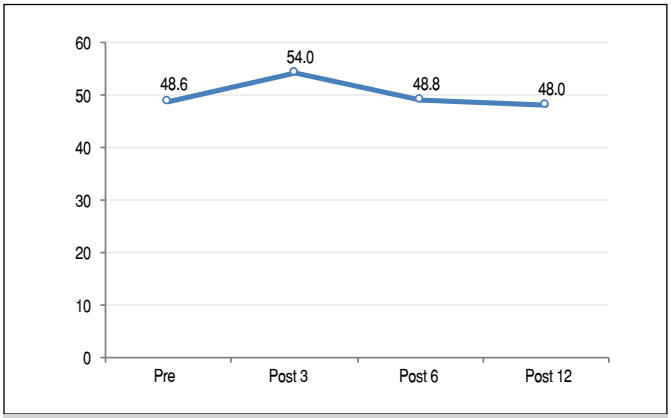

Figure 6. "SF36 – Vitality" evolution.

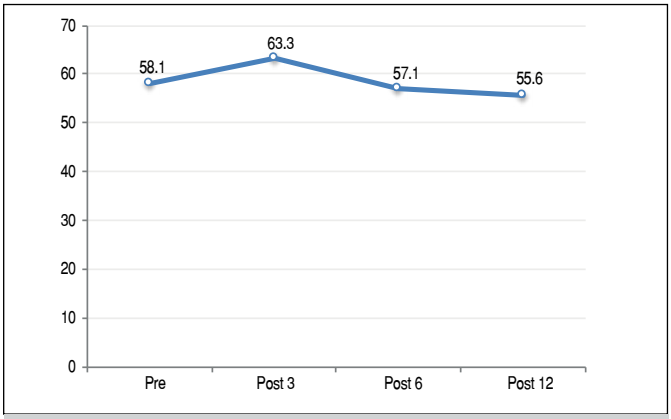

Figure 9. "SF36 – Mental health" evolution.

DISCUSSION

The shockwave therapy is an alternative to non-surgical treatments (drug and physiotherapy) and less aggressive than surgical treatment for refractory cases. After analyzing the collected data, we obtained a significant improvement in the pain parameter, evaluated by the analog visual scale. In our sample, patients had a quick improvement in pain, seen after 3 weeks and later in the remaining periods of re-evaluation, up to 12 weeks. However, a clinically relevant difference is considered to be a 3-point change in the scale, which was achieved only in the twelfth week of follow-up.

Our study agrees with the literature, since it shows an improvement in the pain parameter, as found by Gollwitzer et al.[15] and Dastgir,[16] with a significant improvement in VAS at 12 and 24 weeks, respectively. Based on this conclusion, we can affirm the shock wave therapy may be interesting due to the rapid improvement in pain presented, remaining in the later periods of reevaluation. Our study shows an improvement in the AOFAS functional score, agreeing with the results published by Androsoni et al. (2013)[11], which used the same score and obtained a significant improvement at the end of longer periods of patient reassessment (1 month, 3 months and 6 months),

with patients being subjected to a weekly application for 4 consecutive weeks. However, the study analyzed a small sample of patients, 30 patients (36 feet), who were subjected to the procedure more than once, and the results of quality of life and pain improvement were not evaluated at the end.[11]

In our earlier analysis, we observed a significant increase in the functional score in a shorter period of time, with a single session of SWT, showing that this treatment may positive results in the functionality within three weeks, maintained for up to 12 weeks.

The SF-36 score handles several aspects of patients' quality of life and includes: Functional capacity (FC), Pain (P), Limitation for physical aspects (LPA), General health status (GHS), Vitality (V), Social aspects (SA), Limitation for emotional aspects (LEA) and Mental health (MH). Despite the difficulty in applying it due to its extension, the scale has an advantage: the large amount of information of different aspects involving patients' quality of life. In a review in the literature on the treatment of plantar fasciitis with shock wave therapy, no studies were found to evaluate this questionnaire. After the statistical analysis of the results, we could identify an improvement in most of the aspects addressed by the questionnaire after three weeks, revealing a positive short-term impact of SWT on patients' quality of life. As expected, there were no changes in General Health Status and Limitation for emotional aspects, although most of the patients presented the disease for more than 3 weeks, which could negatively influence these two domains.

Complications of the application of SWT has not been described in the literature. Other studies[15] also considered the application of shock waves as a safe procedure.

Regarding the multivariate analysis, we found no correlation between the result of the shock wave treatment and the epidemiological data collected, probably due to the small sample for this test. Moreover, we consider the absence of a control group as a limitation of our study. Keeping patients' attendance at the follow-up visits was difficult, which hindered the application of the questionnaires for all patients. The strength of our study is the fact that we showed a series with a number of 60 patients in a prospective study with shock wave treatment with a single application and evaluated the outcome in quality of life.

CONCLUSION

We conclude that shock wave therapy was effective in plantar fasciitis treatment according to the proposed protocol, which considered pain, function and quality of life. We could not establish a connection between BMI and the response of the proposed treatment.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. RGL: article writing, review and data collection (questionnaires). GHCA: data analysis and writing of the article. MMA: data collection (questionnaires), statistical analysis, and review of the article. Data collection (questionnaires), writing of the article. MJST: writing of the article, statistical analysis and intellectual concept of the article and preparation of the entire research project. FF: review of the article and also in any intellectual concept of the article.

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ORIGINAL ARTICLE

HALLUX VALGUS ANATOMICAL ALTERATIONS AND ITS CORRELATION WITH THE RADIOGRAPHIC FINDINGS

ALTERAÇÕES ANATÔMICAS ENCONTRADAS NO HÁLUX VALGO E SUA CORRELAÇÃO COM OS ACHADOS RADIOGRÁFICOS

Cristina Schmitt Cavalheiro[1], *Marcel Henrique Arcuri*[1], *Victor Reis Guil*[1], *Julio Cesar Gali*[2]

1. Pontifícia Universidade Católica de São Paulo, School of Medical Sciences and Health, Graduate Training Program in Orthopedics and Traumatology, Sorocaba, SP, Brazil.
2. Pontifícia Universidade Católica de São Paulo, School of Medical Sciences and Health, Department of Surgery, Sorocaba, SP, Brazil.

ABSTRACT

Objective: To describe the anatomical and pathological osteoarticular, muscular and tendinous variations in feet of cadavers with hallux valgus and to correlate them with the degree of radiographic deformity. Methods: Dissections and radiographs were conducted in the feet of 22 cadavers with halux valgus, aged between 20 and 70 years. The feet affected were compared with 5 normal feet in order to document the anatomical and pathological, myotendinous and articular variations found. Results: The extensor hallucis longus and brevis tendons were arched in all degrees of deformity, causing a lateral deviation that forms the arc chord of the metatarsophalangeal angle of the hallux. We also observed a deviation to the plantar face of the abductor muscle tendon and lateral deviation of the flexor hallucis muscle tendon. In the moderate deformities, the medial deviation of the first metatarsal head was observed, sliding out of the sesamoid apparatus, pronation of this head, and formation of medial exostoses. In severe deformities, in addition to all other deformities, we found the extensor hallucis longus tendon with two distal insertions, rather than just one. Conclusion: The anatomical alterations found in the hallux valgus may be related to the degree of radiographic deformity. ***Level of Evidence IV, Case series***.

Keywords: Anatomy. Hallux Valgus. Foot. Radiology.

RESUMO

Objetivo: Descrever as variações anatômicas e patológicas osteoarticulares, musculares e tendíneas em pés de cadáveres portadores de hálux valgo e correlacionar com o grau de deformidade radiográfica. Métodos: Foram feitas dissecações e radiografias de 22 peças de pés de cadáveres portadores de hálux valgo, com idade entre 20 e 70 anos, que foram comparadas com 5 pés normais, no intuito de documentar as variações anatômicas e patológicas ósseas, miotendíneas e articulares encontradas. Resultados: Em todos os graus de deformidade encontramos um arqueamento dos tendões extensores longo e curto do hálux, causando um desvio lateral que forma a corda de arco do ângulo metatarsofalângico do hálux. Observamos, também, um desvio para a face plantar do tendão do músculo abdutor do hálux e desvio lateral do tendão do músculo flexor do hálux. Nas deformidades moderadas foi verificado o desvio medial da cabeça do primeiro metatarseano, deslizando para fora do aparelho sesamoide, pronação dessa cabeça e formação de exostoses mediais. Nas deformidades severas, além de todas as outras deformidades, encontramos o tendão extensor longo do hálux com duas inserções distais, ao invés de apenas uma. Conclusão: As alterações anatômicas encontradas no hálux valgo podem estar relacionadas com o grau de deformidade radiográfica. ***Nível de Evidência IV, Série de Casos***.

Descritores: *Anatomia. Hálux Valgo. Pé. Radiologia.*

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INTRODUCTION

The term *hallux abducto valgus* was introduced by the German surgeon Carl Heuter in 1871, who described the deformity as a lateral deviation of the hallux and its consequent distancing from the median axis of the body.[1,2] *Hallux* is a Latin term meaning *"the largest toe"* and *valgus* corresponds to the position it takes in relation to the longitudinal axis of the body, i.e. away from this axis. The hallux valgus deformity presents a familial tendency, especially in juvenile forms, which are more dependent on intrinsic factors, and it is transmitted by autosomal dominant inheritance with incomplete penetrance.[2]

The incidence of this pathology is higher in females, at a ratio of 2:1 when studying infant populations, but when assessing adult populations, this proportion changes significantly and may reach 15:1. These findings suggest that the frequency increases due to the use of shoes whose characteristics facilitate and stimulate deformity in females.[2]

Hallux valgus is a complex condition with a range of deformities that vary in severity, suggesting that several factors are responsible.

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

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Correspondence: Cristina Schmitt Cavalheiro. Rua Caracas, 418, Sorocaba, SP, Brazil. 18046-718. cristinaschmitt1@gmail.com

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Inheritance and sex are relevant, but other anatomical and biomechanical factors, such as metatarsal anatomical variants, including a long first metatarsal, a rounded joint, and metatarsus primus varus, play an important role in the evolution of the disease. These variants increase vulnerability to hypermobility of the first ray, flat foot, and ligament laxity.[3]

Hallux valgus does not necessarily occur in serial stages but may occur in parallel.[4] The medial support structures of the first metatarsophalangeal joint are the medial sesamoid and the medial collateral ligaments; when these structures fail, the so-called "initial and essential injury" occurs. The first metatarsal head can deviate medially by sliding out of the sesamoid apparatus, and an oblique or unstable joint of the tarsometatarsal joint may favor this movement.[5,6] The proximal phalanx moves in the valgus direction, while its base is fixed to the sesamoid, deep transverse ligament and adductor hallucis tendon. Then the extensor and flexor hallucis longus tendons arch laterally increasing the valgus displacement.[7,8]

As the first metatarsal head slides from the sesamoid apparatus, its pronation occurs for the muscle forces acting on it. Typically, the abductor hallucis tendon strongly resists proximal phalanx valgus, but it becomes dysfunctional as its medial and plantar insertions rotate less efficiently.[3,9] As the adductor hallucis tendon is inserted into the plantar surface laterally, it tends to pull the phalanx in pronation, dislocating the phalanx base. The weakened capsule of the metatarsophalangeal joint is not reinforced by any tendon, so it rotates medially with pronation, providing significant instability.[10]The elevation of the metatarsal head with medial movement may transfer plantar pressure to the lateral.[3,11] Therefore, hallux valgus is essentially a subluxation of the two great toe phalanges in the valgus sense.

According to Dykyj[12], this pathology is associated with the deviation of bones from their axial position and the related destabilization of the muscle group around the joint, specifically: the hallux deviates and rotates laterally, while the first metatarsal deviates medially and also rotates laterally to some degree; deviation of the two main segments of the joint causes rupture and weakening of the medial capsular fibers and pull the sesamoid bones and metatarsal head away from their normal plantar joint; abnormal articulation of the sesamoid bones under the crest and pressure of the medial capsular wall causes erosion of both cartilage and subchondral bone in the metatarsal head; the deviation of the hallux redistributes the insertions of the tendons in relation to the articular axes of the movement, aggravating the deviation; the deviated position of the hallux and the eccentric actions of the tendons create a reaction force in the first metatarsal head, dislocating medially the first metatarsal bone.

The deformity of the first ray associated with hallux valgus is actually a triple deformity with axial, sagittal and coronal components.[13] Several angular parameters such as hallux valgus angles, intermetatarsal angle (between the first and second metatarsals), interphalangeal valgus angle, tarsometatarsal joint angle, degree of sesamoid subluxation, and relative length of metatarsals have been used to determine in both preoperative period (moment of surgical indication) and postoperative period (moment of results evaluation) the appropriate technique, intensity of the deformity, and intended and obtained correction.[14-17] We did not find studies correlating the degree of radiographic deformity with the anatomical changes found. The aim of this study was to describe the osteoarticular, muscular and tendon anatomical and pathological variations in feet of cadavers with hallux valgus and to correlate them with the degree of radiographic deformity, to create a scientific approach to assist the decision of the appropriate treatment for each patient.

MATERIALS AND METHODS

The study was approved by the Research Ethics Committee of our Institution (02282718.7.0000.5373). Dissections were performed on 22 feet of cadavers with hallux valgus, aged between 20 and 70 years (mean age 45 years), 18 of them were female (81.8%) and 4 were male (18.1%), to document the anatomical and pathological, myotendinous and articular variations; five feet without changes were dissected for comparative purposes. Radiographs were obtained in the anteroposterior view of these cadavers. Inclusion criteria for hallux valgus feet were intermetatarsal radiographic angles higher than 15º and hallux valgus higher than 9º. The feet were considered without deformities when the hallux valgus angle was lower than 15° and the intermetatarsal angle was lower than 9°.

The dissections assessed the intrinsic and extrinsic muscles of the foot, also observing its tendon insertions. The procedure was started with a first radius dorsal incision to assess the insertion of the tendon of the extensor hallucis longus muscle, and dissection of deep planes, with resection of all adjacent tissue. The same process was used with the tendon of the extensor hallucis brevis muscle. A medial incision was carried out to assess the insertion of the tendon of the abductor hallucis muscle and the tendon of the tibialis anterior muscle. Finally, a plantar incision was executed for direct visualization of the tendons of the adductor, flexor hallucis longus and brevis muscles. Thus, the osteoarticular assessment process started with the soft tissues following denudation procedures. After dissections, the pieces were treated with 2.5% formaldehyde and, subsequently, the samples were glycerinated for fixation and better photographic record. The radiographic study followed the technical standardization described in previous studies.[10,18]

The angles were assessed on the printed radiographs of the feet using a goniometer. The angles were measured between the first and second metatarsals — formed by the intersection of the longitudinal axes of the diaphyses of these two bones — and hallux valgus angle — formed by the intersection of the longitudinal axes of the first metatarsal diaphysis and the proximal phalanx diaphysis[2,11,19]. (Figure 1)

Radiographic hallux valgus was classified according to Mann and Coughlin[20] standards: mild deformities were those with hallux valgus angle between 15 and 20º and intermetatarsal angle between 9 and 11º; deformities with hallux valgus angle between 21º and 40º and intermetatarsal angle between 11º and 16º were classified as moderate. The severe deformities were those with hallux valgus angle higher than 40º and intermetatarsal angle higher than 16º.

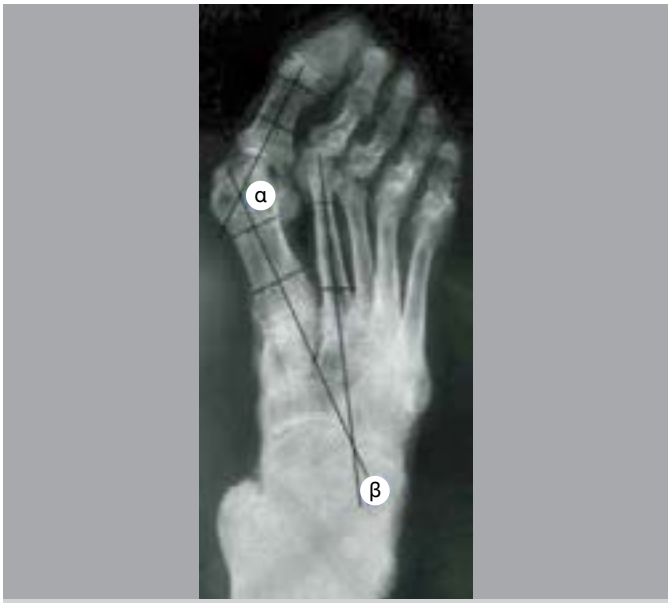

Figure 1. Anteroposterior radiograph of a deformed foot, showing the lines drawn for angle measurements. α = hallux valgus angle and β = intermetatarsal angle.

RESULTS

According to the classification of radiographs by Mann and Coughlin[20], nine feet presented mild deformity (40.9%), seven feet had moderate deformities (31.8%) and six feet presented severe deformities (27.2%). In all degrees of deformity, an arch of the extensor hallucis longus and brevis tendons were found, causing a lateral deviation that formed the curvature of the hallux phalangeal metatarsal angle. We also observed a deviation to the plantar face of the tendon of the abductor hallucis muscle (Figure 2) and lateral deviation of the tendon of the flexor hallucis muscle (Figure 3).
Regarding the moderate deformities, in addition to what has been described for mild deformities, the first metatarsal head was found medially deviated, sliding out of the sesamoid apparatus, pronation of this metatarsal head, and formation of medial exostoses (Figure 4).
In severe deformities, added to the changes shown in mild and moderate deformities, the extensor hallucis longus tendon was found with two distal insertions instead of one (Figure 5).
In the radiographic assessment, the mean value for the measurements of intermetatarsal angles was 27.3°(ranging between 17 and 53°) and for the hallux valgus was 18.6 (ranging between 9 and 26°). We verified exostoses formations and sesamoid complex deviation in moderate and severe deformities, as well as increased intermetatarsal angle — in all degrees of deformity.

DISCUSSION

The main result of our study was to verify that the anatomical and pathological bone variations present in hallux valgus may be related to the degree of radiographic deformity. Henning[4] suggests hallux valgus deformities may occur sequentially and simultaneously. In fact, our study showed that the common denominator in all degrees of radiographic deformity was an arch of the extensor hallucis longus and brevis tendons, a deviation to the plantar face of the abductor hallucis tendon, and lateral deviation of the flexor hallucis tendon.

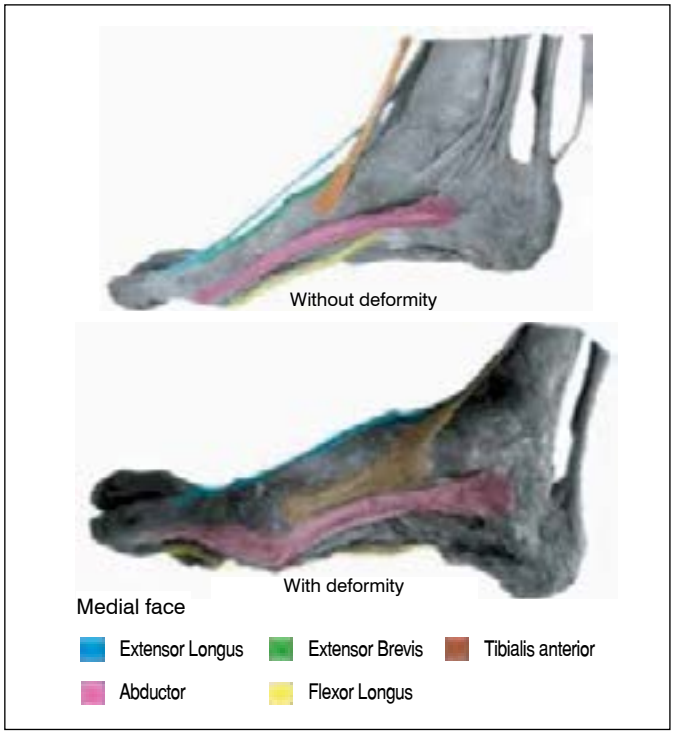

Figure 2. Medial view of the dissection, showing plantar deviation of the abductor hallucis muscle and the comparison between the feet with and without deformity.

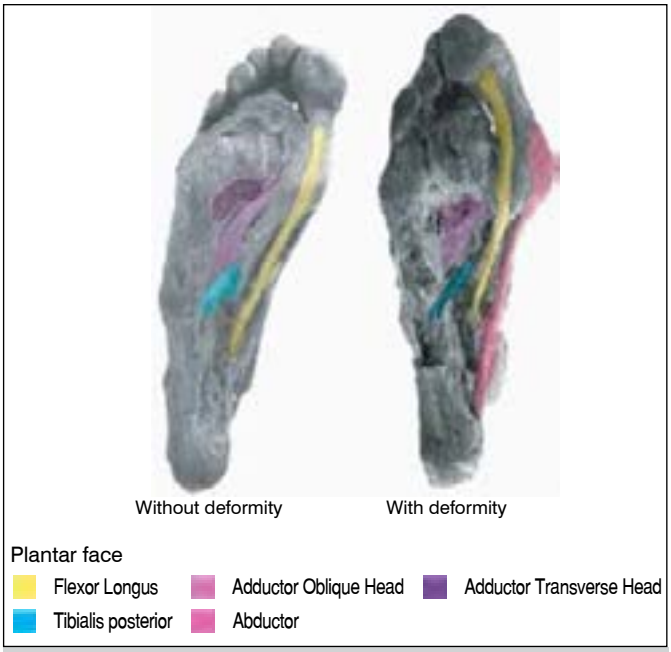

Figure 3. Plantar view of the dissection, showing the plantar deviation of the abductor hallucis muscle, hypotrophy of the oblique and transverse head of the adductor hallucis muscle, medial deviation of the flexor hallucis longus muscle and the comparison between the feet with and without deformity.

