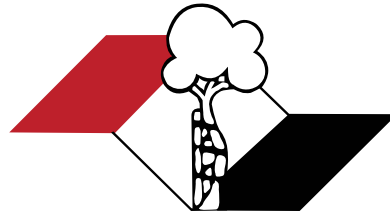


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(Reviewed April 2022)

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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.)

Level	Types of study			
	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 ^e 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 ^g	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 inconsistent results	Lesser quality prospective study (eg, patients enrolled at different points in their disease or <80% followup)		
III		Systematic review ^b of Level II studies		
	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 ^e comparative study ^g		Systematic review ^b of Level III studies	Systematic review ^b of Level III studies
IV	Systematic review ^b of Level III studies		Case-control study	
			Poor reference standard	
V	Case series ^h	Case series		Analyses with no sensitivity analyses
	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.

ORIGINAL ARTICLE**FOOT AND ANKLE**

ANALYSIS OF 45,507 SURGICAL TREATMENT OF DISTAL TIBIA AND MALLEOLAR FRACTURES OVER 14 YEARS
ANÁLISE DE 45.507 TRATAMENTOS CIRÚRGICOS DAS FRATURAS DISTAIS DA TÍBIA E DO TORNOZELO AO LONGO DE 14 ANOS
Dov Lagus Rosemberg, Nelson Wolosker, Marcelo Fiorelli Alexandrino Silva, Tania Szejnfeld Mann, Vincenzo Giordano, Alexandre Leme Godoy-Santos
DOI: <http://dx.doi.org/10.1590/1413-785220233102e263885>

HAND SURGERY

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RESULTADOS DO TRATAMENTO CIRÚRGICO DA SÍNDROME DO TÚNEL DO CARPO POR MEIO DE DUAS VARIAÇÕES DA TÉCNICA ABERTA
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DOI: <http://dx.doi.org/10.1590/1413-785220233102e260893>

KNEE

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S. AUREUS ESTÁ ASSOCIADA COM MAIOR NECESSIDADE DE REABORDAGEM NA ARTRITE SÉPTICA DO JOELHO
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DOI: <http://dx.doi.org/10.1590/1413-785220233102e260592>

KNEE SURGERY

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Fernando Gonzalez Corrêa, Luan Toshio Serikawa, Roberto Bezerra Nicolau, Luis Felipe Brandt Ferres, João Carlos Pedro Filho, Fernando Baldy dos Reis, Luiz Fernando Cocco

DOI: <http://dx.doi.org/10.1590/1413-785220233102e259371>

TRAUMA AND SHOULDER

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Felipe Machado do Amaral, Eduardo Angeli Malavolta, Fernando Brandão de Andrade e Silva, Leandro Sossai Altoé, Cassio Velloso Nunes, José Ricardo Pécora

DOI: <http://dx.doi.org/10.1590/1413-785220233102e263742>

VIRTUAL MODEL EXPERIMENTAL TEST

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Marcelo de Almeida Ferrer, Mariana de Oliveira Lobo, Laís Maria Pinto Almeida, Anderson Freitas, Silvio Leite de Macedo Neto, Leonardo Morais Paiva, Leonardo Rigobello Battaglion

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ANALYSIS OF 45,507 SURGICAL TREATMENT OF DISTAL TIBIA AND MALLEOLAR FRACTURES OVER 14 YEARS

ANÁLISE DE 45.507 TRATAMENTOS CIRÚRGICOS DAS FRATURAS DISTAIS DA TÍBIA E DO TORNOZELO AO LONGO DE 14 ANOS

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ABSTRACT

The distal leg joint fractures are among the most common fractures in humans across all age groups, and 50% of them require surgical treatment. Few studies discuss the epidemiology and costs of this fracture in the global and national literature. Objective: To evaluate the annual incidence and reimbursement value of distal leg joint fractures requiring surgical treatment from 2008 to 2021. Methods: A retrospective study was conducted to analyze the complex structured data of high volume and high variability (Big Data), publicly available on the TabNet platform (DATASUS), via software with artificial intelligence. Data from 2008 to 2021 on surgical treatment for malleolar fracture, distal tibia fracture, and isolated fibula fracture were analyzed. Results: From 2008 to 2021, there was an average incidence of 28.8 fractures/10⁵ inhabitants per year, representing 14.62% of all fractures. The total amount paid for hospitalizations due to these fractures was R\$ 34,218,014.62 over these 14 years. Conclusion: The incidence of distal leg joint fractures follows the pattern of those recorded in other countries. The adjustment of reimbursement over the years was lower than the accumulated inflation. **Level of Evidence II, Economic and Decision Analyses – Developing an Economic or Decision Model.**

Keywords: Tibial Fractures. Ankle Fractures. Fracture Dislocation. Population Characteristics.

RESUMO

As fraturas articulares distais da perna estão entre as fraturas mais comuns do ser humano ao longo de todas as faixas etárias, e 50% delas necessitam de tratamento cirúrgico. Existem poucos trabalhos discutindo a epidemiologia e os custos dessa fratura na literatura mundial e, principalmente, na nacional. Objetivo: Avaliar a incidência anual e o valor de reembolso das fraturas distais da perna com indicação para tratamento cirúrgico entre os anos de 2008 e 2021. Métodos: Estudo retrospectivo para analisar os dados complexos estruturados de alto volume e alta variabilidade (Big Data), disponibilizados publicamente na plataforma TabNet (Datassus), através de um software com inteligência artificial. Foram analisados os dados de 2008 a 2021 do tratamento cirúrgico de fratura maleolar, fratura distal da tíbia e fratura isolada da fíbula. Resultados: Entre 2008 e 2021, houve incidência média de 28,8 fraturas/105 habitantes-ano, representando 14,62% de todas as fraturas. O valor total pago pelas internações dessas fraturas foi de R\$ 34.218.014,62 ao longo desses 14 anos. Conclusão: A incidência das fraturas articulares distais da perna acompanha o padrão daqueles registrados em outros países. O reajuste do repasse ao longo dos anos foi inferior à inflação acumulada. **Nível de Evidência II, Análises Econômicas e de Decisão – Desenvolvimento de Modelo Econômico ou de Decisão.**

Descritores: Fraturas da Tíbia. Fraturas do Tornozelo. Fratura-Luxação. Características da População.

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INTRODUCTION

Distal joint fractures of the leg – ankle fractures (AO44) and distal fractures of the tibia (AO43) – are indicated for hospitalization for surgical treatment in up to 50% of cases,^{1,2} which generates significant direct and indirect costs for the paying sources.³ They are common traumatic injuries in the adult population

up to 60 years old, which also has a negative impact on the economically productive population.⁴

Moreover, epidemiological data and data related to efficiency, efficacy, values, and behavior in the production and consumption of health and health care are still scarce.

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

The study was conducted at Hospital Israelita Albert Einstein.

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Silva et al.,⁵ in 2020, studied the official records of hospitalization from 2004 to 2013 for the treatment of ankle fractures and reported the incidence of 21.39 fractures/10⁵ inhabitants-year in individuals over 50 years of age. American authors observed, in a population study involving all age groups, an incidence of 42.2 fractures/10⁵ inhabitants-year,⁶ which demonstrates a regional incidence variation for these fractures.

This study aimed to evaluate the annual incidence, length of hospital stay, and the amount paid as reimbursement of distal joint fractures of the leg with an indication for surgical treatment in the public healthcare system from 2008 to 2021.

METHODS

This is a retrospective study that analyzes the complex structured data set of high volume and high variability (Big Data), publicly available on the TabNet platform of the public health informatics system, on one of the most populous cities in the world (DATASUS),⁷ using an artificial intelligence software.

Information regarding gender, age group, length of hospital stay, number of hospitalizations, and amount paid by the public healthcare system for the treatment of joint fractures of the leg in patients over 20 years of age were processed. The codes of the table of procedures, medications, orthoses, prostheses, and materials of the SIGTAP/SUS system were used.⁸ The following codes were used:

- 04.08.05.049-7: surgical treatment of bimalleolar/trimalleolar/ankle dislocation-fracture;
- 04.08.05.054-3: surgical treatment of tibial pilon fracture;
- 04.08.05.057-8: surgical treatment of unimalleolar ankle fracture.