Figure 4. Plantar view showing medial deviation of the first metatarsal head, dislocating the sesamoid complex and comparing the feet with and without deformity.

The moderate deformities characteristic were presented as the medial deviation of the first metatarsal head, located outside the sesamoid apparatus, pronation of the head, and the presence of medial exostoses (Figure 3). The severe deformities were characterized by the presence of two distal insertions of the extensor hallucis longus tendon (Figure 4). The literature does not show studies corroborating the anatomical changes presented in hallux valgus with the degree of radiographic deformity.
Aseyo and Nathan[21] assessed 200 hallux: 100 of those hallux by dissections and 100 radiographs of hallux valgus patients. In 40 hallux of cadavers and in 100 patients with this deformity, the sesamoids were displaced laterally in varying degrees.

Figure 5. Dorsal view of the dissection, showing double proximal insertion of the tendon of the extensor hallucis longus muscle, insertion of the tibialis anterior tendon, and comparison between the feet with and without deformity.

Kim[22] dissected 15 feet with hallux valgus to assess changes in tendon insertions in the proximal and distal phalanges of the first toe. The 15 cadavers presented the following alterations: deviation of the tendon of the abductor hallucis muscle to the plantar face, lateral displacement of the tendons of the adductor muscles and flexor brevis hallucis. Kim verified that the rotation angle of the proximal phalanx varied according to the degree of the pathology severity and that the tendon of the extensor hallucis longus muscle and the tendon of the flexor hallucis longus muscle were laterally deviated.

Therefore, to establish a relationship between the degree of radiographically deformity measured and the morphological changes may be a fundamental tool for the planning of hallux valgus treatment, including possible surgical interventions. Based on the knowledge of the anatomical changes that occur in the different degrees of radiographic deformity, the surgical planning can be more effective.

Our study has some limitations. Our sample of 22 feet with hallux valgus may be considered small, although larger than Kim's[22] sample. Furthermore, the radiographs of the cadavers' feet were obtained without load, as recommended in the assessment of this pathology. On the other hand, the anatomical parts were already rigid, which would possibly not be influenced by the load in the production of radiographic images.

CONCLUSIONS

Anatomical changes found in hallux valgus may be related to the degree of radiographic deformity.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. JCG, VRG (0000-0001-5648-1921)* and MHA: bibliographic survey and aid in anatomical dissections; CSC: analysis of the results and writing of the article; MHA: writing of the article and photographic documentation. VRG: aid in anatomical dissections and photographic documentation; JCG and CSC: were present in all dissections, writing and review of the article, results analysis, intellectual concept of the article and preparation of the entire research project.

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ORIGINAL ARTICLE

EPIDEMIOLOGICAL STUDY OF TRAUMATIC BRACHIAL PLEXUS INJURIES

ESTUDO EPIDEMIOLÓGICO DAS LESÕES TRAUMÁTICAS DO PLEXO BRAQUIAL

Álvaro Baik Cho[1], Ana Claudia Guerreiro[1], Carlos Henrique Vieira Ferreira[1], Leandro Yoshinobu Kiyohara[1], Luiz Sorrenti[1]

1. Faculdade de Medicina do ABC, Hand Surgery and Microsurgery Service, Santo André, SP, Brazil.

ABSTRACT

Objective: To conduct an epidemiological study on brachial plexus injuries, through data collection of patients treated in the Hospital São Paulo, which is the referral center for high complexity in this region. Methods: We conducted a retrospective study with a review of the electronic medical records of the Hospital, from August 2008 to June 2013. Results: We estimated an 1.88/100,000 annual incidence, considering that the Hospital is the only referral center for brachial plexus injuries. The mean time between injury and the first visit to the reference hospital was 8.25 months. The mean time interval between injury and surgery was 11.25 months. The percentage of total injuries was 33%, while the upper and middle trunk injuries were 33% and 28%, respectively. Conclusion: We observed many aspects in common with those reported by other centers of excellence in Brazil such as: sex, age and mechanism of injury. However, some findings were different from most other epidemiological studies, namely: level of injury, time between the accident and the first appointment and the time between injury and surgery. ***Level of evidence IV, case series.***

Keywords: Epidemiology. Brachial Plexus Surgery. Brachial. Plexus Injury.

RESUMO

Objetivo: Realizar um estudo epidemiológico das lesões do plexo braquial através do levantamento de dados dos pacientes atendidos no Hospital de referência para alta complexidade da região metropolitana de São Paulo. Métodos: Estudo retrospectivo com avaliação dos prontuários eletrônicos do HMC-SA, de agosto de 2008 até junho de 2013. Resultados: Levando-se em consideração que o Hospital é o único centro de referência para lesões do plexo braquial, chegamos a uma incidência anual estimada em 1,88/100.000 habitantes. A média de tempo entre a lesão e a primeira consulta no hospital foi de 8,25 meses. O intervalo de tempo entre a lesão e a cirurgia foi em média de 11,25 meses. A porcentagem de lesões totais foi de 33%, enquanto as lesões de tronco superior e tronco superior e médio foram de 33% e 28%, respectivamente. Conclusão: Observamos muitos aspectos em comum com os relatados por outros centros de referência no Brasil, tais como: gênero, idade e mecanismo de trauma. No entanto, alguns achados foram diferentes da maioria dos outros estudos epidemiológicos: nível de lesão, tempo decorrido entre o acidente e o primeiro atendimento e o intervalo de tempo entre a lesão e o tratamento cirúrgico. ***Nível de evidência IV, série de casos.***

Descritores: *Epidemiologia. Plexo Braquial, cirurgia. Plexo Braquial, lesões.*

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INTRODUCTION

Traumatic brachial plexus injuries are very prevalent in large urban centers due to the association with traffic accidents, especially motorcycles[1]. The functional loss caused by these injuries is significant, resulting in different degrees of paralysis and anesthesia of the affected upper limb according to the extent of the neurological injury, also causing loss of work capacity and quality of life[2].

In addition to the initial extent of the injury, the functional prognosis of these patients depends on early surgical treatment, since they are neurological injuries.[3] Therefore, there is a need to shorten the period between trauma and surgical treatment as much as possible in patients with indication for surgery.[3] Surgical procedures in this situation are generally of high complexity, requiring adequate hospital infrastructure and a highly specialized team, which is the reason why the centers specialized in the treatment of these injuries are scarce in Brazil, even in the state of São Paulo (Instituto de Ortopedia e Traumatologia do Hospital das Clinicas de São Paulo – IOTFMUSP, Hospital São Paulo – Universidade Federal de São Paulo – UNIFESP, Santa Casa de São Paulo). Hospital Estadual Mario Covas is the only reference center in the treatment of brachial plexus injuries in the "ABC" metropolitan region, which includes the population of the municipalities of

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The study was conducted at the Faculdade de Medicina do ABC, Hand Surgery and Microsurgery Service, Santo André, SP, Brazil.
Correspondence: Carlos Henrique Vieira Ferreira. Rua Braga, 202, Vila Lusitânia, São Bernardo do Campo, SP, Brazil. 09725-160. carlos_vieira84@hotmail.com

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Santo André, São Bernardo do Campo and São Caetano, and the adjacent municipalities of Mauá, Diadema, Ribeirão Pires and Rio Grande da Serra (DATASUS). Epidemiological studies on this injury in the large urban centers of the country are scarce, and inexistent in the metropolitan region[1,4]. Our study sought to conduct an epidemiological study of brachial plexus injuries in this region through data collection of patients treated in the Hospital São Paulo, which is the reference center for high complexity surgery in the metropolitan region of São Paulo.

MATERIALS AND METHODS

A retrospective study of traumatic brachial plexus injuries was conducted with evaluation of the electronic medical records of the Hospital from August 2008 to June 2013.

The survey of medical records was based on the MV-2000 search system, the electronic medical records program used in the institution since 2007, with the International Code of Diseases (ICD-10) of traumatic brachial plexus injury (S14.3, G54.0) as a parameter. The patients included in our study signed the informed consent form according to the ethics committee protocol (68035417.4.0000.0082) of the institution.

The following exclusion criteria were adopted in the survey of medical records:

- Patients with clinical picture not compatible with traumatic brachial plexus injury;
- Children classified as traumatic brachial plexus injury according to the ICD, but of obstetric palsy nature;
- Incomplete medical records, which did not contain the date and mechanism of injury;
- Patients who were not located and were, therefore, not evaluated or examined by the authors.

The data obtained from the medical records were:

- Patient's sex and age;
- Date of accident;
- Affected side;
- Level of brachial plexus injury;
- Mechanism of injury;
- Associated injuries;
- Time between the date of the injury and the first appointment in the group;
- Time between the date of the injury and the surgical procedure;
- The surgical procedures performed.

RESULTS

From August 2008 to June 2013, 94 patients with ICD-10 compatible with traumatic brachial plexus injury were treated. Of these patients, 30 (32%) were excluded from our analysis due to the following reasons:

- 4 due to incomplete medical records;
- 2 due to ICD-10 not compatible with the clinical picture;
- 24 due to obstetric palsy

Therefore, 64 of the 94 patients tracked in this period were included in our study. All patients were residents of the metropolitan region and were treated by the Hand Surgery and Microsurgery team of the Hospital São Paulo. Of the patients selected, 95% were men and 5% women.

Right-side injury was more frequent, with 57% of cases, and then left-side injury, with 41%. There was a case of bilateral injury, corresponding to 2% of the sample.

The mean age of the patients affected was 26 years, ranging between 12 and 50 years. This injury was more frequent in patients between 20 and 24 years.

The mean time between the occurrence of trauma and the first evaluation in the outpatient clinic was 8.25 months, ranging between 3 days and 15 months. Most patients (25%) were evaluated within 4 weeks after the accident.

Traffic accidents were the most frequent mechanism of injury, especially motorcycle accidents, which affected 48 patients (75%). Also, bicycle accidents affected three people (5%), and two patients (3%) were hit by car.

The other mechanisms of injury were:

- 6 due to gunshot wound (9%);
- 2 due to lacerations (3%);
- 1 due to direct trauma (2%);
- 2 due to syncope, followed by a fall (3%).

Forty-one patients (64%) were polytraumatized, while 23 patients (36%) had isolated brachial plexus injuries. Of the associated injuries, 4 (6%) affected both lower and upper limbs, 12 (19%) affected only the lower limbs and 10 (16%) only the upper limbs. Nine patients (14%) had severe traumatic brain injury – TBI, while 3 patients (4%) had severe abdominal or thoracic trauma. (Tables 1, 2 and 3)

Forty-two patients (66%) underwent some type of surgical treatment, 59 (90%) nervous reconstruction procedures and 6 (10%) orthopedic procedures.

Tabela 1. Percentage of the level of injury.

Injury level	Number of Patients	Percentage
C5C6	21	33%
C5C6C7	17	26%
C8T1	5	8%
Total Injury	21	33%

Table 2. Percentage of neurological surgeries performed.

Surgery	Number of patients	Percentage
Neurlysis/Exploitation	5	12%
Median to biceps	12	29%
Ulnar to biceps	3	7%
Median and ulnar to biceps	1	2%
Radial axilla	3	7%
Intercostal to biceps	10	24%
Nerve grafting	0	0%
Phrenic to supra	1	2%
Suprascapular nerve accessory	3	7%

Table 3. Percentage of orthopedic surgeries performed.

Surgery	Percentage
Free transfer from gracilis muscle	2%
Muscle transfers	7%

Twenty-two patients (34%) could not undergo surgical treatment due to the following reasons:

- 12 due to spontaneous neurological recovery of the key muscles initially compromised (18.75%): 4 patients with C5-C6 injury, 2 patients with C5-C7 injury, 2 patients with total injury and 5 patients with C8-T1 injury.
- 3 due to comorbidities that counter-indicated surgical treatment (4.7%)
- 3 due to treatment abandonment (4.7%)

- 4 due to recent injuries with less than 6 months of follow-up (6.25%)

The mean time between injury and surgery was 11.6 months, ranging between 5 and 48 months.

DISCUSSION

We found only three epidemiological studies on traumatic brachial plexus injuries in Brazil.[4-6] Studies on this injury are scarce even in other countries.[7]

The population of the ABC metropolitan region is about 2,771,554 inhabitants, according to DATASUS source (August 7, 2019). We estimated an 1.88/100,000 annual incidence in ABC, considering that the Hospital Estadual Mario Covas is the only reference center for high complexity traumas, with 12.3 cases of traumatic brachial plexus injury per year. This value was similar to the 1.75/100,000 incidence per year estimated by Flores[5] in the population of the Federal District-DF.

Of all patients, 95% were men and only 5% women. This is consistent with the prevalence found in the literature, which shows a greater prevalence of men.[4-6]

The mean age of the patients affected was 26 years, ranging between 12 and 50 years, also consistent with the literature, in which most patients are young, making this injury even more devastating from the socio-economic point of view.[4-6]

The right-side injury was more frequent, with 57% of cases, versus 41% cases of left-side injury. This finding agrees with the results observed by Flores and Rocha et al.[4,5] However, a higher frequency of left-side injury was observed in the study by Faglione et al.[6]

In our study, the mean time between the trauma and the first appointment in the reference hospital was 8.25 months, ranging between 3 days and 15 months. This interval was longer when compared with the study of Flores et al., in which the mean interval between accident and care ranged between 2 and 5 months.[5] A larger population and area of coverage of the health service in our study could, partially, explain the greatest delay for the correct referral of patients with brachial plexus injury. On the other hand, this may also reflect a better organization and communication among hospitals that are part of primary trauma care in the DF region.

Regarding the interval between injury and surgery, the mean of 11.25 months in our study was higher when compared with studies by Rocha et al. and Faglione et al.[4,6].

In the comparative evaluation of the etiology of the injury, motorcycle accident was responsible for 73% of the cases, while this proportion ranged between 28.8% and 79% in the literature.[4-6] Firearm injuries accounted for 9% of cases in our study. This proportion was 3% in Rio de Janeiro-RJ, 20% in Brasília-DF and 4.1% in a large health center in São Paulo. Bicycle accidents occurred in 5% of the cases, while in other studies this proportion ranged between 1.5% and 3.2%.[4,6]

The occurrence of syncope (two cases) as a causal factor of brachial plexus injury in our sample was not reported in previous studies.

Most patients (65%) were polytraumatized and had associated injuries of the lower and upper limbs. More severe life-threatening injuries occurred in 14% of cases. These findings agree with the results found in the literature and were already expected, considering that most patients were victims of motorcycle accidents.[4-6]

Regarding the level of brachial plexus injuries, the percentage of total lesions was 33%, while upper and middle trunk injuries were 33% and 28%, respectively. The proportion of patients with total injury was lower than the proportion observed in the literature (50% to 70%), while the proportion of patients with upper trunk injury was higher (between 15% and 25%).[4-7]

The percentage of patients with isolated lower trunk injury in our study (8%) was similar to that observed in the studies of Rio de Janeiro and the Federal District.[4,5] However, this proportion was much lower in the study by Faglioni et al. (2.9%).[6]

Moreover, we observed a spontaneous neurological recovery of the compromised key muscles in twelve patients (18.75%) in less than 6 months, which made reconstruction or nerve repair unnecessary. All five patients with isolated lower trunk injury recovered without the need for surgical intervention. This proportion was 19% for upper trunk injuries and 11.7% for C5-C7 injuries and total injuries. These data are extremely relevant, but they were not mentioned in other studies.

Sixty-six percent of all patients underwent some type of surgical treatment, which was a nerve repair/reconstruction or orthopedic procedure. The most performed procedures were neurotizations to biceps and shoulder reinnervation. Noteworthily, the transfer of intercostal nerves to the motor branch of the biceps accounted for 24% of the procedures, while the transfer of a motor branch of the median or ulnar nerve accounted for 36%, and the transfer of the accessory spinal nerve to the nerve suprascapular accounted for 7%.

CONCLUSION

We observed many aspects in common with those reported by other reference centers in Brazil after epidemiological analysis of the population with traumatic brachial plexus injury in the region (ABC metropolitan region), namely: sex, age and mechanism of injury. However, some findings were different from other epidemiological studies: level of injury, time between accident and first appointment and time between injury and surgical treatment. We emphasize that almost 20% of our patients had spontaneous functional recovery during outpatient follow-up and did not need surgical treatment.

AUTHORS' CONTRIBUTIONS: Each author made significant contributions to this manuscript. ABC: surgeries, critical review of intellectual content and article, and data analysis. ACG: writing of the article, data analysis and responsibility for data integrity. CHVF: critical review of intellectual content and article, data analysis and responsibility for data integrity. LYK: surgery, data analysis and article review. LYK: surgery, data analysis and article review.

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ORIGINAL ARTICLE

TRENDS IN UNICOMPARTMENTAL KNEE ARTHROPLASTY

TENDÊNCIAS NA ARTROPLASTIA DO JOELHO UNICOMPARTIMENTAL

AHMET NADIR AYDEMIR[1], *MEHMET YUCENS*[1]

1. Pamukkale University, Faculty of Medicine, Department of Orthopedics and Traumatology, Denizli, Turkey.

ABSTRACT

Objective: To evaluate trends in publications on unicompartmental knee arthroplasty (UKA) from the past to the present. Methods: As a web–based analysis, all UKA research articles, editorial letters, case reports, reviews and meeting abstracts published on the Thomson Reuters' Web of Knowledge were evaluated. The period from the first publication in 1980 to January 2019 was divided into four decades and publications were evaluated. Research articles were grouped into headings according to the subjects. Results: A total of 1,658 publications were evaluated in this study. The most frequent term used in the publications title was "outcome," with 260 items, followed by "biomechanics and kinematics," with 99 items. Most reports have been published in the last decade, and the most common type of publication was postoperative follow-up and results. Conclusion: In parallel with technological advancements, publications related to UKA—especially patient–specific instrumentation, navigation, and robotic surgery—will increase in number and become more specific. ***Level of Evidence V, Expert Opinion.***

RESUMO

Objetivo: Avaliar as tendências de publicação da artroplastia unicompartimental do joelho do passado para o presente. Métodos: Nesta análise baseada na web, foi feita uma avaliação de todos os artigos de pesquisa de artroplastia unicompartimental do joelho, cartas editoriais, relatos de caso, resenhas e resumos de reuniões publicados na Thomson Reuters Web of Knowledge. O período da primeira publicação em 1980 a janeiro de 2019 foi dividido em quatro décadas, e as publicações foram avaliadas. Os artigos de pesquisa foram agrupados em títulos de acordo com os sujeitos. Resultados: Um total de 1.658 publicações foram avaliadas neste estudo. O termo mais utilizado no título das publicações foi "resultado", com 260 itens, seguido de "biomecânica e cinemática", com 99 itens. A maioria dos relatos foi publicada na última década, e o tipo mais comum de publicação foi visto como acompanhamento e resultados pós-operatórios. Conclusão: Em paralelo aos avanços tecnológicos, as publicações relacionadas à artroplastia unicompartimental do joelho, especialmente instrumentação personalizada, navegação e cirurgia robótica, aumentarão em número e se tornarão mais específicas. ***Nível de Evidência V, Opinião de Especialista.***

Keywords: Arthroplasty, Replacement, Knee. Trends. Publications.

Descritores: *Artroplastia do Joelho. Tendências. Publicações.*

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INTRODUCTION

Osteoarthritis (OA) is defined as a syndrome of joint pain and dysfunction caused by substantial joint degeneration.[1] The epidemiology of the disorder is complex and multifactorial, with genetic, biological, and biomechanical components.[2] Arthroplasty is a good treatment option in the disease advanced stages, which provides better functional outcomes than other conservative treatments. Since unicompartmental knee arthroplasty (UKA) first definition, this has become a common procedure for the treatment of single compartment osteoarthritis. UKA restores knee biomechanics with minimal bone and soft tissue damage.[3] Today, UKA is an alternative to TKA (total knee arthroplasty) for single compartment osteoarthritis with the advantages of faster surgeries, less bleeding, lower costs, and faster rehabilitation.

Naturally, UKA has undergone an evolutionary process, with many changes in designs, surgical techniques and indications. The influence of this evolutionary process in the literature is not surprising. Better surgical outcomes with improved technology have led to increased number of applications and subsequent literature reports. Literature reports, which were initially very few, increased exponentially.

Bibliometric analysis is a method that quantitatively analyzes academic literature, mainly using citation reports and content analysis.[4,5] Few bibliographic studies relate to the musculoskeletal system in the literature.

This study aimed to learn more about the UKA evolution process and to analyze its changing trends. It was a web–based analysis.