For a comparative analysis, information regarding length of hospital stay, number of hospitalizations, and amount paid by the public healthcare system in the treatment of all grouped body fractures, excluding face and skull, were also processed using ICD-10 classification (codes S12, S22, S32, S42, S52, S62, S72, S82, and S92) in patients over 20 years of age. Data from the last population census of the city studied and its behavior in relation to age group and gender distribution were also extracted from the TabNet platform.⁹ All information was collected from the website using a data collection program. It was encoded using Python v. 2.7.13 (Python Software Foundation, Beaverton, OR, USA), running on a Windows 10 operating system computer (Microsoft Corporation, Redmond, WA, USA). Data collection, field selection, and table ordering were done by the open source programs selenium-webdriver v. 3.1.8 (Selenium HQ, various developers worldwide) and pandas v. 2.7.13 (Lambda Foundry, Inc. and PyData Development Team, New York, NY, USA). After data collection, standard data transformation and cleaning procedures were performed in each file, including removing header and footer information, removing health facility code, and converting data columns into rows. The data was saved and stored in a spreadsheet in Microsoft Office Excel 2016[®] v. 16.0.4456.1003 (Microsoft Corporation).

The data were analyzed statistically, having relevance only when $p \leq 0.05$, using the ANOVA single factor and T-test method paired by mean.

RESULTS

From 2008 to 2021, 45,507 cases of distal joint fractures of the leg were recorded in hospitals that serve the public healthcare system in the city of São Paulo – Brazil; when corrected by the total population of adults over 20 years (11,253,503), the incidence of these fractures in the population studied during the period is 28.8 fractures/10⁵ inhabitants-year on average (Table 1).

When we analyzed the annual pattern of these fractures, we found a statistical difference among the three fracture patterns over the years ($p < 0.001$), with an increase in the incidence of these

Table 1. Occurrence and incidence of each fracture.

	Total cases ($p < 0.001$)	Incidence of fractures/10 ⁵ inhabitants-year ($p < 0.001$)
Malleolar fracture	18,921	12.01
Isolated fibula fracture	22,099	14.03
Distal tibia fracture	4,487	2.85

fractures (Figure 1A). During the same period, 311,166 hospitalized cases of fractures of the entire skeleton, excluding face and skull, were recorded, and distal joint fractures of the leg accounted for 14.62% of the total fractures (Figure 1B).

The three types of fractures have a higher total incidence in males ($p < 0.001$), with distal tibia fractures presenting the highest male:female ratio of 3.2:1 and malleolar fractures presenting the lowest ratio of 1.16:1 (Figure 1C).

After age group segmentation, we noted that the three fractures occurred most commonly in the third and fourth decade of life; however, when corrected for incidence, this pattern changes according to the fracture (Table 2).