MATERIALS AND METHODS

This study was conducted on Thomson Reuters' Web of Knowledge database using the keywords "unicondylar," "UKA," "uni-condylar," "unicompartmental," and "partial knee" in the title of indexed reports,

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

The study was conducted at the Pamukkale University, Faculty of Medicine, Department of Orthopedics and Traumatology, Denizli, Turkey.
Correspondence: Ahmet Nadir Aydemir. Kalp Merkezi 7, Çamlaraltı mahallesi, Kınıklı/Denizli, Turkey. 20070. anaydemir@yahoo.co.uk

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reviews, articles and letters from 1980—year of the first paper published in the database—to January 2019. No retrospective time constraints were set when scanning the database. All abstracts were read individually and then evaluated according to the main subject. If a publication appeared more than once when scanning with different keywords, only one evaluation was applied. Early, mid and late postoperative follow-up series were categorized under the heading of "outcome." Biomechanical or kinematic studies were evaluated under the heading of "biomechanical and kinematic"; studies on arthroplasty revision or loosening, under the heading of "revision"; studies comparing unicompartmental arthroplasty with total knee prosthesis, under the heading "U-T"; and editorial letters, answers and comments, under the heading "non-original." Case reports were evaluated under the heading "case"; review studies, under the heading "review"; navigation or computer–assisted studies, under the heading "navigation"; publications related to balancing or alignment, such as varus or valgus, under the heading "alignment"; publications focused on radiological imaging methods, under the heading "radiology"; and robotic–assisted surgery publications were evaluated under the heading "robotic." Abstracts were also evaluated according to journal, authors and date of publication.
Data obtained in the study were presented graphically, using Windows Excel program. The number of publications with increasing and decreasing trends over the years were evaluated at 10–year intervals and the results were stated as graphical data rather than as a statistical evaluation.

RESULTS

A total of 1,658 publications were evaluated. The most frequent term in the titles of the publications was "outcome," with 260 items, followed by "biomechanics and kinematics," with 99 items. Figure 1 shows the graphical distribution of the top 10 publication headings. The number of publications in the last decade was higher than the total published in the first three decades. Of the last decade, 2017 was the year with the most publications (n = 177).
Most publications came from the United States, followed by the United Kingdom, when they were evaluated according to countries. Figure 2 shows this distribution according to countries.
The evaluations according to journals showed that "Journal of Arthroplasty" had the highest number of publications, followed by "Knee." The distribution of journals according to number of publications is shown in Figure 3. Publications evaluated according to the authors showed that DW Murray have made the most contributions to literature, followed by Dodd Caf. Figure 3 shows a graph with the distribution of authors by number of publications. The most cited publication was by DW Murray, with 429 citations.[6]

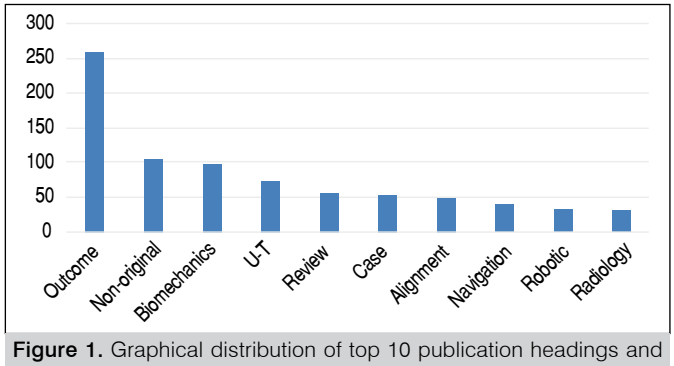

Figure 1. Graphical distribution of top 10 publication headings and numbers.

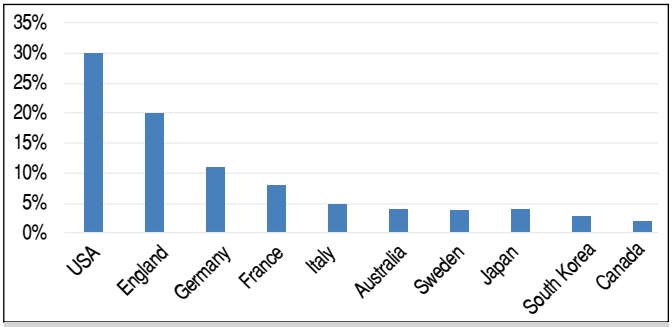

Figure 2. Graphical distribution of top 10 countries and publication percentages.

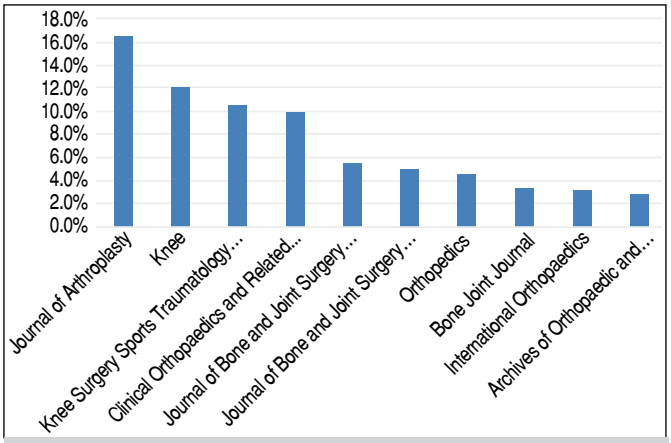

Figure 3. Graphical distribution of top 10 journals and publication percentages.

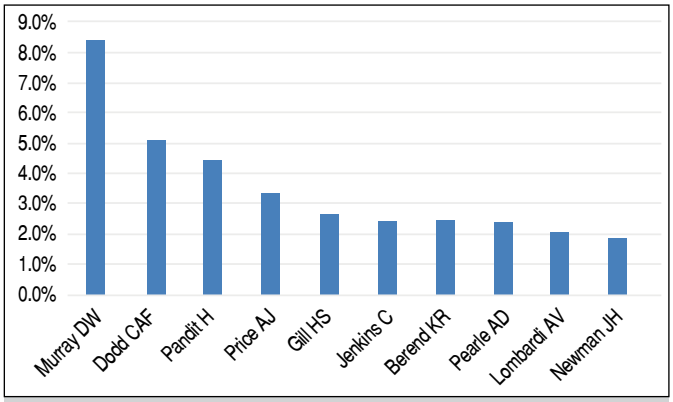

Figure 4. Graphical distribution of top 10 authors and publication percentages.

DISCUSSION

From 1980 to the date they were scanned, publications on unicompartmental knee arthroplasty have increased rapidly, especially in the last two decades. Undoubtedly, the effect of increasing patient satisfaction with developments in technology and prosthetic design is enormous. At the beginning of the 1980s, TH Mallory and J Danyi reported a revision rate of 30% in a study with an average follow-up of 5.5 years, while the revision rate in a study in 2015 with similar follow-up decreased to 7%.[7,8]
Studies on prosthesis design and concept are still recurrent. More than 70% of the "biomechanics and kinematics" studies carried out in this process have been published in the last decade. Among all poly–designed prosthetic studies, 87% were published in the

last decade. In a study by D Bruni et al.,[9] Kaplan-Meier estimates of 8-year survival with revision for any reason as the endpoint was reported at the rate of 83%. Review articles published in last decade constitute 91% of all reviews. Arguably, the accumulation of publications, and therefore the knowledge and experience on UKA, is reasonably current. The most cited review was by SC Kozinn with 276 citations.[10]

Surgical technique and assistive technology are also areas that changed and developed. Patient–specific instrument (PSI), navigation and robotic–assisted surgery articles have been published in the last two decades. In a 9–year mean follow-up study, navigation was compared with conventional techniques, and better coronal sequence and clinical scores were determined in the navigation group.[11] In a study by Ollivier, Parratte, Lunebourg, Viehweger and Argenson, a group of patients was operated on with PSI and another group with conventional techniques.[12] After a 1–year follow-up, it was reported that PSI may confer small, if any, advantage in alignment, pain, and function after UKA. Routine use of PSI was unrecommended by the authors because of the extra cost and uncertainty related to the technique. In a prospective, randomized controlled study, robotic–assisted surgical procedures led to improved accuracy of implant positioning compared with conventional UKA surgical techniques.[13] Indications also changed in UKA. Contraindications such as age, obesity, anterior cruciate ligament (ACL) deficiency are now becoming more flexible. Faour Martín, Valverde García, Martín Ferrero, Vega Castrillo, Zuil Acosta and Suárez de Puga reported 96% excellent or good results in a 12–year follow-up of a series of 51 patients (59 interventions) who underwent surgery when aged < 60.[14] In another study that compared two groups according to body mass index (BMI; $<$ vs $\geq$ 30 kg/m^2), 10–year survival rates were reported to be similar in the two weight subgroups.[15] A study of UKA in the presence of ACL deficiency showed no significant difference between the ACL intact groups at an average 5–year follow-up.[16] A recently trending approach to UKA with ACL deficiency is simultaneous or subsequent ACL repair.[17,18]

CONCLUSION

In this study, publications from 1980 to January 2019 and trends in UKA were evaluated. Most reports have been published in the last decade, and the most common type of publication was postoperative follow-up and results. Assumingly, parallelly with advances in technology, publications related to UKA, especially PSI, navigation, and robotic surgery will increase in number and become more specific.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of the manuscript. ANA: writing, performing, data analysis. MY: reviewing, language editing, intellectual concept.

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ORIGINAL ARTICLE

ASSESSMENT OF THE POSTERIOR APPROACH FOR SURGICAL TREATMENT OF SPINAL METASTATIC BREAST CANCER

AVALIAÇÃO DO TRATAMENTO CIRÚRGICO DA METÁSTASE VERTEBRAL DE MAMA POR ABORDAGEM POSTERIOR

Mariana Demétrio de Sousa Pontes[1], *Breno de Paula Faleiros Pires*[1], *Felipe de Paula Albuquerque*[2], *Carlos Fernando Pereira da Silva Herrero*[1]

1. Universidade de São Paulo, Ribeirão Preto Medical School, Department of Biomechanics, Medicine and Rehabilitation of Locomotor, Ribeirão Preto, SP, Brazil.
2. Universidade de São Paulo, Ribeirão Preto Medical School, Ribeirão Preto, SP, Brazil.

ABSTRACT

Objective: To assess the clinical and radiological aspects of patients with spinal metastatic breast cancer who underwent surgical treatment by posterior approach. Methods: This is a retrospective and descriptive study. Clinical assessment included the patient's sex, age, surgical treatment employed and complications. Radiological assessment comprised the study of the morphopathological characteristics of the lesions. Results: Data from 44 patients (93.2% female) submitted to surgical treatment of spinal metastasis were collected. The average age of diagnosis was 56.79 years. Decompression and posterior fixation with pedicle screws were performed in 43.1% of patients, while 36.3% underwent decompression and posterior fixation with pedicle screws associated with corpectomy and replacement with intersomatic device filled with bone cement. In 20.4%, kyphoplasty was the chosen procedure. Eighteen percent of patients had surgical complications, and the thoracic spine was most affected by the tumor. Conclusion: The clinical and radiological presentation of this group of patients is variable. The posterior portion of the vertebrae was more affected than the anterior. Although surgical treatment by posterior approach does not have the objective of curing the underlying disease, it can present favorable results, with higher rate of complication in major surgeries. ***Level of evidence IV, Therapeutic Studys.***

Keywords: Tumor. Spine. Arthrodesis. Breast Neoplasms.

RESUMO

Objetivo: Avaliar aspectos clínicos e radiológicos de pacientes portadores de metástase vertebral de mama, submetidos ao tratamento cirúrgico por via posterior. Métodos: Estudo retrospectivo e descritivo. A avaliação clínica incluiu o sexo, a idade, os procedimentos cirúrgicos empregados e as complicações. A avaliação radiológica envolveu o estudo das características morfopatológicas das lesões. Resultados: Foram estudados 44 pacientes submetidos ao tratamento cirúrgico das metástases vertebrais (93,2%: feminino), com média de idade de 56,79 anos. Em 43,1% dos pacientes foi realizada descompressão e fixação posterior com parafusos pediculares, ao passo que em 36,3% foi feita descompressão e fixação posterior com parafusos pediculares associadas à corpectomia e substituição por dispositivo intersomático preenchido com cimento ósseo. Em 20,4%, a cifoplastia foi o procedimento cirúrgico de escolha. Dezoito por cento dos pacientes apresentaram complicações pós-operatórias, e a coluna torácica foi a região mais acometida. Conclusão: A apresentação clínica e radiológica desse grupo de pacientes é variável. A porção posterior das vértebras foi mais acometida em relação à anterior. O tratamento cirúrgico por abordagem posterior, apesar de não possuir objetivo de cura da doença de base, pode apresentar resultados favoráveis, com taxas de complicações maiores em procedimentos mais agressivos. ***Nível de evidência IV, Estudos Terapêuticos.***

Descritores: *Tumor. Coluna Vertebral. Artrodese. Neoplasias da Mama.*

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INTRODUCTION

Breast cancer is the second most frequent malignant tumor in the world, being the most common among women and the leading cause of death by cancer in this population.[1] It usually grows slowly; however, depending on extrinsic and intrinsic characteristics, evolution may be more aggressive, with greater potential for dissemination.[1] In these cases, the axial skeleton is the most frequent site of metastases, although pulmonary, hepatic and cerebral assailment are common.[1] As a consequence, some patients with spinal metastases may develop secondary pain or neurological deficit to pathological fracture and/or direct compression of the spinal cord.[2]

The best treatment of spinal metastases involves the approach of several specialists. Although the therapeutic strategies used lately have been more aggressive and have shown better results, they

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

Study developed at the Hospital das Clínicas of Ribeirão Preto Medical School of the Universidade de São Paulo, Ribeirão Preto, SP, Brazil.
Correspondence: Mariana Demétrio de Sousa Pontes. Av. Bandeirantes, 3900, Vila Monte Alegre, Ribeirão Preto, SP, Brazil, 14049900. mdspontes@hcrp.usp.br; marianadpontes@gmail.com

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remain with the palliative purpose of reducing morbidity and improving the patients' quality of life.[3-5] Surgical treatment is specifically indicated in situations such as mechanical instability, progressive tumor growth despite clinical treatment, uncontrolled pain despite medications, and significant or progressive neurological symptoms.[4-6]

Different surgical techniques can be chosen to treat spinal metastatic lesions, and subsequent approaches with decompression and instrumentation for stabilization and corpectomy with implant replacement are commonly carried out.[7] The choice of method considers its practicality in relation to the affected column region, once not every level is equally accessible, the objectives of each procedure, and the familiarity of the surgeon with the various techniques.[7]

Although surgical therapy of spinal metastases has been widely adopted, the literature still lacks results according to breast cancer histopathology and the influence of negative prognostic variables, such as visceral metastases, surgical complications and advanced age at diagnosis.[4-8]

Accordingly, this study aims to investigate the clinical and radiological parameters of patients with breast metastasis in the spine who underwent surgical treatment by posterior approach, as well as to identify post-treatment complications.

MATERIALS AND METHODS

This is a descriptive and retrospective study of a prospective database, including 44 patients diagnosed with breast tumor metastasis in the spine, who were operated by the Orthopedics—Spinal Surgery team of the Hospital das Clínicas of the Ribeirão Preto Medical School, USP, from 2005 to 2017. The research project was approved by the Research Ethics Committee of the institution, including the exemption from the informed consent form (protocol HC 354/2018—CAAE: 82389518.0.0000.5440). The authors declare no conflict of interest regarding this article.

The inclusion criteria consisted of patients diagnosed with primary malignant breast tumor, with histopathological confirmation, submitted to posterior surgery for the treatment of spinal metastases, of both sexes, of any race, and aged over 18. Patients under the age of 18, with another primary malignant tumor, operated by an anterior or combined approach, and non-diagnosed with spinal metastasis, were excluded from the study.

Data were collected by researchers from the Medical Archiving Sector (SAME) of the hospital, and information from medical records and imaging exams were used. Clinical assessment included sex; the patient's age at the time of diagnosis; time between the secondary initial symptom to spinal metastasis and imaging diagnosis; time between the breast tumor diagnosis and the metastasis in the spine; neurological manifestations classified by the Frankel scale;[9] surgical approach used; postoperative complications; and need for surgical reapproach. Radiological assessment involved the study of simple radiography, computed tomography and magnetic resonance exams, and the morphopathological characteristics of the lesions were studied: level of metastasis in the spine and affected portion of the vertebra.

The parameters were stored in a spreadsheet and studied with Microsoft Excel, and the results were presented as percentages, means and medians.

RESULTS

Of the 44 patients evaluated, 41 (93.2%) are women and 3 (6.8%), men . Mean age at diagnosis was 56.79, ranging from 33 to 94 years. The time between the initial symptom in the spine and the confirmation of the diagnosis of metastasis by magnetic resonance exam varied from 1 day to 3.6 years, with a mean time of 7 months, and median of 45 days. In six patients (13.6%), the diagnosis of spinal metastasis preceded the diagnosis of primary tumor.

Forty-three percent (n = 19) of the individuals presented secondary neurological deficit to spinal assailment, either by fracture or by spinal cord and/or direct root compression. To classify these alterations, the Frankel scale was used in the pre and postoperative period, and we observed that 22.7% (n = 10) of the patients improved their postoperative deficit, and 2.2% (n = 1) worsened neurologically after the procedure. It was not possible to evaluate these data in two patients due to severe adverse events.

Regarding the surgical procedures used, all 44 patients underwent treatment by the posterior approach. In 19 (43.1%) patients, decompression and posterior fixation with pedicular screws were performed (Figure 1), whereas 16 (36.3%) patients underwent decompression and posterior fixation with pedicular screws associated with corpectomy and replacement with an intersomatic device filled with bone cement (Figure 2). In addition, kyphoplasty was the chosen surgical procedure in nine (20.4%) patients.

Figure 1. Sagittal cut of T2-weighted preoperative magnetic resonance evidencing image compatible with extradural metastasis by compressing the spinal cord canal at T5-T6 level. Postoperative radiographies of decompression and posterior fixation with pedicular screws.

Eight (18.1%) patients presented postoperative complications: extradural hematoma (4.5%, n = 2), cerebrospinal fluid leak (4.5%, n = 2), infection (9%, n = 4), surgical wound dehiscence (2.2%, n = 1), seroma formation (2.2%, n = 1), and neurological deficit (2.2%, n = 1); and six (13.6%) patients required surgical reapproach to treat complications related to the first procedure: hematoma or seroma drainage (6.8%, n = 3); dressing in the operating room (6.8%, n = 3). Other seven (15.9%) patients underwent a new procedure due to tumor recurrence.

Of the eight patients who presented postoperative complications, six (75%) were submitted to decompression, corpectomy, replacement with intersomatic device and fixation with pedicular screws, while two (25%) were subjected to decompression and fixation. Patients who chose the kyphoplasty procedure did not present complication.

The spine level most affected by metastases was the thoracic, in 86.3% of the cases (n = 38), followed by the lumbar (25%, n = 11), cervical (13.6%, n = 6) and sacral (9%, n = 4); and the posterior portion of the vertebrae was preferably affected (65.9%, n=29) if compared with the anterior portion (43.1%, n = 19).

DISCUSSION

Although retrospective, the study adequately assessed the patients, with a thorough description of the information from the database in the Medical Archiving Service (SAME), thus offering significant conclusions. Most of the patients included in the study were women with a mean age of 56.79 at the time of diagnosis, ranging from 33 to 94 years.

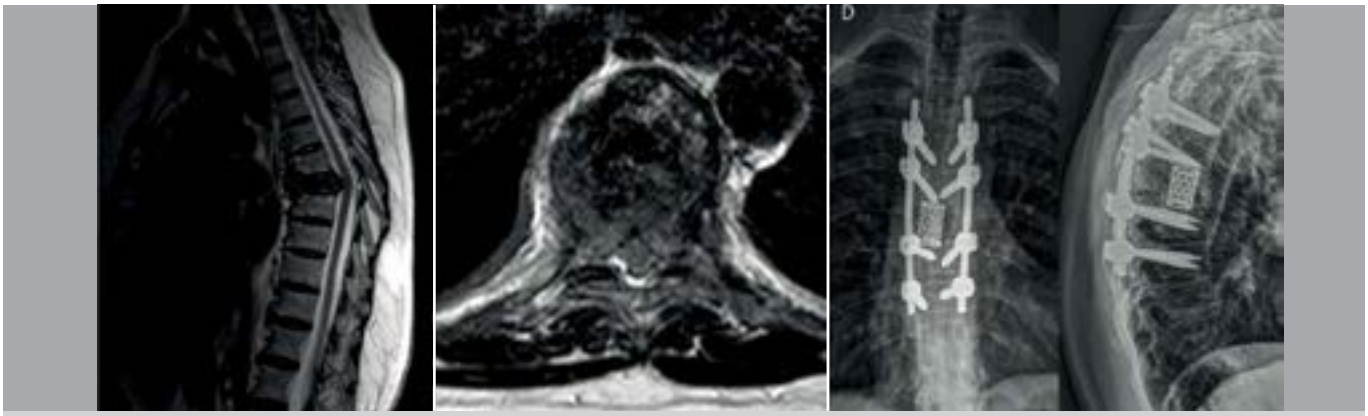

Figure 2. Sagittal and axial cuts of T2-weighted preoperative magnetic resonance showing metastatic assailment of the T7 vertebral body and spinal compression. Postoperative radiographies of decompression and posterior fixation with pedicular screws associated with corpectomy and replacement with intersomatic device filled with bone cement.

This is in accordance with the literature, which shows that breast cancer is relatively rare before the age of 35, progressively growing in incidence, especially after the age of 60.[1] In 13.6% of the patients, diagnosis of spinal metastasis preceded the diagnosis of primary tumor, since it can detect failure in screening and in the early diagnosis or even high tumor aggressiveness. Frequently, the presence of pain is not appreciated, and the correct diagnosis is postponed until more evidences of spinal or root dysfunction manifest.[10]

Based on the available medical literature, the mean rate of neurological improvement is 63.8% (53% to 100%), and of decline is 4.1% (0% to 8%).[4] In this study, 22.7% showed improvement in Frankel's classification, and only 2.2% neurologically worsened. According to Molina,[7] outcomes are not clinically significant among the different surgical approaches employed, and the reported results of pain relief were almost identical for posterior decompression and decompression with fixation. The contributions of concomitant and adjuvant treatment administered in the perioperative context should be considered.[8]

The choice of the most appropriate surgical approach for an individual case depends on several factors, including tumor pathology, location, and patient's overall status.[11] The best technique should provide adequate exposure to safely remove the injury.[7] Decompression by laminectomy is usually considered with metastatic involvement of the epidural space and blade, but it is limited because it does not allow the decompression of the ventral epidural spinal cord.[7] The addition of instrumentation to stabilize a laminectomy can protect against instability due to tumor involvement in the facet joints, pedicles or anterior vertebral body.[7] Approaches with corpectomy and replacement with intersomatic device provide the extra benefit of ventrally decompressing the spinal cord or dural sac and increasing the space between the injury and the spinal cord.[7]

A review of multiple series of surgical treatments for metastatic disease in the spine, cited by Shehadi[8], shows that complication rates range from 10% to 52%. In this study, 18.1% of the patients presented postoperative complications, which shows the procedures employed had lower morbidity rates. Of the individuals studied, 16% were reapproached due to tumor recurrence. Data available in the literature are congruent with the clinical notion that circumferential decompression results in more complete tumor resections, and thus decreases recurrence.[7] In this study, 75% of the patients who presented complications were submitted to decompression, fixation with pedicular screws, corpectomy and replacement with intersomatic device. Patients submitted to kyphoplasty did not present complications, which may support the idea that complication rates increase with major surgeries, since kyphoplasty is a minor procedure, fastly executed and does not require long periods of hospitalization in the postoperative.[12]

The thoracic spine was the most frequent site of secondary assailment in this study (86.3%), followed by lumbar (25%) and cervical (13.6%) levels. This corresponds to the international literature, in which metastasis to the thoracic spine corresponds to 70%, to the lumbar spine, 20%, and to the cervical spine, 10%.[13,14] On the other hand, the posterior portion of the vertebrae was more affected than the anterior portion in this study, different from the established in other studies, in which most metastases occur in the anterior region, corresponding to the vertebral body.[6] Algra and collaborators[15] showed, with tomography analysis, the vertebral body was the portion most frequently affected by metastases, and the destruction of a pedicle was unidentified in the lack of body involvement. The opposite was true when assessing simple exams, in which the most common finding was the assailment of the pedicles.[15] Therefore, we assume that depending on the imaging exam to be evaluated, the initial findings may diverge. Besides, this study included only individuals submitted to the posterior surgical approach.

CONCLUSIONS

The clinical and radiological presentation of patients with breast metastasis lesions in the spine is variable, similar to that described in the literature, except that the posterior portion of the vertebrae was more affected than the anterior portion in the sample of this study. Although surgical treatment by posterior approach does not aim to cure the underlying disease, it may have favorable results, improving the quality of life and neurological prognosis, with higher complication rates in major procedures.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article: MDSP: literature review, data collection and analysis, writing of the article. BPFP: literature review, data collection, writing of the article. FPA: literature review, data collection, writing of the article. CFPSH: development of the research project, data analysis, review of the article to be published.

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ORIGINAL ARTICLE

THE EPIDEMIOLOGY OF DEVELOPMENTAL DYSPLASIA OF THE HIP IN MALES

EPIDEMIOLOGIA DA DISPLASIA DO DESENVOLVIMENTO DO QUADRIL NO SEXO MASCULINO

Ellen de Oliveira Goiano[1], Miguel Akkari[1,2], Juliana Pietrobom Pupin[1], Claudio Santili[1,2]

1. Santa Casa de São Paulo, Pediatric Orthopedics and Traumatology Group, São Paulo, SP, Brazil.
2. Santa Casa de São Paulo, Faculdade de Ciências Médicas, São Paulo, SP, Brazil.

ABSTRACT

Developmental Dysplasia of the Hip (DDH) is one of the most common orthopedic hip diseases of the pediatric population. There is a predominance in females and patients with known risk factors. Objective: To evaluate the characteristics of DDH in a reference center and compare them with the literature. Methods: This is a cross-sectional observational study based on the review of medical records and radiographs from which epidemiological data such as laterality, age at diagnosis, acetabular index, radiographic classification and others were collected. Results: A total of 297 medical records were found between May 1974 and June 2009. Of those, 147 patients (216 affected hips) were eligible for the survey. Most of the patients came from the state of São Paulo (91.1%), were born in autumn/winter (66.7%), reported as Caucasians (76.9%), with bilateral involvement (46.9%) and mean age at diagnosis of 22.8 months. Conclusion: The most frequent type of DDH was high dislocation (28.7%), and the acetabular index progressively increased with the age. The International Hip Dysplasia Institute classification was found to be more reproducible than Tönnis classification. Delayed diagnosis was associated with the absence of risk factors and with bilaterality. ***Level of Evidence III, Retrospective comparative study.***

Keywords: Hip Dislocation, Hip Dislocation, Congenital, Epidemiology.

RESUMO

A displasia do desenvolvimento do quadril (DDQ) é uma das alterações ortopédicas mais frequentes na população pediátrica. Há predominância no sexo feminino e em pacientes com fatores de risco conhecidos. Objetivo: Avaliar as características da DDQ no sexo masculino de um grande centro de referência e cotejá-las com a literatura. Métodos: Trata-se de estudo observacional transversal baseado na revisão de prontuários e radiografias de onde foram coletados dados epidemiológicos tais como lateralidade, idade no diagnóstico, índice acetabular, classificação radiográfica e outros. Resultados: Foram encontrados 297 prontuários no período de maio de 1974 a junho de 2009. Destes, 147 pacientes (216 quadris afetados) foram elegíveis para a pesquisa. A maioria dos pacientes era procedente do estado de São Paulo (91,1%), nascidos no outono/inverno (66,7%), autodeclarados caucasianos (76,9%), com acometimento bilateral (46,9%) e idade média no diagnóstico de 22,8 meses. Conclusão: O tipo de DDQ mais encontrado foi a luxação alta (28,7%); o índice acetabular apresentou-se progressivamente aumentado quanto maior a idade do paciente. A classificação do International Hip Dysplasia Institute mostrou-se mais reprodutível que a Classificação de Tönnis. O atraso no diagnóstico foi associado à ausência de fatores de risco e à bilateralidade. ***Nível de Evidência III, Estudo retrospectivo comparativo.***

Descritores: *Luxação do Quadril. Luxação Congênita de Quadril. Epidemiologia.*

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INTRODUCTION

Developmental Dysplasia of the Hip (DDH) is a multifaceted condition of the pediatric hip that can present clinically in different ways. Cases of transient neonatal hip instability, as well as isolated acetabular dysplasia, to severe cases of open dislocation where there is a primitive acetabulum and/or acetabular neoformation are treated in the orthopedic routine. In recent decades there has been considerable evolution in the diagnosis and treatment protocols of DDH and many epidemiological aspects as well as risk factors have been studied.[1-4] It is known, for example, that there is a prevalence of unilateral disease and the most affected side is the left side, the white race and the female sex are more frequently associated with the condition, and the risk factors include pelvic presentation, oligohydramnios, among others.[4-5] However, little is known about the characteristics of DDH in males and if there are sex differences in the characteristics of the disease, since there is a shortage of studies that highlight them.

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

Work performed at Santa Casa de São Paulo, Pavilhão Fernandinho Simonsen, Pediatric Orthopedics and Traumatology Group, São Paulo, SP, Brazil.
Correspondence: Ellen Goiano, Rua Dr. Cesário Mota Júnior, 112, Pavilhão Fernandinho Simonsen, 2º andar, São Paulo, SP, Brazil, 01221020. ellengoiano@hotmail.com

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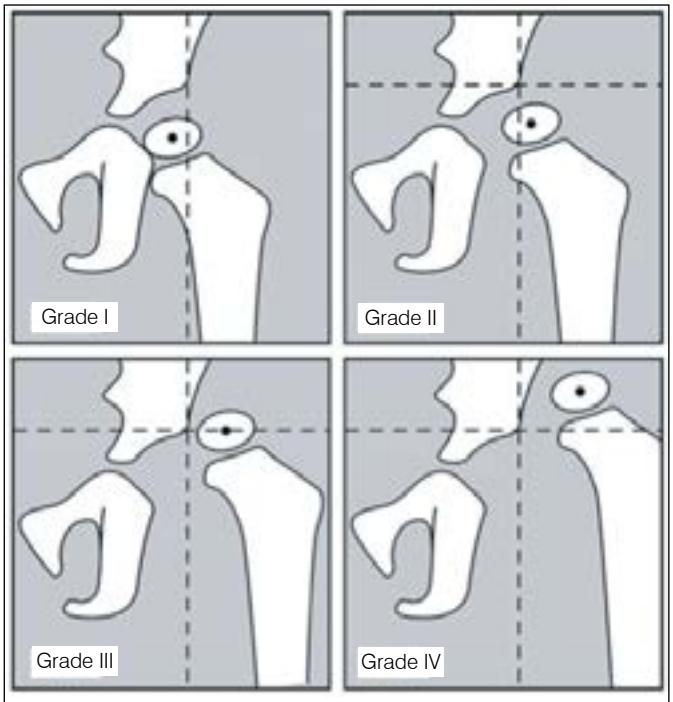
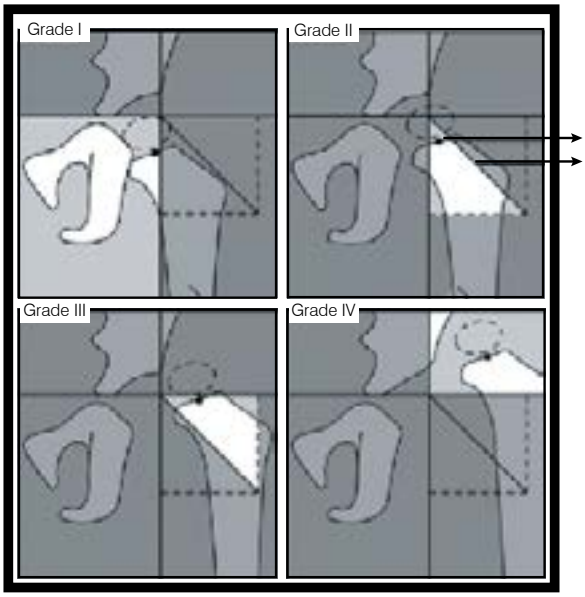
The incidence of DDH for children without associated risk factors is estimated at 11.5/1,000 live births, based on meta-analysis protocols and multiple logistic regression.[5] When the risk is calculated for each sex separately, the incidence ranged from 4.1/1,000 for boys to 19/1,000 for girls. The relative risk with positive family history is 1.7 times higher (6.4/1,000 for boys and 32/1,000 for girls) and at pelvic presentation the relative risk compared with vertex is 6.3 times higher (29/1,000 for boys and 133/1,000 for girls).
For each male patient there are 4 or 5 female patients[4], which made us infer that the epidemiology and demographic characteristics reported in the literature predominantly reflect the characteristics of DDH in girls.
The objective of this study was to evaluate the epidemiological characteristics of developmental dysplasia of the hip in males and secondly to investigate if these characteristics are the same as those generally reported in the literature.

MATERIALS AND METHODS

This study was based on the review of medical records of all male patients registered with the diagnosis of developmental dysplasia of the hip at the Pediatric Orthopedics Outpatient Clinic of Santa Casa de São Paulo. We found 297 male patients from a total of 2,000 consecutive cases of DDH, recorded from May 1974 to June 2009. The study design was cross-sectional.
The criteria for inclusion in the study were: having a diagnosis of developmental dysplasia of the hip in any form of presentation (instability, dysplasia, subdislocation and dislocation); being male; having been included in the DDH protocol of the reference center concerned. Patients with atypical acetabular dysplasia and/or hip dislocation or acquired otherwise (traumatic, infectious, etc.), those who had poorly completed medical records, lacking the epidemiological data necessary to conduct the work, and those who underwent some kind of previous therapeutic intervention for DDH elsewhere were excluded.
We collected data from medical records and reviewed the radiographs of each patient's medical file for epidemiological data that could show possible differences between females and males such as race, laterality, age at diagnosis, Acetabular Index (AI) at diagnosis (up to 8 years old), type of DDH according to the Tönnis Classification and according to the International Hip Dysplasia Institute (IHDI) classification (up to 4 years old).
The AI was considered altered when it was above 30 degrees in younger children and above 20 degrees in children older than 2 years of age.
To categorize the type of DDH, the hip was classified as Instability when there were no signs of dysplasia in X-rays (XR) but there was a positive Barlow/Ortolani description on physical examination; Dysplasia when the acetabular index was increased in relation to the respective age group, but without the breaking of the Shenton Arch or lateralization of the femur (Tönnis Grade I) (Figure 1); Subdislocation with any acetabular index, associated with Shenton's arch fracture and/or femur lateralization (Tönnis Grade II), with hip centralization on the frog position radiograph (Lauenstein); Low dislocation similar to subdislocation but without hip normalization at Lauenstein position (Tönnis Grade III); and High dislocation when the femur head/proximal metaphysis cranially exceeded the Hilgenheiner line for the IHDI classification or the lateral edge of the acetabulum (Tönnis Grade IV).
For the IHDI Classification the parameter used was the location of the midpoint of the upper face of the metaphysis (H-Point) and D-line, which divides Ombredanne's inferolateral quadrant at 45 degrees, forming two hemiquadrants (Figure 2). It has been used in children from birth until 48 months of age, characterizing the most medially centered hip as Grade I and the others with progressive severity from II to IV.
After data collection the variables were statistically analyzed using the SPSS program (IBM Version 13.0 IBMä). Besides descriptive analysis, Pearson's chi-square test and Kappa agreement index were evaluated when relevant.



Source: Adapted from Narayanan U et al. [6]
Figure 1. Tönnis classification for developmental dysplasia of the hip.



Source: Adapted from Narayanan U et al.[6]
Figure 2. Classification of the International Hip Dysplasia Institute

This study was approved by the Ethics Committee of the Faculdade de Ciências Médicas da Santa Casa de São Paulo on Nov 25, 2014. Opinion number: 895.438. CAAE: 38084214.9.0000.5479. As this was a retrospective and observational study, informed consent form was waived.

RESULTS

Of these 297 registered cases, 106 were excluded because their medical records did not include the clinical and/or radiographic information considered valid for the epidemiological analysis in question, 9 patients had no clinical and/or radiographic signs of DDH, 21 were excluded because they were submitted to previous surgical treatment, and 14 for presenting atypical forms (syndromic or teratologic) of hip dysplasia. There were 147 patients (216 affected hips), 24 of whom had only initial radiographs and did not follow through with the service.

Age at diagnosis ranged from birth to 14 years of age (adolescent dysplasia), with a mean of 22.8 months (median 10.1 months). Almost half of the patients, 66 boys (45%) were diagnosed before 6 months of age, 42 of them were diagnosed between 6 months and 2 years of age (28.5%) and 39 (26.5%) were diagnosed after 2 years (Table 1). Regarding the season of birth, 54 boys were born in autumn (36.8%), 44 in winter (29.9%), 25 in summer (17%) and 24 in spring (16.3%).

The distribution by race was 113 (76.9%) Caucasian patients, 6 (4.1%) brown, 4 (2.7%) black and 24 (16.3%) did not report. Of the 147 patients, 94 were from São Paulo capital (63.9%), 40 (27.2%) from the interior of the state, and only 3 came from other states. In 10 patients this information was not obtained.

Regarding laterality, 69 (46.9%) boys had bilateral DDH, 51 (34.7%) had dysplasia exclusively on the left side, and 27 (18.4%) only on the right side, totaling 216 affected hips.

Regarding the type of DDH found on the initial radiograph, 62 had high dislocation (28.7%), a similar number of 60 (27.8%) subdislocations, followed by 44 hips with low dislocations (20.3%), 35 hips with isolated dysplasias(16.2%), and 15 hips with instability without dysplasia (6.9%).

Table 1. Distribution of patients/hips by age and type of developmental dysplasia of the hip

Age of diagnosis	DDH Type	Laterality	Total
0-6 months	15 instabilities 32 dysplasias 44 subdislocations 16 low dislocations 3 high dislocations	45 bilateral 12 left 8 right	66 patients (45%) 110 hips (50.9%)
> 6-24 months	11 subdislocations 22 low dislocations 16 high dislocations	10 bilateral 17 left 12 right	42 patients (28.5%) 49 hips (22.7%)
> 24 months	3 dysplasias 5 subdislocations 6 low dislocations 43 high dislocations	14 bilateral 22 left 7 right	39 patients (26.5%) 57 hips (26.4%)

Also in relation to the type of DDH, the data of respective radiographic Type, IHDI classification and acetabular index (AI) found in each patient's initial radiograph (Table 2) were crossed. The mean acetabular index on AP radiograph was 37 degrees with a standard deviation of 7.5, and on Lauenstein it was 36 degrees with a standard deviation of 7.6.

Table 2. Relationship between type of developmental dysplasia of the hip, International Hip Dysplasia Institute classification and acetabular index

DDH Type	IHDI	AI (AP)	AI (Frog-leg)	Total
Instability	14 type I 1 type II	18º -29º Mean (25.1º)	18º -28º Mean (24.2º)	15 hips 7 left 8 right
Dysplasia	13 type I 20 type II	30º -46º Mean (34.7º)	22º -44º Mean (32.9º)	33 hips 17 left 16 right
Subdislocation	52 type II 4 type III	25º -50º Mean (36.6º)	26º -50º Mean (35.1º)	56 hips 27 left 29 right
Low dislocation	1 type II 43 type III	15º -50º Mean (38.8º)	24º -50º Mean (38.2º)	44 hips 29 left 15 right
High dislocation	38 type IV	33º -54º Mean (42.2º)	32º -58º Mean (41.8º)	38 hips 20 left 18 right

IHDI: International Hip Dysplasia Institute; AI: Acetabular Index; AP: Anteroposterior incidence

DISCUSSION

The epidemiology of DDH has always been considered a conundrum due to the lack of standardization of criteria by various authors in the literature.[1] There is much diversity in the studies regarding the definition of DDH itself, as already mentioned in the introduction, and on aspects such as diagnostic methods, classification, among others.[2] In addition, the literature is very scarce regarding the possible sex differences concerning the epidemiology, risk factors and prognosis of evolution. In 2010, the International Committee for Medical Journal Editors (ICMJE) recommended the inclusion of representative populations in all clinical studies, including gender. Therefore, the present study was designed following the recommendation of the 2016 Sex and Gender Equity in Research (SAGER)[7] guidelines in all its stages.

In this study, the 14 patients with syndromes associated with hip dysplasia were excluded, but they accounted for only 4.7% of the total sample (297 boys). Dunn (1976) described that DDH in boys usually occurs in association with other concomitant deformities and oligohydramnios, while in girls DDH is more associated with hormone-induced capsular ligament laxity.[3] A limitation of our study was the impossibility of retrospectively verifying the occurrence of primiparity, pelvic delivery, oligohydramnios and a positive family history, as this information was not included in the children's medical records.

In our bibliographic research we found only two studies exclusively focused on DDH in males and only one of them addresses epidemiological aspects.[8,9] In the study conducted by Samarah, Al Hadidi, Hamdan and Hantouly (2016)[9], boys with neuromuscular syndromes and diseases were excluded and not mentioned. In the other, conducted by Borges, Kumar and Guille (1995)[8], the objective was to evaluate factors associated with treatment outcome, but nevertheless it was used as a reference for comparison. The said study, carried out from 1965 to 1990, identified 92 boys (143 hips) with DDH in their form of frank dislocation, with or without previous treatment. Among these, 37 (40.2%) were associated with syndromic forms or neuromuscular diseases, much higher data than those found in our survey. We justify this difference by the fact that we are in a reference center where patients with neuromuscular diseases are directly referred for specific treatment at the Neuromuscular Diseases Clinic.

The incidence and prevalence of DDH vary considerably across individuals of different ethnicities and geographical locations. According to the American Academy of Pediatrics[5], the overall relative risk of DDH incidence in children is 11.5/1000 live births, 4.1/1000 in boys and 19/1000 in girls. When there is family history or pelvic presentation this risk is even greater. We estimate that the incidence of DDH in our population is 4.6-5/1000 live births, according to the main studies conducted in South America[10,11] in predominantly Caucasian individuals. Based on the data we obtained, the gender incidence ratio is 1 boy for every 5.7 girls in the 2,000 medical records evaluated.

Our series included patients cataloged for 35 years, in a total of 2,000 consecutive cases, where 297 patients were male (14.8%) and 1,703 female (85.2%). The incidence in girls was higher than the world average of 75.5%[4]. However, for the epidemiological analysis we computed only the 147 patients (216 hips) who were referred for primary treatment and had in their medical records all the clinical/radiographic data necessary for the survey. This significant loss, in part, is probably related again to the fact that we are in a reference center to which many patients are referred only after initial treatment in other hospitals.

Regarding the period of birth, 66.7% of patients were born in "cold" months, 54 boys were born in autumn (36.8%), 44 in winter (29.9%), 25 in summer (17%) and 24 in spring (16.3%). In the study by Loder and Skopelja (2011)[4], most of the included studies showed an increased incidence of DDH in children born in fall/winter months, both in the northern and southern hemispheres, corroborating the data of this research.