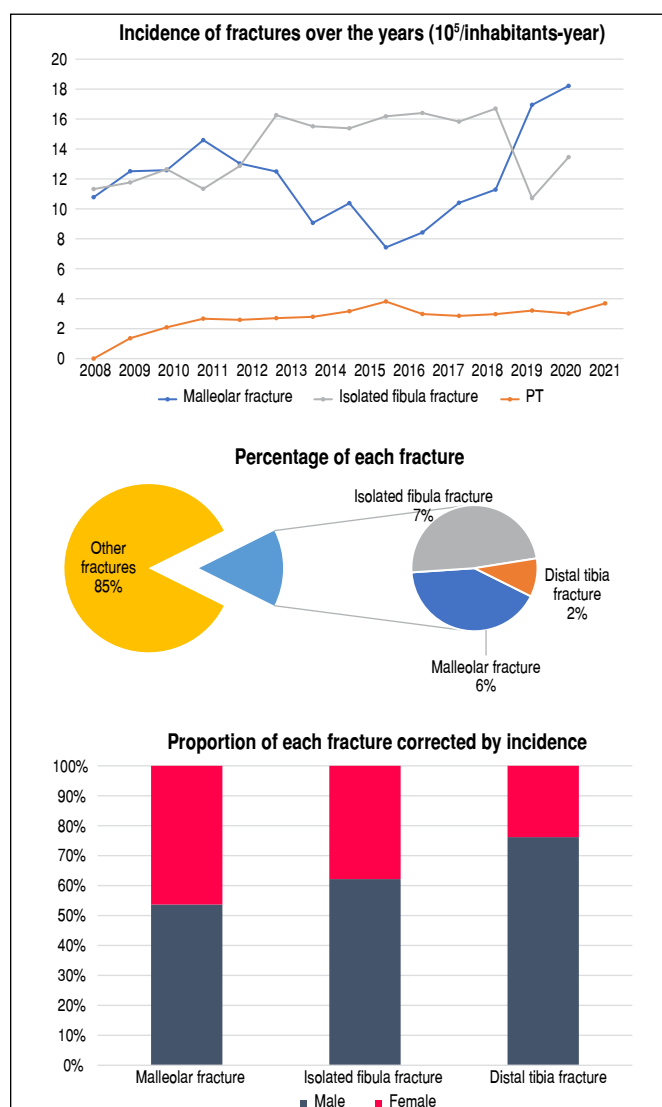


Figure 1. A) Incidence of each fracture over the studied years; B) Percentage of fractures in relation to total fractures over the years; C) Male/female ratio of each fracture incidence.

Table 2. Fractures incidence by age group.

Incidence	20-29	30-39	40-49	50-59	60-69	70-79	> 80
Malleolar fracture	15.44	16.15	17.18	19.86	20.03	13.61	7.93
Isolated fibula fracture	21.60	20.49	19.59	19.95	17.95	12.35	7.44
Ankle fracture	37.03	36.64	36.77	39.82	37.98	25.96	15.37
Distal tibia fracture	2.63	4.24	5.20	4.98	4.28	2.69	1.12

When we analyzed the patients by comparing gender by age group, we found unimodal curves with peaks in different decades of the patients' lives, with earlier peaks in man and later peaks in women. In ankle fractures, fracture prevalence showed an inversion according to the gender gender, whereas distal tibia fractures are always more prevalent in men (Figure 2).

The total amount paid to hospitals for hospitalizations of distal joint fractures of the leg was R\$ 34,218,014.62 over these 14 years. Correcting this value for the number of interactions, the average amount paid per hospitalization was R\$ 783.04, ranging from R\$ 672.68 in 2008 to R\$ 893.81 in 2021, which is equivalent to a readjustment of 32% in 14 years (Table 3, Figure 3A).

When we compare the distal ankle fractures with other lower limb fractures, this discrepancy in the amount paid increases. The average value for surgical treatment of lower limb fractures was R\$ 1,396.85, which represents 35.59% more than the amounts paid for the treatment of distal tibia fractures, 47.85% for malleolar fractures, and 48.39% for isolated fibula fractures.

The average length of hospital stay of distal joint fractures was 5.12 days, ranging from 6 days in 2008 to 4.42 days in 2021 ($p < 0.001$). When compared to the average hospital stay of the other fractures (5.25 days), distal joint fractures represent 3% less ($p < 0.001$) (Figure 3B).

When analyzing the codes used, we found that the code for distal tibia fractures presented a significantly longer hospital stay (6.78 days – 8.85 days in 2008 to 5.94 days in 2015), whereas the code for malleolar fractures presented an average hospital stay of 4.67 days (5.94 days in 2018 to 3.51 days in 2021) and the code for isolated fibula fracture presented an average of 3.92 days (4.76 days in 2008 to 3.19 days in 2021 – $p < 0.001$).



Figure 2. A) Malleolar fracture incidence per decade of life (/10⁵ inhabitants-year); B) Isolated fibula fracture incidence per decade of life (/10⁵ inhabitants-year); C) Distal tibia fracture incidence per decade of life (/10⁵ inhabitants-year).

Table 3. Cost per fracture.

Fracture	Average reimbursement per hospitalization (BRL)	Lowest Price (Year – R\$)	Highest value (Year – R\$)	Readjustment rate (%)	Reimbursement considering the average of fractures (%)
Malleolar fracture	728.45	2008 – 605.01	2019 – 868.45	43.54	35.18
Isolated fibula fracture	720.96	2008 – 646.27	2020 – 791.70	22.50	35.32
Distal tibia fracture	899.70	2008 – 766.77	2021 – 1,172.76	52.95	19.94
All fractures	1,123.77	2008 – 960.57	2021 – 1,294.44	–	34.76

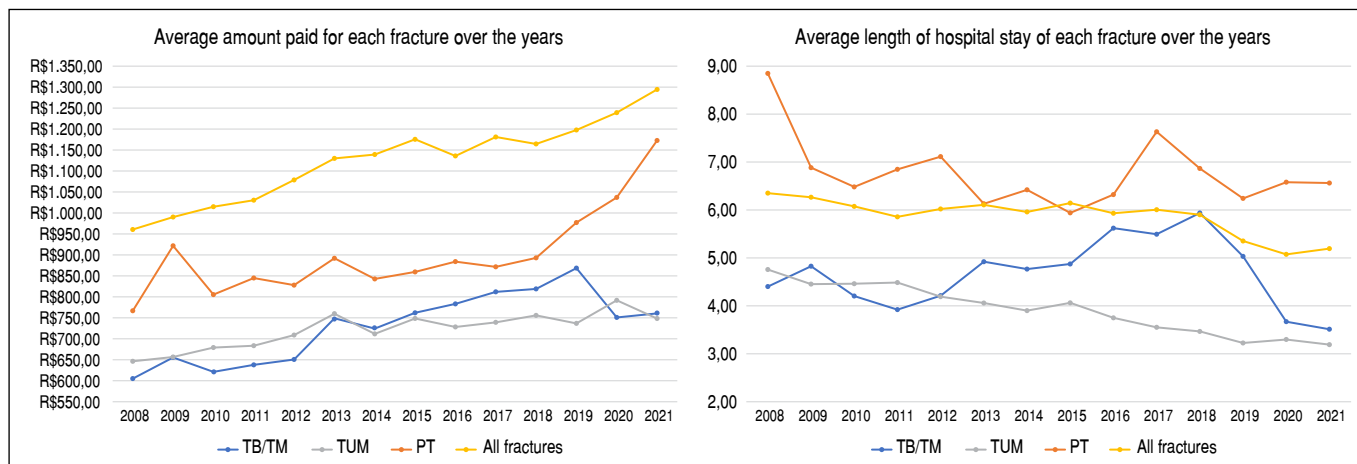


Figure 3. A) Average amount paid for each fracture over the years; B) Average length of hospital stay of each fracture over the years.

DISCUSSION

Distal joint fractures of the leg are the most frequent cause of post-traumatic hospitalization for surgical treatment in the population up to 60 years old and represent 10.3-17% of total skeletal fractures in the adult population.^{4,10,11} In this study, distal joint fractures leg represented 14% of all fractures during the study period, whereas ankle fractures represented over 12% of all body fractures.

Somersalo et al.,⁴ studied 6,788 cases of skeleton fractures hospitalized for treatment from 2002 to 2008. The reported ankle fracture incidence was 83 fractures/10⁵ inhabitants-year. The literature indicates a large variation in the incidence of this traumatic injury, ranging from 41.2 to 187 fractures/10⁵ inhabitants-year.^{1,2,4,6,10-13} Part of this variation in incidence is due to the fact that the studied populations present different ages and socioeconomic and cultural patterns, which reinforces the importance of using local data for strategic action in public health. Liu et al.¹⁴ found a difference in the number of cases in urban centers and rural areas.