In this study we used the definition of race based on the work of Eveleth and Tanner (1990)[12], who chose a version based on historical and geographical criteria to define populations, and although there are possible failures due to the miscegenation of the Brazilian population, the scope of the authors' survey is broad in both quantitative and qualitative terms and considered valid for other epidemiological studies. In our study there was a predominance of patients who were declared Caucasian at the initial appointment, in a total of 113 patients (76.9%). These data are in line with general knowledge about the epidemiology of DDH. The data available in the literature for South America consider an incidence of 69% in Caucasians, irrespective of sex[4,13].

Regarding laterality, 69 (46.9%) boys had bilateral DDH, 51 (34.7%) had dysplasia exclusively on the left side, and 27 (18.4%) only on the right side, totaling 216 affected hips. In this regard, we found the largest variation as compared to other studies.

The systematic review by Loder and Skopelja (2011)[4] based on English-language articles published between 1947 and 2010 focused exclusively on etiological, epidemiological and diagnostic aspects and provided good scientific support for comparison with the data found here. From a total of 9,717 cases studied, 63.4% presented unilateral involvement, of which 36% involved the right side and 64% the left side, leaving 36.6% of bilaterality. Although the left side is typically more involved, significant ethnic variation was found, being smaller in the Indo-Mediterranean (44%) and larger in the Australians/New Zealanders (81.4%). South Americans had a balanced distribution with 52% on the left side and 48% on the right side.

In our study, left dysplasia had a much higher incidence in unilateral cases. When we consider only these patients (78 boys), the statistics are similar to the data reported by Borges et al. (1995)[8] with 65.4% of DDH exclusively on the left (Borges – 62.5%) and 34.6% on the right (Borges – 37.5%), both including only the male pediatric population.

In this study, the high incidence of bilaterality was considered an impacting factor of difference from the current literature, which describes little variation of DDH by sex in the different races, but considerable variation in bilaterality.[4] In our series, besides the predominance of Caucasian patients, the incidence of bilaterality (46.9%), although lower than the 60.5% found by Samarah et al. (2016)[9], was similar to that found by Borges (41.8%)[8]. Caucasian South Americans were considered ethnically the patients with the highest incidence of bilateral DDH (69%). This statement was based on the study byRomero et al. (1989)[13,] who analyzed 97 Chilean patients, regardless of sex, where only 13 (13.4%) were boys. If we consider that the studies by Samarah and Borges were carried out exclusively with male patients and analyzing the four studies in question, including the present one, in all of them the incidence of bilaterality in the male population was higher than reported in the literature, and this reinforces that there are epidemiological gender differences to be considered.

The mean age at diagnosis of our patients was 22.8 months (median 10.1 months) with 66 boys (45%), i.e. about half of them diagnosed before 6 months of age, and 39 patients (26.5%) had a "late" diagnosis after 2 years old. A Canadian study[14] considering 20 months of age as the cutoff point found that the main factor associated with late diagnosis was bilateral presentation (44%), similar to this study. In the study by Samarah et al. (2016)[9], who investigated 1,145 boys and found 43 children with DDH (70 hips), the main factors associated with late presentation in males were primiparity and bilaterality.

At the time of diagnosis, the patients were radiographically classified according to DDH type, and we observed that upper hip dislocation along with subdislocations were the most prevalent presentations, with 62 hips affected by the former (28.7%) and 60 hips by the latter, respectively (27.8%). Together they represented 56.5% of the cases, while patients with isolated instabilities and dysplasia were the least representative of the sample with 13.1%. Despite being found in all age groups of our study, high dislocation showed a significant increase in the older the patient, unlike the subdislocations, which were more frequent in the youngest age group (0-6 months). This progression of DDH makes us infer a worse prognosis the older the age, which is not exclusive to males, but draws attention to an earlier diagnosis.

In the radiographic evaluation, the progression of the Acetabular Index on AP radiograph was assessed according to the severity of the type found. In cases of pure instability the mean was 25.1 degrees, and in cases of high dislocation 42.2 degrees. This gradual increase in angles is in line with the concept of developmental dysplasia as a progressive disorder of the hip, considering the finding that the vast majority of cases of high dislocation were diagnosed in older patients. As compared to other articles on the subject, the mean and standard deviation of AI on AP radiograph were similar to those found in the literature. We did not find references to acetabular index values in Lauenstein pelvic radiograph (frog-leg position), all reference authors in their classic studies for acetabular index did so on the anteroposterior radiograph (AP)[15-19].

Many studies have been written discussing the so-called normal values for the acetabular index. Kleinberg and Lieberman (1936)[15] found a mean index of 27.5 degrees in newborns and 20 degrees in 11-24-month-olds, while in 12-36-month-olds with dysplastic hip the mean index was 37.5 degrees. Despite the controversies regarding this study, especially regarding the proper positioning of the patient and the possible variations in the angle[17,18], it remains a good reference for diagnosis and evolution of the cases provided it is used in conjunction with the well-established clinical parameters[19]. Broughton, Brougham, Cole and Menelaus (1989)[16] investigated the intra- and interobserver correlation of several possible assessments for acetabular dysplasia and found great variability between measurements. Of all the parameters studied, the acetabular index

was the most accurate, with 95% agreement between observers. In our study, the relative values of the acetabular index in Lauenstein incidence were always slightly lower than values of the same angle in the AP radiograph, but with a very similar mean. It is possible that the frog incidence is more accurate than AP radiograph when the exams come from non-standard radiology services, because in this position the flexion and abduction of the hips, in addition to decreasing lumbar lordosis correcting the pelvis, make the child be positioned more in front of the equipment, decreasing the lateral inclination and, consequently, the angle variation.

When we crossed the data of the acetabular index with the type of DDH and the IHDI classification, we found a close correlation between radiographic type and classification and, although not a specific objective of this research, it evidenced and validated for us the reproducibility of the classification proposed by the International Hip Dysplasia Institute as an "evolution" of the classic Tönnis Classification, because the IHDI classification is independent of the appearance of the proximal secondary ossification center of the femur to be applied[6,20].

Therefore, we consider from the above-mentioned factors that the higher incidence of bilaterality in males is a factor that may justify late diagnosis and, consequently, the higher incidence of high dislocations with a tendency to a worse prognosis.

These findings emphasize the need for both a more vigilant assessment in the neonatal diagnosis and the institution of treatment as soon as the condition is identified, as well as mandatory screening tests in all maternity wards and for all newborns, regardless of the presence or absence of risk factors.

CONCLUSIONS

DDH in males presents different characteristics from those reported in the literature. We found a higher frequency of bilaterality, later age of diagnosis and a higher percentage of high dislocations than in other epidemiological studies. Therefore we recommend the diagnostic investigation in the maternity ward for both sexes, regardless of the presence of risk factors.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. EOG: radiographic analysis, database construction, article writing, statistical analysis and intellectual concept of the article and preparation of the entire research project; MA: critical review of the intellectual content of the paper and review of the article; JPP: radiographic analysis and database construction; CS: writing and proofreading of the article as well as the entire intellectual concept of the article.

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EFFECT OF PLATELET-RICH PLASMA, FAT PAD AND DURAL MATRIX IN PREVENTING EPIDURAL FIBROSIS

EFEITO DO PLASMA RICO EM PLAQUETAS, ENXERTO DE GORDURA E MATRIZ DE COLÁGENO NA PREVENÇÃO DA FIBROSE EPIDURAL

SERKAN GULER[1], OMER AKCALI[2], BARAN SEN[2], SERAP CILAKER MICILI[3], NAMIK KEMAL SANLI[4], DENIZ CANKAYA[1]

1. Aksaray University, Faculty of Medicine, Department of Ortopaedic and Traumatology, Aksaray, Turkey.
2. Dokuz Eylul University, Faculty of Medicine, Department of Ortopaedic and Traumatology, Izmir, Turkey.
3. Dokuz Eylul University, Faculty of Medicine, Department of Histology, Izmir, Turkey.
4. Dokuz Eylul University, Faculty of Medicine, Department of Haematology and Oncology, Izmir, Turkey.

ABSTRACT

Objective: Epidural fibrosis is one of the main reasons for requiring repeated surgical intervention. Our objective was to compare the effect of Platelet Rich Plasma (PRP) on the development of epidural fibrosis with collagen dural matrix and free autogenous fat graft. Methods: Male rats were separated into 3 groups. Laminectomy was implemented on the rats and epidural fat pad was placed in the first group (n = 7); equal size of collagen dural matrix was applied in the second group (n = 7); a single dose of PRP was applied in the third group (n = 7). Results: Epidural fibrosis was more common in the group that collagen dural matrix was applied when compared the ones that PRP was applied. PRP group presented better values in preventing epidural fibrosis when compared to the fat pad group, however this difference was not statistically significant. Conclusion: PRP is a material that can be easily obtained from the very blood of patients and at an extremely low cost; the main clinical relevance of our study is that the PRP might be an efficient material for better clinical results after laminectomy surgery due to its tissue healing and epidural fibroris preventing potentials. ***Level of Evidence V, Animal research***.

Keywords: Platelet-Rich Plasma. Laminectomy. Fibrosis. Collagen.

RESUMO

Objetivo: A fibrose epidural é uma das principais razões que motiva intervenções cirúrgicas repetidas. O objetivo deste estudo foi comparar o efeito do plasma rico em plaquetas (PRP) no desenvolvimento de fibrose epidural com matriz de colágeno e enxerto de gordura autógena. Métodos: Ratos machos foram separados em 3 grupos. A laminectomia foi aplicada nos ratos e gordura epidural foi colocada no primeiro grupo (n = 7); matriz de colágeno de tamanho igual foi aplicada no segundo grupo (n = 7); uma dose única de PRP foi aplicada no terceiro grupo (n = 7). Resultados: A fibrose epidural foi mais comum no grupo em que a matriz de colágeno foi aplicada, quando comparada aos animais do grupo PRP. O grupo PRP apresentou os melhores valores na prevenção da fibrose epidural quando comparado ao grupo enxerto de gordura, porém a diferença não foi estatisticamente significante. Conclusão: PRP é um material de fácil obtenção do sangue dos pacientes e a baixo custo; a principal relevância clínica de nosso estudo é que o PRP pode ser um material eficiente para obter melhores resultados clínicos após a laminectomia devido à sua cicatrização tecidual e potencial de prevenção de fibrose epidural. ***Nível de evidência V, Pesquisa com animais****.*

Descritores: *Plasma Rico em Plaquetas. Laminectomia. Fibrose. Colágeno.*

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INTRODUCTION

Low back pain is a recurrent clinical situation even after surgical treatment of disc herniation lumbar spine surgeries.[1,2] In some cases, recovery is achieved by light scale medical intervention or minimally invasive methods, but in some cases postoperative back pain is not relieved, even with interventions such as complex surgeries.[1,3-5] Failed back surgery syndrome is characterized by recurrent continued pain after neurosurgical intervention such as lumbar laminectomy, and has gained the attention from spinal surgeons.[5-7]

Epidural fibrosis is a natural outcome of laminectomy, being the formation of excessive scar tissue at the surgical site.[2,4,8] The literature has already reported that scars may cause clinically significant sequalae by creating adherences in between the tissues, or as a result of the dense fibrous tissue exerting pressure on the surrounding anatomical structures.[1-9] Although there is no consensus on the

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Study was conducted at the Dokuz Eylul University, Alsancak, Turkey.
Correspondence: Deniz Cankaya. Aksaray University, Faculty of Medicine, Department of Orthopaedics and Traumatology. Bahcesaray Mahallesi 68100. Aksaray, Turkey. cankayadeniz78@gmail.com

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ratio of fibrosis related problems, the possibility has been considered in many studies that, if there was no alternative bone or vertebral disk pathology, the cause of recurrent symptoms following lumbar disc surgery interventions may be fibrosis.[2,5,7-9] The literature has already stated that 24% of the reasons patients required repeated surgical intervention was epidural fibrosis.[9]

Approaches using the minimally invasive techniques, drugs, biomaterial and non-biomaterial barriers to prevent the postoperative epidural adhesion were intensively investigated,[3] and several studies are being conducted to prevent or reverse the development of epidural fibrosis.[10] Among these materials, platelet-rich plasma (PRP) can be defined as a plasma fraction with platelet concentration higher than the baseline concentration in whole blood and that has antifibrotic action.[11] Autologous fat grafts have been commonly used to prevent the epidural adhesion after lumbar laminectomy.[3,12] Collagen dural matrix (DuraGen) is a chemical cross-linked type 1collagen foam made from bovine tendon and has been suggested to reduce fibrosis.[13] However, all articles on the literature emphasize the need for further studies on the preventive nature of these materials. As previously mentioned, the effects of PRP, autologous fat graft and collagen dural matrix on the development of epidural fibrosis after laminectomy have been investigated individually. However, little attention has been given to a comparative analysis of all these factors. The objective of this study was to analyze the comparative effect of the intraoperative application of PRP, autologous fat graft and collagen dural matrix on the prevention of epidural fibrosis after laminectomy in an experimental model with rats.

METHODS

Twenty-eight rats were randomly divided into four groups of 7 rats. One rat was used for a pilot study for laminectomy and PRP preparation, not included in this study. All specimens were Wistar rats (250-300 gram) and were housed individually at 22 °C with a twelve-hour light/twelve-hour dark cycle in Animal Research Facilities. The research procedures were in full compliance with Veterinary Medicine Deontology Regulation 6.7.26, Helsinki Declaration of Animal Rights, and approved by the University Ethics Committee of Animal Research (approval number 61/2012). Surgical interventions were performed by a single surgeon. Induction of anesthesia was performed by intraperitoneal ketamine hydrochloride 35 mg/kg and xylazine hydrochloride 5 mg/kg. Following anesthesia, the subjects were immobilized in prone position. The lumbar region was shaved, and the surgical site was prepared. Local antisepsis was achieved using povidone-iodine. The lumbar area was determined by taking interscapular distance as reference, and a 4 cm midline skin incision was applied at L1-L5 level. Subcutaneous tissues and paraspinal muscles are divided and a small self-retaining retractor was used for exposure. The areas between the sacrum and L3 spinous process were exposed. L3 and L4 total laminectomy and ligamentum flavum excision was performed by a small Kerrison rongeur. All layers were sutured in anatomic architecture.

The posterior surface of the dura in the laminectomy site were covered with fat pad in Group 1 (n = 7). In Group 2 (n = 7), collagen dural matrix (DuraGenPlus™) of equal size (4 × 2.5 mm) were used for coverage. Single dose (1.5cc) PRP were applied over dura mater in Group 3 (n = 7). Seven additional rats (Donation Group) were used to obtain cardiac blood for PRP preparation. One rat was used for pilot study for laminectomy and PRP preparation and was not included into the study. After applying the materials, all layers were sutured in anatomic architecture. Preoperative and postoperative (24th and 48th hours) neurologic status of the subjects was determined by Basso, Beattie and Bresnahan (BBB) scoring system.[14]

PRP was prepared by obtaining 10 cc blood from a rat in the donation group and put into tubes with citrate phosphonate dextrose (CPD). Additional 0.5 cc blood put into pediatric tubes with EDTA and sent to the autoanalyzer for cell count;10 cc blood with citrate were transported to the hematology laboratory in the cold chain for the preparation of PRP. The sample was centrifuged for 10 minutes at 1500 rpm and 10 °C. Supernatant plasma and buffy-coat were taken and separated from the blood cells. Following, it was centrifuged for 10 minutes at 2000 rpm. The supernatant thrombocyte-poor part was separated and kept to be used for dilution during measurement. The sediment was centrifuged again at 2500 rpm and 1.5 cc PRP was obtained from the bottom 1/3 part. To achieve a gelatinous texture, 0.30 cc of 10% CaCl2 was added using a micropipette. All procedures in the laboratory were performed under sterile conditions. The samples were transported to the animal laboratory in the cold chain and used in epidural PRP application.

The rats in all three groups were sacrificed at the end of 4th week. Their spinal column was excised as an en-block that contained upper and lower intact segments of laminectomy level. Histological examinations were done at the Histology Department by using a light microscope operated by a senior histologist who was blinded to the groups. Tissue samples were kept in 10% formaldehyde for 24-48 hours for fixation, and then placed in a EDTA solution for 8 weeks for bone tissue softening. Two sets of paraffine were applied in a 60 °C incubator, each for 1 hour; immersion was thus achieved, and tissues were embedded inside paraffine blocks after the acetone solution treatment process. Cross sections sized 5 μm were taken from paraffine blocks by microtome. They were then treated in 4 changes of acetone solutions, each for 20 minutes, kept in 2 changes of acetone solutions each for 30 minutes. Following, 5 μm paraffine cross sections were left in the 60 °C incubator overnight for the deparaffinization process, being exposed to 3 changes of xylol, each for 20 minutes. After 10 minutes of staining with hematoxylin, they were washed under running water for 10 minutes to remove excessive stain from the tissue, and then stained for 2 minutes with eosin stain. Following, the cross sections were treated with alcohol series of 80% and 95%, respectively and then dried in air. They were treated with two changes for transparentization for 30 minutes each and covered with Entellan.

The method of He et al. was used to evaluate the epidural fibrosis.[15] This classification presents additional definitions for the degree of severity, ranges from normal to a severe degree of epidural fibrosis, and is described as follows: grade 0 (normal, no epidural fibrosis), grade 1 (mild degree, thin fibrous band(s) over dura), grade 2 (moderate degree, continuous adherence observed but less than two-thirds of laminectomy defect), and grade 3 (severe fibrosis, large scar tissue adherence, more than two-thirds of laminectomy area, and/or extending to nerve roots).[15,16] Epidural fibrosis classification is shown to have almost perfect agreement among the assessors with its high interrater reliability.[16]

The results were evaluated with SPSS for Windows. When the structure of the study groups and study design were considered, for statistical comparison, the Kruskal Wallis variance analysis test was used to compare three groups between each other, whereas Mann-Whitney's U test with Bonferroni's correction was used for bilateral comparison within groups. Statistical significance was considered when $P < 0.05$.

RESULTS

All subjects survived throughout the study. No allergic, infectious and foreign body reaction findings were observed. Axial cross sections of the spine segments at laminectomy level

were histologically examined. Grade 1 fibrosis was noticed in five samples (71%) in group 1 (fat pad group), and grade 2 fibrosis was determined in the remaining two samples; moreover, fibrotic extensions were also determined as less than 2/3 of the cross section. Grade 3 findings were not observed. Intensive revascularization areas were observed on medulla spinalis and duramater with 10x magnification examination of the samples in this group (Figure 1). At higher magnification (20x), grade 1 fibrosis was also observed as thin fibrotic bands besides the revascularization areas (Figure 2).

In Group 2 (collagen dural matrix), grade 1 (n = 2) and grade 2 (n = 2) fibrosis were equal in four of seven subjects in total. In the remaining three samples, fibrotic scar tissues were observed with more than 2/3 of the cross-section area and extending up to the nerve stems that can be visualized. These three cases were classified as grade 3 (43%). Dense fibrous tissue formation and plenty of fibroblasts are the main different findings when compared to the others. In some samples, we observed that fibrous tissue was dense and the development of scar tissue became apparent (Figure 3). In other examples, histological findings corresponding to scar tissue development were not determined. However, collagen dural matrix residues were also observed in the histological cross-section through laminectomy area at higher level magnification (20x). Dense fibrous tissue was covered more than 2/3 of epidural space after collagen dural matrix application (Figure 4).

In Group 3 (PRP group), no fibroblastic activity was determined in one sample and was accepted as grade 0 (14%). One subject showed grade 2 fibrosis. Grade 1 fibrosis (71%) was observed in the rest of the subjects (n = 5). Epidural fibroblasts were rare. In the epidural tissue, histologically fibrous tissue was scarce and cellular properties were observed that are very similar to those where surgery was not applied. Recovery findings in the epidural tissue were observed close to those of the classical descriptions. At higher magnification (20x), the sample taken from the PRP group showed revascularization areas that were observed in the free autogenous fat pad placed group that were not detected. Collagen fibers in the tissue were dense; however, the data cannot be assessed quantitatively since grading via collagen staining was not implemented. Figure 5 shows a sample in which the fibrosis level was determined as grade 0. Statistical comparison of three groups is shown in Table 1. Paired comparison of groups and p values are shown in Table 2.

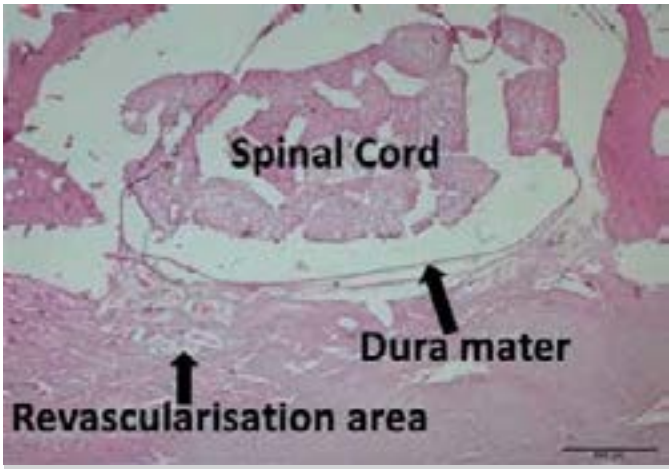

Figure 1. In the free fat pad applied sample (Group 1), intensive revascularization areas are seen right above dura mater (10x magnification).

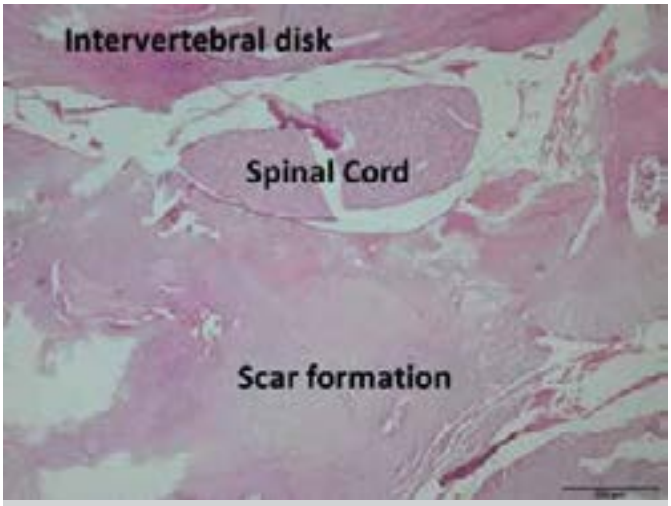

Figure 3. Scar tissue development in the sample that collagen dural matrix was applied (Group 2) (10x magnification).

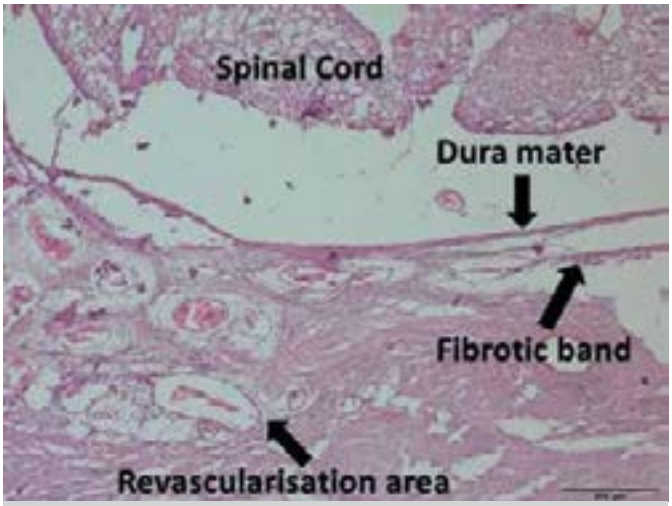

Figure 2. In the histological cross-section of a free fat pad applied sample (Group 1), fibrotic band can be distinguished between dura mater and the revascularization areas and it can be evaluated as grade 1 (20x magnification).

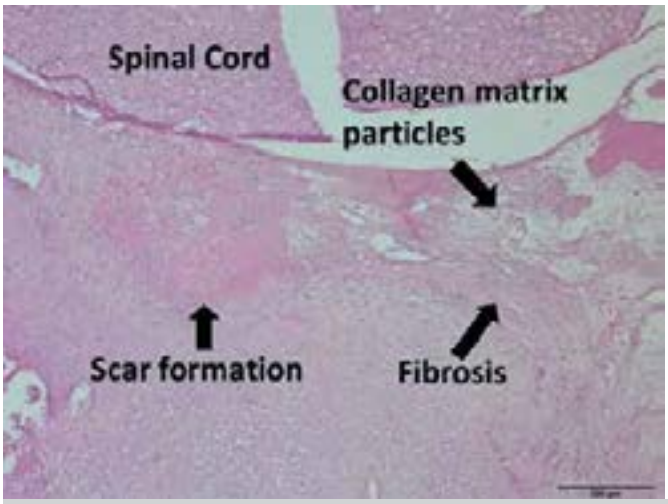

Figure 4. In higher magnification images of the sample that collagen dural matrix was applied (Group 2), scar and fibrosis tissue (20x magnification).

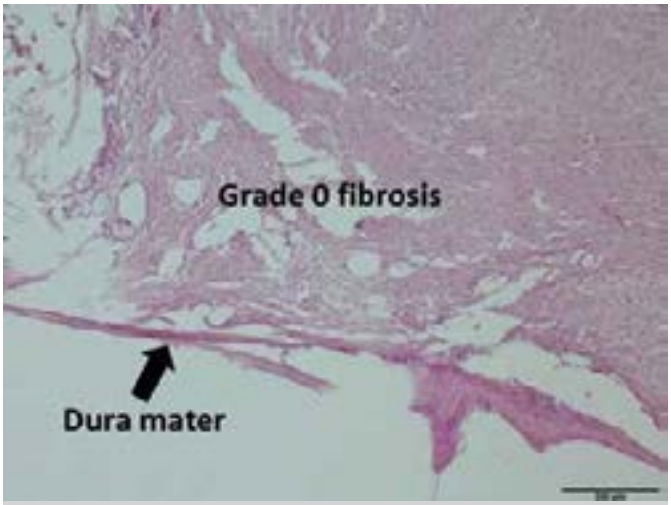

Figure 5. A sample from the PRP applied group where fibrosis grade 0 was determined (20x magnification).

Table 1. The results of non-parametric evaluation of histological examinations. Comparison of histological fibrosis grading data of three experimental groups with each other was implemented by Kruskal Wallis's test. The difference of the distributions of histological results of three experimental groups were statistically significant ($p < 0.05$).

Sample (n)	Fat Pad	Collagen matrix	PRP
1	1	2	1
2	1	3	2
3	1	3	1
4	1	1	1
5	2	1	1
6	1	3	0
7	2	2	1

Table 2. Paired comparisons of the groups by Mann-Whitney's U test.

Groups	p values
Fat pad – Collagen Matrix	0.097
Collagen Matrix – PRP	0.038*
Fat pad – PRP	0.456

*Statistically significant difference was found between collagen dural matrix group and PRP group ($p < 0.05$).

DISCUSSION

Despite the application of all treatment modalities, patients who undergo posterior spinal surgery – including laminectomy – may develop epidural fibrosis. Clinically, late leg pain may result from epidural and perineural fibrosis. Epidural fibrosis may display clinical view by adhering to the dura mater, nerve roots, erector spinae muscles, intervertebral disk and vertebrae. Several biological and non-biological materials have been tested to prevent epidural fibrosis – which is considered one of the most prominent factors of lumbar pain that persists after lumbar spinal surgery.[3,12,17,18] Free autogenous fat grafts, collagen matrix (DuraGen™), hyaluronic acid, licofelone, Seprafilm™, Adcon-L™, PRP and Rapamycin, etc. are the prominent experimental materials.[2,4-7,9,12,13,15,16,18,19] Some of these materials have been used clinically. Although most studies are animal experiments, as of today, satisfactory clinical studies confirming that these materials can help attenuate fibrosis in clinical applications have not been achieved yet. DuraGenPlus™ (Integra LifeSciences Corporation 311 Enterprise Drive Plainsboro, NJ 08536, chemical cross-linked type 1collagen foam made from bovine tendon) is a collagen matrix with spongy texture, generally used as graft for covering dural defects.[13,20] This component is resorbed in 6-8 weeks and it is not encapsulated, thus undergoing a purification process to decrease foreign body reaction, and encapsulation with fibrosis and immune reactions. Some studies have been published proposing that it can decrease fibrosis in spinal surgery[13,20,21]

In experimental modelling, the application of fat grafts was frequently preferred among these materials to prevent fibrosis. Bryant, Bremer & Nyugen studied 44 free autogenous fat graft applications.[7] They proposed that the application of autogenous fat grafts increased the revascularization during the healing stage, so fibrotic tissue could thus be prevented. Similar to our study, the formation of revascularization was distinguishable in the fat graft areas and decrease in fibrotic tissue formation was histologically observed. But no sufficient data was obtained to allow us to comment on the contribution of fat application to increase vascularization, underlying reasons, and the vascularization mechanism effect on the decrease of fibrotic tissue. However, another clinical study reported the results of 99 patients operated due to lumbar disc herniations and concluded that the fat grafts were clinically ineffective in preventing epidural fibrosis.[12] In our study, when comparing the fibrosis grade of the autogenous fat graft group to that of the PRP group, we observe that the PRP group has better values in preventing epidural fibrosis but that this difference did not create statistical difference. PRP is a popular material in the field of tissue healing after trauma or surgery, and became the hot topic of many studies nowadays. Studies about PRP use in spinal surgery are limited, but we found no studies comparing the fibrotic effects of PRP, fat pad, and frequently used biologic material such as collagen dural matrix. Gigante et al. published the results of an animal study on the effects of PRP on rat muscle tissues.[22] They did not observe metaplasia, calcification or heterotopic ossification during the healing process following PRP application on paravertebral muscle lesions. Similarly, no abnormal cell formations in the PRP group were observed in our study. Any fibrosis formation beyond grade 2 was not observed in these samples as well; thus, cellular reactions look similar in both studies. Intradiscal PRP applications have been studied to evaluate the disk changes in animals. Obata et al. reported a positive effect in disk regeneration with PRP application following disk degeneration in a rabbit model and observed an increase in collagen matrix and type 2 collagen rate in nucleus pulposus cells.[23]

As limitations of our study we can cite its experimental character, which limits the direct application of the results to clinical practice, like in any other experimental study. Due to the ethical regulations in providing experimental animals, we were unable to obtain the minimum number of experimental animals according to the nonparametric statistical tests. Selecting small animals such as rats can also be a disadvantage, given that working with larger animals would be easier when considering the surgical technique and histological slice preparations.

CONCLUSION

Our study investigated the effects of two frequently used materials in spinal surgery. There is no consensus in the literature due to the studies reporting positive and negative results of epidural free fat application and collagen matrix applications. Our study is the first study to compare the effects of free fat pad, collagen dural matrix, and PRP on epidural fibrosis. When the results of our study are interpreted, PRP was determined to not be superior to the fat pad, but better than collagen matrix group in preventing epidural fibrosis after laminectomy. PRP is a material that can be easily obtained from the patient's own blood and at an extremely low cost. The main clinical relevance of our study is that PRP might be an efficient material for better clinical results after laminectomy surgery with its tissue healing and epidural fibrosis preventing potentials. However, as data on this issue are limited, further studies with different amounts and application methods are needed to reach generally accepted conclusions about the routine use of PRP in lumbar discs surgery.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this study. SG: animal lab surgeries. OA*: study design. BS: data analysis and interpretation. SCM: histopathologic examination. NKS: PRP preparation and language edit. DC: literature research, writing of the article, and corresponding author.

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ORIGINAL ARTICLE

INTER/INTRA-OBSERVER EVALUATION BETWEEN RADIOGRAPHS AND TOMOGRAPHIES FOR PROXIMAL HUMERUS FRACTURE

AVALIAÇÃO INTER E INTRA-OBSERVADOR ENTRE RADIOGRAFIAS E TOMOGRAFIAS PARA FRATURA DE ÚMERO PROXIMAL

Guilherme Augusto Stirma[1], Armando Romani Secundino[1], Guilherme Ferreira Garcia Gonzalez[1], Wilson Carlos Sola Junior[1], Geovanna Andrade Labres de Souza[1], Leonardo Dau[1]

1. Universidade Federal do Paraná, Hospital do Trabalhador, Department of Orthopedic Surgery, Curitiba, PR, Brazil.

ABSTRACT

Objective: The use of images in 3D reconstruction is an instrument that facilitates the interpretation of the fracture, observations of deviations, rotations and articular surface. Objective: To evaluate the inter-observer and intra-observer reliability of the Neer x AO proximal humerus fracture classification on radiographs versus computed tomography with three-dimensional reconstruction (3D). Methods: We evaluated the digital radiographs (anteroposterior and profile) and computerized tomography with 3D reconstruction of patients presenting with a proximal humerus fracture, surgically treated at an Orthopedics and Traumatology Service. All radiographs and computed tomography were classified (Neer and AO) by eight (8) orthopedic surgeons, specialists in the upper limb and sent, following the pre-established numeration by the author, in a spreadsheet to the author of the study. Results: The Neer and AO scores were more reproducible when determined by computed tomography with 3D reconstruction, mainly in fractures of greater complexity (Neer 4 parts and AO group C). However, in absolute values, inter and intra-observer reproducibility and concordance still remain low. Conclusion: Computed tomography with 3D reconstruction allows a better analysis of fractures of group C and Neer 4 parts. However, the inter and intra-observer agreement does not increase significantly in comparison to the radiographs. ***Level of evidence III, Study of non-consecutive patients, without gold standard, applied uniformly.***

Keywords: Tomography. Proximal Humeral Fracture. Inter and intra-observer.

RESUMO

Objetivo: O uso de imagens em reconstrução 3D são um instrumento facilitador na interpretação da fratura, observações dos desvios, rotações e superfície articular. Objetivo: Avaliar a confiabilidade inter-observador e intra-observador da classificação da fratura de úmero proximal, descrita por Neer x AO, em radiografias versus tomografias computadorizadas com reconstrução tridimensional (3D). Métodos: Avaliamos as radiografias digitais (anteroposterior e perfil) e tomografias computadorizadas com reconstrução 3D de pacientes que apresentavam fratura de úmero proximal, tratados cirurgicamente em um Serviço de Ortopedia e Traumatologia. Todas as radiografias e tomografias computadorizadas foram classificadas (Neer e AO) por oito (8) cirurgiões ortopédicos especialistas em membro superior e enviadas, seguindo a numeração pré-estabelecida pelo autor, em uma planilha para o autor do trabalho. Resultados: A classificação de Neer e AO foram mais reprodutíveis quando determinadas pela tomografia computadorizada com reconstrução 3D, principalmente em fraturas de maior complexidade (Neer 4 partes e AO grupo C). Porém, em valores absolutos, a reprodutibilidade e concordância inter e intraobservador ainda permanecem baixas. Conclusão: A tomografia com reconstrução 3D, permite uma melhor análise das fraturas do grupo C e Neer 4 partes. Entretanto, não aumenta significativamente a concordância global inter e intraobservador em comparação as radiografias. ***Nível de Evidência III, Estudo de pacientes não consecutivos, sem padrão ouro, aplicados uniformemente.***

Descritores: *Tomografia. Fraturas do Úmero Proximal. Inter e Intraobservador.*

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INTRODUCTION

Proximal humerus fracture corresponds to 5% of fractures, and it is the third most common fracture, only behind distal radius fractures, femur in its proximal portion, and it corresponds to 80% of humerus fractures.[1] The most frequent mechanism of trauma is the fall on the same level. Approximately 80% of cases present or not small deviations and can be treated conservatively.[2] However, understanding the most complex fractures can be a challenge to the orthopedic surgeon. Inadequate and poorly performed radiographs may alter or even hinder analysis.[3] In 1970, Charles Neer created the classification of four segments for humerus fracture in his proximal portion, namely greater tuberosity, lesser tuberosity, humeral head and humeral shaft.

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

Study developed at the Universidade Federal do Paraná (UFPR), Department of Orthopedics and Traumatology, Hospital do Trabalhador, SESA, Curitiba, PR, Brazil.
Correspondence: Guilherme Augusto Stirma. Rua São Mateus, 370, Portão, Curitiba, PR, Brazil, 81070080. guilhermeaugusto89@hotmail.com

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After 46 years, it continues to be used due to its usability, guidance in the treatment and explanation of pathological characteristics of the injury.[4-6] However, its reliability is increasingly contested due to the low inter-observer agreement,[4] explained by the poor image quality and poor positioning of patients.[7] Charles Neer claims this low agreement occurs due surgeons' inexperience, in the case of 4-part fracture.[8]
The AO classification (Arbeitsgemeinschaft für Osteosynthesefragen) values the vascularization of the humeral head.[1] Created in 1986 and revised in 1990, it uses an A-to-C system related to the fracture pattern. A subdivision into 3 subgroups (1, 2 and 3) is added based on the degree of fragmentation and complexity of the fracture, obtaining 27 fractures with different patterns.[1,9]
Conventional radiography has an important role in the initial evaluation. However, computed tomography and 3D reconstruction have stood out in observations of deviations, rotations and joint surface due to technology improvement. The AO and Neer classifications have shown low reproducibility during conventional radiographic and tomographic evaluation. Images in 3D reconstruction facilitates the interpretation of the fracture. Neer emphasizes that better understanding of the fracture pattern is essential to recommend a treatment.[3]
Our study sought to evaluate the inter- and intra-observer reliability of the classification of proximal humerus fracture described by Neer compared with AO classification on radiographs, versus computed tomographies with three-dimensional reconstruction (3D).

MATERIAL AND METHODS

This project was submitted to the ethics committee in human research and was approved on 11/02/2016 by code 59901816.0.0000.5225.
Based on the codes of procedures and surgery records, we identified all patients that underwent initial digital radiographs and computed tomographies with 3D reconstruction for proximal humerus fracture. All patients were treated surgically in the orthopedics and traumatology service of a large hospital and signed an informed consent form.
All radiographs and computed tomographies were classified by 8 orthopedic surgeons specialized in the upper limb. The tests were previously edited by one of the authors (who did not participate in the evaluation) to remove the identification and randomization of the sequence of patients. Radiographies were first sent digitally to each orthopedist and, about one month after, tomographies. Each orthopedist classified each fracture using Neer (number and fractured segments), and using AO (with subgroups) and classified in tables, following the pre-established numbering, in a spreadsheet to the author responsible for randomization of the images.
After data collection, radiographic and tomographic classifications were compared by inter- and intra-observer analysis. A statistical study of the data, values found and a discussion on the basis of the current literature in already published data were conducted.
Patients without initial radiographs and computed tomographies for proximal humerus fractures and pathological fractures were excluded from the study.

We used the Kappa coefficient of agreement for statistical analysis between the inter- and intra-observer agreement. The coefficient values found in this test can be classified as follows: 0-0.19 as unsatisfactory, 0.20-0.39 low agreement, 0.40-0.59 moderate agreement, 0.60-0.79 satisfactory agreement and 0.80-1.00 as almost perfect.

RESULTS

Inter-observer

In total, 54 patients were included in the sample. The tomographies and radiographs of the 54 cases were evaluated by eight orthopedists specialized in the upper limb.
Regarding the radiographs for the Neer classification, kappa agreement values were 0.275 (2 parts), 0.083 (3 parts), 0.204 (4 parts), 0.178 general kappa, $p < 0.001$. (Table 1). In tomographies, the kappa values were 0.229 (2 parts), 0.147 (3 parts), and 0.32 (4 parts), 0.22 mean kappa, with $p < 0.001$. (Table 2)
The results regarding the radiographs classified according to AO showed kappa values of 0.232 to A1, 0.194 to A2, 0.266 to A3, 0.15 to B1, 0.21 to B2, 0.078 to B3, 0.045 to C1, 0.133 to C2 and 0.419 to C3, with 0.201 general kappa. (Table 3)
Regarding the tomographies, the results showed kappa 0.535 to A1, 0.273 to A2, 0.28 to A3, 0.242 to B1, 0.221 to B2, 0.236 to B3, 0.114 to C1, 0.479 to C2 and 0.311 to C3, with 0.277 general mean. (Table 4)

Table 1. Concordance Table with radiographs by Neer.

0	2 parts	3 parts	4 parts
Kappa of the category	0.275	0.083	0.204
P-value of Kappa of the category	< 0.001	0.001	< 0.001

General Kappa	0.178
P-value	< 0.001
95% CI Kappa	**upper:** 0.213 **lower:** 0.144

Table 2. Concordance Table with tomographies by Neer.

	2 parts	3 parts	4 parts
Kappa of the category	0.229	0.147	0.32
P-value of Kappa of the category	< 0.001	< 0.001	< 0.001

General Kappa	0.22
P-value	< 0.001
95% CI Kappa	**upper:** 0.256 **lower:** 0.184

Table 3. Concordance Table with AO radiographs.

	A1	A2	A3	B1	B2	B3	C1	C2	C3
Kappa of the category	0.232	0.194	0.266	0.15	0.21	0.078	0.045	0.133	0.419
P-value of Kappa of the category	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.081	< 0.001	< 0.001
General Kappa									
General Kappa	0.201								
P-value	< 0.001								
95% CI Kappa	**upper:** 0.221 **lower:** 0.18								

Table 4. Concordance Table with AO tomographies.

	A1	A2	A3	B1	B2	B3	C1	C2	C3
Kappa of the category	0.535	0.273	0.28	0.242	0.221	0.236	0.114	0.479	0.311
P-value of Kappa of the category	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
General Kappa									
General Kappa	0.277								
P-value	< 0.001								
95% CI Kappa	upper: 0.298 lower: 0.256								

On radiographs, according to Neer classification, the mean agreement between the classification was 4.71 physicians for each case, while by the AO classification there was an agreement between 4 or more physicians, totaling 36 cases.
In the tomographies, according to Neer classification, the agreement between the classification was 5.06 physicians for each patient, while in AO there was an agreement between 4 or more physicians, totaling 42.

Intra-observer

Regarding intra-observer evaluations, there was agreement in the classification on radiographs with tomographies on average of 26.92 cases, ranging from 15 to 31 according to Neer classification in the 54 patients and 17.125, ranging from 12 to 22 correct answers, according to AO classification.

DISCUSSION

Radiography is the standard method for evaluation, diagnosis and classification. However, computed tomography is expected to facilitate and improve the reproducibility of the analyzed fractures, providing a greater intra-observer agreement, enabling a better choice of treatment and a more reliable and reproducible classification system.[7,10]
Despite numerous complaints regarding its reproducibility, Neer classification is widely accepted and commonly used to guide treatment and anticipate prognosis; it is pedagogically useful, of easy learning and separates fractures into broad categories, being easy to understand.[5,7] AO classification (Arbeitsgemeinschaft für Osteosynthesefragen) divides fractures according to their complexity and facilitates choice of treatment and prognosis. The AO is one of the most complete classification system, however, its intra- and inter-observer reproducibility has reduced.[1,9,11]
In our study, we evaluated 54 patients with proximal humerus fracture, whose initial evaluation was performed by radiography and tomography with 3D reconstruction.
In the evaluation of the inter-observer results regarding radiographs according to Neer classification, we observed that kappa agreement ranged between 0.083 (analysis with fractures classified into 3 parts), 0.204 (4 parts) and 0.275 (2 parts), with 0.178 general kappa, with $p < 0.001$. (Table 1) These data are lower than those of Papakonstantinou et al.[12], which showed a 0.40-0.58 global kappa, Bernstein et al.[13], a 0.52 kappa, Siebenrock and Gerber[14], a 0.40 kappa, and Sidor et al.[15], a 0.48 kappa. Brorson and Hróbjartsson[16] conducted a systematic review, finding 11 studies with kappa ranging from 0.17 to 0.52. However, of the revised studies, the higher the number of evaluations and the larger the group that classified them, less is the kappa agreement. Among the studies mentioned, Schwartz and Cuny[17] used 11 orthopedists to evaluate the radiographs of 21 patients, obtaining a 0.17 kappa value; Kristiansen[18] studied 100 patients, obtaining a 0.07-0.48 kappa value. The best result was found in the study by Bernstein et al.[13], with 20 cases analyzed by 2 orthopedists and 2 orthopedic residents, which obtained a 0.52 kappa value.
In the evaluation of the results of the tomographies, we found a 0.22 mean kappa, with $p < 0.001$, ranging between 0.147 for fractures classified in 3 parts, 0.229 in 2 parts and 0.32 in 4 parts, as shown in Table 2. Brorson and Hróbjartsson[16] had a 0.34-0.72 mean.We can justify the low agreement in our study by the evaluation of tomography with 3D reconstruction being conducted without radiographic analysis. Sjödén et al.[19], on the other hand, showed that the addition of tomography did not improve the Neer classification reproducibility. However, our study showed a small improvement in reproducibility in computed tomography (5.06), obtaining a better agreement in the classification of computed tomography versus 4.71 on radiographs. When analyzing the results of the radiographs classified according to AO, a greater agreement was obtained when classifying fractures in C3, 0.419 kappa, and A3, 0.266 kappa, with a 0.201 general mean. Tomographies showed higher agreement when classified according to AO and compared with radiographs, A1 0.535 kappa, C2 0.479, C3 0.311 with a 0.277 general mean, as shown in Tables 3 and 4. The values found were similar to the results of Matsushigue et al.[9], in which a 0.25 kappa value was obtained for radiographs and a 0.36 kappa for tomographies. The values were higher than in the analysis by Majed et al.[10], which showed weak inter-observer reliability, with a 0.11 kappa. Values below Sjödén et al.[19], a 0.31 kappa, Siebenrock and Gerber et al.[14], a 0.42 kappa and Papakonstantinou et al.[12] with a 0.31-0.54 kappa were observed in our analysis. The high complexity of the classification system and the high number of categories and subcategories explains the low inter-observer agreement.[12,14,15,19]
In our study, we showed the Neer and AO classification were more reproducible and presented better results when performed through tomography with 3D reconstruction, especially in fractures of greater complexity (Neer 4 parts and AO group C). However, inter- and intra-observer reproducibility and agreement (26.92 cases, ranging from 15 to 31 according to Neer and 17.125, ranging from 12 to 22 correct answers, according AO in the 54 cases analyzed) still remain low in absolute values.
The statistical method used in our study was kappa agreement analysis. This measure of agreement presents values between 1 (one), representing total agreement, and values near 0 (zero), representing no agreement. Although this form of calculation is planned for two observers, Kappa was used with more than 2 observers in our study and in the other studies we analyzed. Thus, the Kappa values obtained are below the real, since the rate of chance is calculated for each observer. However, Kappa is still the most assertive statistical method for this type of analysis.[20]
One of the limitations of our study was its retrospective nature. All radiographs were performed in the emergency room, in emergency situations, some with limited quality. This is the reason why we could not repeat radiographs or request new ones so that they would improve quality.
Eight orthopedists specialized in the upper limb participated in our study to level the agreement indexes and to obtain professionals with the same experience level. The classification was not repeatedly

applied at different times because, according to studies, it would not change the reproducibility.

CONCLUSION

The 3D resection tomography did not significantly improve inter- and intra-observer global agreement for Neer and AO classifications compared with radiographs. We found a low agreement for the evaluation of proximal humerus fracture, except in group C and Neer fracture 4 parts. Despite being applied to 8 specialists in the upper limb, this supports previous studies on the difficulty of achieving good reliability and reproducibility of classifications.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of the manuscript. GAS: writing, review, intellectual concept of the article, preparation of the entire study project Research. ARS: writing, review, intellectual concept of the article. GFGG: article review. WCSJ: writing, review, intellectual concept of the article. GALS: data collection, article review. LD: writing, review, intellectual concept of the article.

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ORIGINAL ARTICLE

EVALUATION OF PREDICTIVE FACTORS OF IN HOSPITAL MORTALITY IN PATIENTS WITH PROXIMAL FEMORAL FRACTURE

AVALIAÇÃO DE FATORES PREDITIVOS DA MORTALIDADE INTRA-HOSPITALAR EM PACIENTES COM FRATURA PROXIMAL DO FÊMUR

José Guilherme Lollo Correa[1], Fernando Brandão Andrade-Silva[2], Sileno Fortes Filho[3], Kodi Edson Kojima[2], Jorge dos Santos Silva[2], Luiz Eugênio Garcez Leme[3]

1. Universidade de São Paulo, Medical School, Institute of Orthopedics and Traumatology, São Paulo, SP, Brazil.
2. Universidade de São Paulo, Medical School, Institute of Orthopedics and Traumatology, Trauma Group, São Paulo, SP, Brazil.
3. Universidade de São Paulo, Medical School, Institute of Orthopedics and Traumatology, Geriatrics Group, São Paulo, SP, Brazil.

ABSTRACT

Objective: To investigate the existence of a causal association between orthopedic treatment and the occurrence of in hospital death. Methods: 338 patients with proximal femoral fracture were evaluated, of whom 27 faced in hospital death. Patients who faced in hospital death (case group) were compared to patients who did not (control group) regarding exposure to risk factors prior to injury and factors related to orthopedic treatment. Results: The factors related to higher in hospital mortality rate were: male sex (case group: 52%, control: 26%; p = 0.005), lower Parker's score (case group: 5.0 points, control: 6.2; p = 0.048), delirium on admission (case group: 26%, control: 10%; p = 0.011); delirium developed during hospitalization (case group: 77%, control: 35%; p <0.001), and time until surgery (13.3 days, 9.1; p = 0.049). Conclusion: The in hospital mortality rate of patients with proximal femoral fracture was 8%, and the main associated risk factors were male sex, reduced Parker's score, delirium diagnosed on hospital admission or developed during hospitalization, and time until surgery. ***Level of Evidence III, Case control study.***

Keywords: Fractures, Bone. Femur. Mortality. Delirium.

RESUMO

Objetivo: Pesquisar a existência de associação causal entre fatores do tratamento ortopédico e a ocorrência de morte intra-hospitalar. Métodos: Foram avaliados 338 pacientes com fratura proximal do fêmur, dos quais 27 apresentaram óbito intra-hospitalar. Compararam-se pacientes que apresentaram óbito intra-hospitalar (grupo caso) com pacientes que não apresentaram óbito hospitalar (grupo controle) quanto à exposição a fatores de risco prévios à lesão e fatores relacionados ao tratamento ortopédico. Resultados: Os fatores relacionados a uma maior taxa de mortalidade intra-hospitalar foram: gênero masculino (grupo caso: 52%; controle: 26%; p = 0,005), menor escore de Parker (grupo caso: 5,0 pontos; controle: 6,2 pontos; p = 0,048), delirium na admissão (grupo caso: 26%; controle: 10%; p = 0,011); delirium desenvolvido durante a internação (grupo caso: 77%; controle: 35%; p < 0,001), e tempo até a cirurgia (13,3 dias vs. 9,1 dias; p = 0,049). Conclusão: No presente estudo, a taxa de mortalidade intra-hospitalar em pacientes com fratura proximal do fêmur foi de 8%, e os principais fatores de risco associados a esse desfecho foram o gênero masculino, escore de Parker reduzido, delirium diagnosticado na admissão hospitalar ou desenvolvido durante a internação, e tempo até a cirurgia. ***Nível de Evidência III, Estudo caso controle.***

Descritores: *Fraturas Ósseas. Fêmur. Mortalidade. Delirium.*

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INTRODUCTION

The frequency of fractures of the proximal extremity of the femur increased significantly in recent decades. This is believed to be directly related to the increase in the older population in our society, given that this disease occurs mainly in older patients and with progressive incidence as age advances.[1]

In Brazil, in 2015, 47,000 femoral fractures were recorded among older adults.[2] We believe this number is even higher, given the low notification of diseases by public and private health services.

This fracture is strongly related to mortality and functional loss since the main affected population are patients with multiple comorbidities and high risk of postoperative complications. A recent data assessment with 91,401 patients with femur fracture in the United States identified hospital mortality rates of 1.8%, 11% for rehospitalization within 30 days, and 10.4% for early sequelae

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

Study was conducted at the Universidade de São Paulo, Medical School, Institute of Orthopedics and Traumatology, São Paulo, SP, Brazil.
Correspondence: Jose Guilherme Lollo Correa. Rua Dr. Ovídio Pires de Campos, 333, São Paulo, SP, Brazil, 05403010. guilhermelollo@gmail.com

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(venous thromboembolism, pressure ulcers, and pneumonia within 30 days).[3] The risk of death remains even after hospital discharge; however, mortality rates varied greatly in the literature consulted. A study conducted in Brazilian hospital in 2007 observed mortality of up to 36% 24 months after fracture, and 60% 48 months after the occurrence.[4] Another study conducted in Rio de Janeiro in 2009 identified 28.7% as the mortality rate in the first year after hip fracture in patients.[5]

Although the causes for the high mortality of older patients with fracture on the proximal extremity of the femur have been well-documented in developed countries, little is known about this subject in developing countries. There is no consensus among the scientific literature when studying the existence of an association between waiting time for surgical treatment and mortality of these patients. The risk of in hospital death after proximal femoral fracture has been associated with the patient's prior clinical condition and cardiovascular risk factors. However, the in hospital mortality rate changes in the literature and risk factors are inconsistent between different studies.[6] The descriptive analysis of patients who suffer in hospital death and the identification of risk factors for this event may help in decision making for the treatment of this fracture and in the adoption of preventive measures.

The primary objective of this study is to investigate the existence of a causal association between factors of orthopedic treatment, including waiting time for surgery, type of surgery and time of surgery, and the occurrence of in hospital death. Our secondary objectives are to study the association between in hospital mortality and demographic characteristics, characteristics of the fracture and clinical risk factors.

METHODS

Study design

This is an observational study that assessed risk factors for in hospital mortality after proximal femoral fracture in older adults. The study was approved by the Research Ethics Committee of our Institution (66729616100000068) The data in this study come from a prospective cohort study previously conducted in the same institution – the analyzed cases did not sign the informed consent form –, that evaluated the predictive factors of mobility and mortality in older adults with proximal femoral fracture for 12 months.

In total, 338 patients were included, 27 of whom died in hospital. This study compared patients who presented in hospital death (case group) to patients who did not (control group) regarding the exposure to previous risk factors to the injury, and factors related to the orthopedic treatment. The objective is to verify a possible causal association between the evaluated factors and the occurrence of in hospital death.

Casuistry

This study included all patients evaluated on the previously cited prospective cohort, which used the following selection criteria:

• Inclusion: Patients aged 60 years or older, hospitalized in our service due to proximal femoral fracture from June 2014 to January 2017; having indication of surgical treatment at the time of hospitalization.

• Exclusion: Impossibility of telephone contact for patient follow-up and measurement of outcomes, refusal to participate in the study, severe hearing deficit, and not speaking the Portuguese language.

Analyzed exposure factors

The following variables will be compared between the case and control groups to assess the risk of in hospital death, being divided into the following categories:

• Demographic data and fracture characteristics: age; sex; ethnicity; type of fracture (femur neck, transtrochanteric, subtrochanteric);

• Clinical risk factors: existence of a previous fracture; comorbidities (systemic arterial hypertension, diabetes, congestive heart failure, coronary heart disease, stroke, kidney failure, pulmonary disease, cancer, dementia, depression, smoking, and alcoholism); "10-point Cognitive Screener" scale for delirium detection; Parker's mobility score; fall history in the past year; weight loss in the last month; ASA score; cardiovascular risk; existence of delirium on admission; delirium developed during hospitalization; type of delirium (hypoactive, hyperactive, mixed).

Parker's score evaluates the mobility of patients prior to a fracture in their own home, away from home and when shopping. Each step ranges from 0 to 3 points – total score ranges from 0 to 9 points, and the higher the score, the better the mobility. Participants who cannot walk score zero; those who walk only with the help of another person score one; those who walk with the help of an instrument (cane, walker) score two; and those who walk normally, without any help score three.[7]

• Factors related to orthopedic treatment: time between admission and surgery; type of surgery; surgery time; intraoperative intercurrence.

Sample calculation and statistical analysis

No specific sample calculation was performed for this study. The sample size was defined by previously collected data in the prospective cohort.

Descriptive statistical analysis of the variables listed above was performed using absolute numbers and percentages for categorical variables, and by the mean and standard deviation for quantitative variables. The proportion of categorical variables was compared between the groups using the Chi-square test or Fisher's test, according to the number of observations in each group, to calculate the odds ratio (OR). Quantitative variables were compared between groups by Student's t-test or Mann-Whitney's test, when presenting parametric or non-parametric distribution, respectively. Possible confounding variables that could be related to both the exposure factor and outcome were analyzed through univariate regression analysis. The stratified comparison between groups was performed if confounding variables existed. All tests were two-tailed, and statistical significance was considered when $p < 0.05$. The analyses were performed with the software Stata version 13.1 (StataCorp, College Station, TX).

RESULTS

Initially, 338 individuals were selected. Of these, 8 were discarded due to presenting incomplete or missing data in the medical records. The sample for our study was thus 330 patients. They were separated into two groups: those who presented in hospital death (control), and those who did present in hospital death during hospitalization (case).

Table 1 shows the characteristics of this sample and the comparison between the patient's sex, ethnicity, presence of previous fracture, dementia, number of medications, Parker's score, time until surgery, delirium on admission, and delirium at any time during hospitalization between the case and control groups. Statistical significance was observed in the analysis of sex, Parker's score, time until surgery, delirium on admission, and delirium at any time during hospitalization.

The topography of the fracture ($p = 0.981$), ethnicity ($p = 0.797$), history of previous fracture ($p = 0.133$), dementia ($p = 0.210$), and the number of medications used by patients ($p = 0.143$) were not statistically significant factors for the increase in in hospital mortality. Sex showed a clear statistical difference regarding the outcome. Although only 28% of the patients were male, the in hospital mortality of this population was 17.5%, whereas the mortality of females was 5.8% ($p = 0.05$).

Table 1. Comparison between the case and control groups considering risk factors.

	CONTROL (n = 303)	CASE (n = 27)	Total (n = 330)	P-value
Age	80.1 (9.2)	82.6 (10.1)	80.3 (9.3)	0.184
Sex				**0.005**
Male	80 (26%)	14 (52%)	94 (28%)	
Female	223 (74%)	13 (48%)	236 (72%)	
Type of Fracture				0.981
Femur neck	129 (43%)	11 (40%)	140 (43%)	
Transtrochanteric	139 (46%)	14 (52%)	153 (46%)	
Subtrochanteric	20 (6%)	1 (4%)	21 (6%)	
Others	14 (5%)	1 (4%)	15 (5%)	
Ethnicity				0.797
White	246 (81%)	23 (85%)	269 (82%)	
Non-white	57 (19%)	4 (15%)	61 (18%)	
Previous fracture	91 (30%)	12 (44%)	103 (31%)	0.133
Dementia	58 (19%)	8 (30%)	66 (20%)	0.210
Number of medications	4.4 (3.1)	5.0 (2.2)	4.5 (3.0)	0.143
Parker's Score	6.2 (2.8)	5.0 (3.1)	6.1 (2.8)	**0.048**
Time until surgery	9.1 (17.3)	13.3 (16.6)	9.4 (17.3)	**0.049**
Delirium on admission	30 (10%)	7 (26%)	37 (11%)	**0.011**
Delirium during hospitalization	106 (35%)	20 (77%)	126 (38%)	**< 0.001**

Parker's score was also a statistically significant for the patients' death outcome (p = 0.048). The mean for Parker's score for the control group was 6.2 (2.8), and for the case group it was 5.0 (3.1) (p = 0.048). Delirium on hospital admission proved to be another factor of worse prognosis for older adults with proximal femoral fracture (p = 0.011). Among the patients in the case group (n = 27), 7 (26%) of them presented delirium on admission. On the other hand, the control group presented only 10% of delirium on admission. Delirium at any time during hospitalization – whether at admission or developed within the hospital environment – was another predictive factor for the outcome of death (p < 0.001). In the case group, 77% of the patients presented delirium at some point in their hospitalization, contrasting with only 35% of patients who presented delirium from the control group.

Finally, the waiting time until the surgical procedure was another statistically relevant factor (p = 0.049) for the outcome difference between the case and control groups. In the control group, the mean waiting time for surgical treatment was 9.1 (17.3) days, in the control group the waiting time was 13.3 (16.6) days.

DISCUSSION

In this study, we showed the existence of factors that cause a worse prognosis for the occurrence of in hospital mortality in older patients with proximal femoral fracture. According to our data, male patients, with 5 mean Parker's score, and presented delirium on admission or during hospitalization have greater risk of presenting in hospital death. The time until surgery also presented an association with in hospital death; however, this variable depends on other factors such as the existence of clinical comorbidities, and should be interpreted with caution in the analysis of the risk of in hospital death. The data from this study may assist in decision making regarding the choice of treatment and in defining the prognosis of patients with proximal femoral fracture.

Regarding the demographic analysis, patients who suffered proximal femoral fracture were females (72%). Similar results were observed in a retrospective study in the Lazio region with 8,896 patients – of which 78% were women among the older adults hospitalized with proximal femoral fracture –, and the higher rate of in hospital mortality was observed for men when compared to women.[8] Paksina et al.[9] found that men are at 41% risk of death outcome. Kannegard et al.[10] found that being male is a strong risk factor for death after proximal femoral fracture. According to the authors' opinion, such higher mortality may be related to undiagnosed or undertreated comorbidities in this group, leading to more severe and potentially fatal postoperative complications.

In this study, delirium was an important factor for the worse prognosis and mortality among patients. Dubljanin Raspopovic E. et al.[11] followed, for 30 days, the postoperative period of patients with proximal femoral fracture and observed that 6.4% died. Postoperative delirium was the only independent variable related to mortality within 30 days of the fracture in their study. Moreover, male older patients with worse cognitive status had a higher chance of developing postoperative delirium. The identification of patients at risk of developing postoperative delirium at admission and the early detection of delirium enables the development of targeted prevention and intervention strategies in older patients with hip fracture.

Although most of the literature finds similar results regarding delirium and mortality of older adults with proximal femoral fracture, Juliebø V et al.[12] contradicts such finding. Delirium presented no association when adjusted for the severity of the chronic cognitive impairment measured by the Informant Questionnaire for Cognitive Decline in the Elderly.

In 1993, Parker MJ et al.[7] presented a new score for the evaluation of mobility pre-proximal femoral fracture and a mental test score to determine what was the most important value in predicting mortality within a year. Both scores provided a highly significant prediction, but the mobility score had a higher predictive value. In the our study, Parker's score also proved to be a predictive factor for in hospital mortality of patients with proximal femoral fracture. Kristensen MT et al.[13] showed that patients with proximal femoral fracture who died in the hospital environment had a lower functional level before the fracture when compared to those who were discharged. This study thus corroborates the literature in this regard, showing the need for a good preoperative evaluation for better surgical programming and postoperative care of patients with worse status-performance before the fracture.

The 8.1% mortality during hospitalization found by our study was higher than that cited by Sakaki et al.[14] in a review article, in which the authors stress that the incidence of deaths in older adults with proximal femoral fracture is significantly higher than in the general older adult groups. In their study, the factors identified as closely

related to higher mortality were, among others, males and the presence of cognitive impairments, similar to our study. The authors also showed a correlation, although weak, between the prior walking capacity and the increase in mortality of these patients, which was also observed in our study. However, Sakaki et al.[14] observed that the time before the surgery did not interfere with mortality, contrary to data from our study and other previous studies.

The mean waiting time for surgery since admission in our study was 9.4 days, shorter than the one found by Souza et al. (14.8 days).[15] Although this association has been identified in the literature,[16,17] there is no consensus on the role of waiting time to be operated on the chance of death. In our study, the waiting time for surgery had a significant correlation with the final outcome death in the hospital environment ($p = 0.049$); however, as previously discussed, this data may not represent a direct causal factor for mortality, and may be consequence of other variables such as the presence of clinical comorbidities that contraindicate surgical treatment.

The main favorable points of this study were the broad casuistry and prospective data collection in a controlled environment (with retrospective data analysis), which ensured the good internal validity of the study. Similarly, external validity was adequate, evaluating fracture patterns and common treatment methods in orthopedic practice. Therefore, the data in this study can be generalized to the general population. As the main limitations, we can cite the limited number of patients with the outcome of interest (in hospital death), making a broader statistical analysis impossible, e.g., including the risk rates of the identified variables. Due to the heterogeneity of patients and the observational character of the study, we cannot state specific recommendations regarding the indication of surgical or non-surgical treatment based only on the data in this study.

CONCLUSIONS

Hospitalized older adults with proximal femoral fracture had an 8% in hospital mortality rate. The main risk factors for in hospital death were male sex, low previous functional capacity indicated by a reduced Parker's score, delirium diagnosed at hospital admission or developed during hospitalization, and a longer waiting time until surgery.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of the manuscript. JGLC and FBAS were the main contributors to the writing of the manuscript. SFF and LEGL analyzed the medical records and collected data. JSS evaluated the data from the statistical analysis. KEK performed the bibliographic research, reviewed the manuscript, and contributed to the intellectual design of the study.

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SYSTEMATIC REVIEW ARTICLE

THE 50 MOST CITED ARTICLES IN THE BRAZILIAN MEDICAL LITERATURE ON KNEE SURGERY

OS 50 ARTIGOS MAIS CITADOS DA LITERATURA MÉDICA BRASILEIRA SOBRE CIRURGIA DO JOELHO

Renan Vinicius Romano Martinelli[1], *Diego Costa Astur*[1], *Gustavo Kenzo Miyashita*[1], *João Victor Novaretti*[1], *Moisés Cohen*[1], *Alexandre Pedro Nicolini*[1]

1. Universidade Federal de São Paulo, Department of Orthopedics and Traumatology, São Paulo, SP, Brazil.

ABSTRACT

Objective: To provide an analysis of the 50 most cited articles on knee surgery in the Brazilian medical literature. Methods: This is a study of systematic review and meta-analysis, level of evidence 3. It was carried out through search in the SCOPUS database to identify scientific articles published in the Brazilian medical literature. Eighty-six Brazilian journals were analyzed, and articles with ten or more citations and which had the word "*joelho*" or "knee" in the title, abstract or keywords were selected. Results: All articles were published as of the year 2000 in 14 journals. The Journal Clinics presented the largest number of publications, followed by Acta Ortopédica Brasileira. The main focus of the studies was on anatomy and biomechanics, mainly from Brazilian authors. Most of the authors were Brazilian, from Brazilian and public research institutions. Conclusion: Biometric analysis has been gaining ground in recent years, but its interpretation must consider various aspects related to the paramount analytical importance.

Keywords: Knee. Systematic Review. Data base.

RESUMO

Objetivo: Fornecer uma análise dos cinquenta artigos mais citados sobre cirurgia do joelho na literatura médica brasileira. Métodos: Foi utilizada a base de dados da SCOPUS para identificar artigos científicos publicados na literatura médica brasileira de 1945 a junho de 2008 com o tema referente ao joelho. Foram analisados 86 periódicos brasileiros e selecionados os artigos com número de citações igual ou superior a dez que possuíam a palavra "joelho" ou knee no título, resumo ou palavras-chave. Foram selecionados aqueles que possuíam a articulação do joelho como foco principal do estudo, chegando ao resultado final de cinquenta artigos mais citados. Resultados: Todos os artigos foram publicados a partir do ano 2000, em quatorze revistas. A Revista Clinics apresentou maior número de publicações, seguida da Acta Ortopédica Brasileira. A maior parte foi sobre estudos sobre anatomia e biomecânica, preponderamente de autores brasileiros. Instituições de pesquisa brasileiras e públicas foram as responsáveis pela maior parte das pesquisas. Conclusão: Análise biométrica vem ganhando espaço nos últimos anos, contudo sua interpretação deve considerar variados aspectos relacionados a importância analítica.

Descritores: *Joelho. Revisão Sistemática. Bases de Dados.*

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INTRODUCTION

The knee joint is an area of wide interest in medicine, and the subject of intense debate among specialists in Orthopedics and Trauma. Since the first attempts of surgically treating osteoarthritis more than a century and a half ago, the interest in knee surgery has arisen enormously, particularly with milestones in the treatment of degenerative diseases and the introduction of arthroscopic and joint preservation surgery,[1] making this articulation the focus of many human body scientific studies.

Society's growing demand and requirement for results that keep getting closer to perfection, coupled with technological innovations, have helped to drive a greater quest for knowledge. Researchers' personal ambitions also contribute to the exponential increase of scientific studies in various areas of interest, especially in the medical literature, where authors combine the satisfaction of new discoveries with the increasing demand for scientific publications by universities, employers and societies.[2] Thus, countless researches have emerged in the last decades, contributing to a better understanding of knee aspects, especially in relation to anatomy, biomechanics, treatment, surgical techniques and rehabilitation, among others.[3]

In view of this growth in the academic area, the researchers needed methods to efficiently track the most impacting advances and identify the existing challenges. Bibliometric science can accomplish this goal,[4,5] since it can provide qualitative and quantitative publications analysis, as well as their characteristics, thus providing their academic impact within a field of research.[3]

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

Study was conducted at the Universidade Federal de São Paulo, Department of Orthopedics and Traumatology, São Paulo, SP, Brazil.
Correspondence: Renan Vinicius Romano Martinelli. Avenida Onze de Junho, 970, Vila Clementino, São Paulo, SP, Brazil. 04041-003. renanmartinelli08@gmail.com

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Bibliometric studies fall into the category of systematic reviews, representing an instantaneous analysis that provides a cross-sectional view of the current state of the object studied. They have a limited half-life due to being part of a continuous process in which high quality impact articles are constantly produced.[3]

A useful method for determining the impact of an article on the scientific community is by performing a citation analysis. Each article that is referenced by another scientific article is credited as a "citation."[6] This form of analysis is an important method to determine the influence of an article on scientific progress, as well as to evaluate the Impact Factor (IF) of a scientific journal.[7] The study of citation analysis can help identify articles, research topics, and authors of influence.[8] In the field of international research, several analyses were done to identify the most cited articles about different themes, such as: epilepsy,[9] encephalic brain trauma[10], orthodontics,[11] radiology,[12] surgery[13] and orthopedics[3], among others. However, we need to collect bibliometric data in the context of the Brazilian national literature.

The objective of this study is to provide an analysis of the 50 most cited articles of the Brazilian medical literature on knee surgery, allowing a more accurate comprehension of the qualities of the citation classics, as well as highlighting the main intellectual research marks in this field in Brazil.

MATERIALS AND METHODS

This is a systematic, quantitative, observational and analytical cross-sectional review study. Articles were identified by a bibliometric analysis in July 2018 using SCOPUS database search tools. We chose this index because it contains the largest number of Brazilian journals. We selected 86 journals with affiliation to Brazil with "area of interest in medicine" (Table 1 and Figure 1), obtained from official information from SCOPUS. The study population consisted of a sample of scientific articles published in the Brazilian medical literature from 1946 to June 2018, regardless of the language. Each of these journals was individually examined, and the articles analyzed according to the flowchart presented below (Figure 1). Initially, the articles were arranged in descending order of citation and the ones with ten or more citations were selected. From this selection, a new search was performed with the identification of all articles that presented the word "joelho" or "knee" in the title, abstract or keywords, excluding those that did not refer to the knee joint. They were arranged in alphabetical order (Table 2) to identify duplicates and later analyzed by two independent observers who, reading the abstract, selected the articles that presented the knee as the main focus of the study. In cases of divergence in the selection process, the analysis was submitted to a third observer. This new sample was placed in the descending order, according to the number of citations

Table 1. List of journals of the Brazilian medical literature with area of interest in "Medicine" searched in the SCOPUS database.

Journals		
Acta Cirurgica Brasileira	Jornal Brasileiro de Nefrologia	Revista Brasileira de Medicina do Trabalho
Acta Ortopedica Brasileira	Jornal Brasileiro de Patologia e Medicina Laboratorial	Revista Brasileira de Neurologia e Psiquiatria
Acta Scientiarum – Health Sciences	Jornal Brasileiro de Pneumologia	Revista Brasileira de Oftalmologia
Adolescencia e Saude	Jornal Brasileiro de Psiquiatria	Revista Brasileira de Ortopedia
Agora	Jornal Brasileiro de Reproducao Assistida	Revista Brasileira de Otorrinolaringologia
Anais Brasileiros de Dermatologia	Jornal de Pediatria	Revista Brasileira de Plantas Medicinais
Archives of endocrinology and metabolism	Jornal Vascular Brasileiro	Revista Brasileira de Psiquiatria
Arquivos Brasileiros de Cardiologia	Journal of Coloproctology	Revista Brasileira de Reumatologia
Arquivos brasileiros de cirurgia digestiva: ABCD = Brazilian archives of digestive surgery	Journal of Morphological Sciences	Revista Brasileira de Saude Materno Infantil
Arquivos Brasileiros de Oftalmologia	Journal of Physical Education (Maringa)	Revista Brasileira de Terapia Intensiva
Arquivos de Gastroenterologia	Medicina (Brazil)	Revista da Associacao Medica Brasileira
Arquivos de Neuro-Psiquiatria	Memorias do Instituto Oswaldo Cruz	Revista da Sociedade Brasileira de Medicina Tropical
Brazilian journal of Anesthesiology (Elsevier)	Motriz. Revista de Educacao Fisica	Revista de Nutricao
Brazilian Journal of Cardiovascular Surgery	O Mundo da Saude	Revista de Psiquiatria Clinica
Brazilian Journal of Infectious Diseases	Pesquisa Brasileira em Odontopediatria e Clinica Integrada	Revista de Saude Publica
Brazilian Journal of Medical and Biological Research	Pesquisa Odontologica Brasileira = Brazilian oral research	Revista do Colegio Brasileiro de Cirurgioes
Brazilian Journal of Physical Therapy	Physis (Rio de Janeiro, Brazil)	Revista do Instituto de Medicina Tropical de Sao Paulo
Cadernos de Saude Publica	Psiquiatria Biologica	Revista Gaucha de Enfermagem / EENFUFRGS
Ciencia e Saude Coletiva	Radiologia Brasileira	Revista Latinoamericana de Psicopatologia Fundamental
Clinics	Revista Ambiente e Agua	Revista Paulista de Pediatria
CoDAS	Revista Brasileira de Anestesiologia	Sao Paulo Medical Journal
Coluna/ Columna	Revista Brasileira de Cardiologia Invasiva	Saude e Sociedade
Dementia e Neuropsychologia	Revista Brasileira de Cineantropometria e Desempenho Humano	Scientia Medica
Einstein (São Paulo, Brazil)	Revista Brasileira de Enfermagem	Sleep Science
GED – Gastrenterologia Endoscopia Digestiva	Revista Brasileira de Epidemiologia	Surgical and Cosmetic Dermatology
Genetics and Molecular Research	Revista Brasileira de Ginecologia e Obstetricía	Tempo Psicanalitico
Historia, Ciencias, Saude – Manguinhos	Revista Brasileira de Hematologia e Hemoterapia	Trends in Psychiatry and Psychotherapy
International Braz J Urol	Revista Brasileira de Medicina	
International Journal of High Dilution Research	Revista Brasileira de Medicina do Esporte	

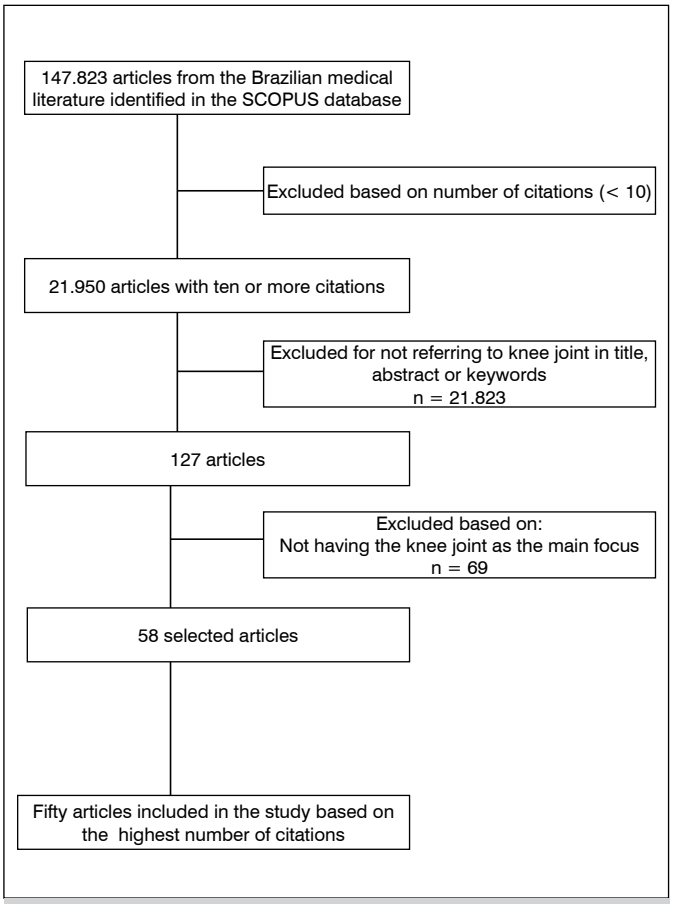

Figure 1. Flowchart.

and the first fifty were selected (Table 2). All authors of this research signed the Informed Consent Form and the work was submitted to the Ethics and Research Committee of Unifesp – Hospital São Paulo.

RESULTS

Each of these articles was analyzed individually according to the authors' most relevant information, such as academic affiliation of the main author, year of publication, main focus of the study, number of citations, and the journal of publication.

Among the 89 journals, *Clinics* was the main medium of publication, being responsible for 19 indexes from different studies, followed by *Acta Ortopédica Brasileira* with 7.

The main focus varied considerably among all the fields of research, with a higher prevalence on anatomy and biomechanics, totaling 11 articles, followed by biomolecular studies (9) and studies on prevention and rehabilitation (8).

Although we identified a total of 211 different authors, only twenty of them were published more than once. In the specific analysis about the first author, only four were published at least twice from a total of 46 different first authors, all Brazilian.

Finally, we analyzed the institutions related to the articles considering only the first author's academic affiliation. The Universidade de São Paulo (USP), with 18 articles, stood out as the most predominant, followed by the Universidade Federal de São Paulo (Unifesp), with 8 articles.

DISCUSSION

The amount of citations has become an important instrument for the assessment of an article and, besides being valuable to measure its own impact in the academic context, it also contributes to the analysis of the publication vehicle and of its authors. However, its data should not be analyzed in isolation and the social and temporal context in which it is inserted should be considered.

In this study, it is important to highlight that all the fifty most cited articles were published after the year 2000, which lets us infer that studies with higher quality and importance began to arise from then on. This was the moment of intense global technological transformations, with changes in the form of communication, driven by the spread of ever faster and more effective communication networks, such as the internet. This event contributed to the greater access to knowledge, reflecting the increase of research done in the scientific world. This pattern of publication dates found in our study resembles the findings of the international literature, except for the so-called "classic articles" that correspond to the ones that became important milestones in the medical literature on the subject studied, which have had a fundamental relevance since its production, being more present in international studies than in our country.

Although there are a large number of different authors, totaling 211, it is noted that only twenty of them (9.47%) were present in more than one occasion, which may indicate difficulties on the part of Brazilian authors in the production of works or, more likely, they have directly chosen to publish in international journals. Thus their research is not found in the national literature.

All articles were present in 14 of the 86 journals surveyed (16.27%), reflecting the greater searching tendency, with a specific focus on surgical, genetic and musculoskeletal system subjects. Although not only linked to orthopedics and traumatology, the journal Clinics was predominant in this study, which shows its high capacity of scientific production in the national territory, occupying the fourth position in the biometric analysis of citations in the CiteScore ranking. Acta Ortopédica Brasileira appears as the second most prevalent in publications, possibly because it is specifically devoted to studies with an interest in orthopedics and traumatology.

Interestingly, 34 articles (68%) are from research institutions located in the state of São Paulo, highlighting their academic importance in the national territory. USP and Unifesp, both public educational institutions, stood out as the most prevalent academic institution.

All three articles published in the journal Genetics and Molecular Research had as their main focus the study classified as "biomolecular" and, differently from the pattern found in this study, there were no Brazilian first authors, two of them were Chinese and one was Thai. Although they are all foreigners, the superficial analysis may bring misinterpretations. In recent years studies of this nature have been widely developed all over the world, due to the interest in new discoveries abounding intensively, even in Brazil, although through eventual investment restrictions that we face constantly. The absence of articles by Brazilian authors with this focus leads us to infer that such articles are probably intended for publication in the international literature, rather than their nonexistence.

Still under this perspective, it is possible to observe that all foreign works were published after 2011 and focused almost exclusively on biomolecular research. These data suggest that researchers from other countries find opportunities in Brazil for publication that they sometimes do not find around the world, either because our journals actually have academic value or because they simply did not find space in international journals, which are very demanding.

CONCLUSION

We conclude that the biometric analysis has been gaining ground in recent years, as a means of evaluating scientific studies; however, this study did not aim to analyze the quality of articles and first authors, since many relevant articles are probably published in the international literature, an issue not addressed by this study.

Table 2. List of the 50 most cited articles.

List of the most cited articles	Citations
Questionário específico para sintomas do joelho Lysholm Knee Scoring Scale – tradução e validação para a língua portuguesa	42
Changes in joint kinematics in children with cerebral palsy while walking with and without a floor reaction ankle-foot orthosis	40
Tradução e Validação Cultural do Questionário Algofuncional de Lequesne para Osteoartrite de Joelhos e Quadris para a Língua Portuguesa	40
Isokinetic assessment of the hip muscles in patients with osteoarthritis of the knee	34
Metric measurements and attachment levels of the medial patellofemoral ligament	33
Comparison of two methods of femoral tunnel preparation in single-bundle anterior cruciate ligament reconstruction. A prospective randomized study	21
Diacerhein versus glucosamine in a rat model of osteoarthritis	20
Epidemiological study on tibial plateau fractures at a level i trauma center	20
Anserine syndrome	19
Avaliação do ligamento anterolateral do joelho por meio de exame de ressonância magnética	19
Electromyographic activity evaluation of the patella muscles during squat isometric exercise in individuals with patellofemoral pain syndrome	19
Anterior cruciate ligament reconstruction with double bundle versus single bundle	18
Muscle strength and exercise intensity adaptation to resistance training in older women with knee osteoarthritis and total knee arthroplasty	18
The influence of tourniquet use and operative time on the incidence of deep vein thrombosis in total knee arthroplasty	17
Association of the IL-6 -174G/C gene polymorphism with knee osteoarthritis in a Thai population	16
Biomechanical and histological evaluation of hydrogel implants in articular cartilage	16
Efeito de exercícios terapêuticos no equilíbrio de mulheres com osteoartrite de joelho Uma revisão sistematica	16
Manual for guided home exercises for osteoarthritis of the knee	16
Study of human acellular amniotic membrane loading bone marrow mesenchymal stem cells in repair of articular cartilage defect in rabbits	16
The effects of stretching on the flexibility, muscle performance and functionality of institutionalized older women	16
Anatomical study on the anterolateral ligament of the knee	15
Isokinetic dynamometry in elderly women undergoing total knee arthroplasty	15
Positioning of the femoral tunnel for arthroscopic reconstruction of the anterior cruciate ligament	15
Qualidade de vida após artroplastia total do joelho/ revisão sistemática	15
An in vitro biomechanical comparison of anterior cruciate ligament reconstruction Single bundle versus anatomical double bundle techniques	14
Current concepts in osteoarthritis	14
Effectiveness of radiation synovectomy with samarium 153 particulate hydroxyapatite in rheumatoid arthritis patients with knee synovitis	14
Influence of patellofemoral pain syndrome on plantar pressure in the foot rollover process during gait	14
Knee extensor torque of men with early degrees of Osteoarthritis is associated with pain, stiffness and function	13
Oral administration of curcumin (Curcuma longa) can attenuate the neutrophil inflammatory response in zymosan-induced arthritis in rats	13
Avaliação muscular isocinética da articulação do joelho em atletas das seleções brasileiras infanto e juvenil de voleibol masculino	12
Comparative study on anterior cruciate ligament reconstruction Determination of isometric points with and without navigation	12
Correlation between magnetic resonance imaging and physical exam in assessment of injuries to posterolateral corner of the knee	12
Economic impact of treatment for surgical site infections in cases of total knee arthroplasty in a tertiary public hospital in Brazil	12
Efetividade da estimulação elétrica na reabilitação pós-lesões ligamentares e meniscais/ Uma revisão sistemática	12
Eficacia Analgésica do Uso de Dose Alta de Morfina Intra articular em Pacientes Submetidos a Artroplastia Total de Joelho	12
Isokinetic Evaluation of Knee Extensor and Flexor Muscles in Professional Soccer Players	12
Translation and validation of the knee society score – KSS for Brazilian Portuguese	12
Análise biomecânica das articulações do quadril e joelho durante a marcha em participantes idosos	11
Early osteoarthritis and reduced quality of life after retirement in former professional soccer players	11
Energy expenditure during cane assisted gait in patients with knee osteoarthritis	11
Implantation of platelet-rich fibrin and cartilage granules facilitates cartilage repair in the injured rabbit knee Preliminary report	11
Increased serum ADAMTS 4 in knee osteoarthritis A potential indicator for the diagnosis of osteoarthritis in early stages	11
Isokinetic torque peak and hamstrings quadriceps ratios in endurance athletes with anterior cruciate ligament laxity	11
Knee joint dysfunctions that influence gait in cerebrovascular injury	11
Knee pain and associated occupational factors	11
Measurement of tibial slope angle after medial opening wedge high tibial osteotomy/ Case series	11
Physical activity and its association with quality of life in patients with osteoarthritis	11
Protective effects of tumor necrosis factor-α blockade by adalimumab on articular cartilage and subchondral bone in a rat model of osteoarthritis	11
Treatment of infections following total knee arthroplasty 2 Year follow up outcomes	11

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