In our study population, we observed an incidence of 28 fractures/10⁵ inhabitants-year for malleolar fractures. However, our study evaluated the number of hospitalized cases for surgical treatment, disregarding the cases that were exempted from hospitalization for non-surgical treatment. Beerekamp et al.² reported that only 28-35% of fractures of the distal third of the leg require hospitalization for treatment and Jensen et al.¹ estimated hospitalization for surgical treatment in about 50% of cases.^{1,2} Applying this percentage to the studied sample, the incidence of total fractures would be approximately 52-92.85 fractures/10⁵ inhabitants-year considering only malleolar fractures, which is similar to the results found in the literature. Papin and Berthonnaud¹² also surveyed surgical treatment fractures and found an incidence of 41.2 fractures/10⁵ inhabitants-year for malleolar fractures and 5.6 fractures/10⁵ inhabitants-year for distal tibia fractures.

In this study, isolated fractures of the fibula were 15% more frequent than malleolar fractures. However, studies have reported that malleolar fractures represent 57% of these cases in women.¹⁵ Our findings corroborate with other studies regarding less incidence of distal tibia fractures.^{1,15,16}

For all types of fractures in this study, men had a higher incidence, especially in the young adult age group (peak around 20-29 years), possibly due to greater involvement in sports activities and automobile accidents, whereas women recorded more hospitalizations in older groups (peak between 60-69 years). This difference in incidence between genders observed by us differs from some findings in the literature that refer to these fractures as more common in women.^{6,10,11}

Regarding the pattern of distribution throughout life, our findings corroborate most of the publications.^{1,2,4,6,10,13} Scheer et al.⁶ also observed a higher incidence of ankle fractures in young men and women over 50 years of age.

Another point to be highlighted is that the peak incidence of isolated fibular fractures in women occurs a decade earlier than ankle fractures. The bone mineral density decreases with age in women, which can increase the risk of more complex fractures with low energy traumas. A population study in patients over 65 years of age demonstrated that ankle fractures are the second most common fracture of the lower limbs, predominantly in women.⁵

Studies that evaluate the risk of bone fragility observed an incidence of up to 150 fractures/10⁵ inhabitants-year in ankle fractures related to corticosteroid use, previous history of fractures, and personal history of rheumatoid arthritis.¹⁶

We observed a greater amount paid for surgical treatment for distal tibia fractures than for malleolar fractures, which is expected for more complex fractures; however, fibula isolated fractures present a greater amount paid in the SIGTAP/SUS table for hospitalization compared to malleolar fractures (bi and trimalleolar (R\$481.49 and R\$432.14 respectively)).⁸ It is interesting to note how these reimbursements were established since they do not follow the degree of complexity of the surgical treatment of these fractures. The average reimbursement of distal leg fractures was lower compared to the other body fractures, and the difference is more significant when compared with other lower limb fractures. Other joint fractures, such as in the knee and hip, require more expensive implants and longer hospital stays, which may justify this difference in the amount paid.

Another point to be discussed is the price readjustment of the procedures. When we calculated the readjustment of the payment made to hospitals for the surgical treatment of these fractures, we found that the readjustment in the last 14 years was 52.95% in distal tibia fractures, 43.54% in malleolar fractures, and 22.50% in fibula isolated fractures, whereas the total readjustment of fractures treatment was 34.76%. When we used the central bank tool to calculate inflation in the same period, we found that it is significantly higher than the readjustment of reimbursement (193.741710% by the IGP-M and 124.045490% by the IPCA).¹⁷

Furthermore, when we compared the reimbursement in the Brazilian public healthcare system for these treatments to other countries, we observed a significant discrepancy in the amounts of US\$ 62,000.00 in the United States (private financing system) and £ 4,730.28 in the United Kingdom (public financing system).^{6,18} The value discussed in this article is the amount paid by the public health system to public hospitals, and does not represent all of the

hospital costs for patients with injuries (such as surgical materials and hospital medications), which likely leads to a growing financial deficit for hospital administrations.

In this study, an average increase in the necessary hospitalization time was observed as the trauma associated with higher energy increased, and the average hospitalization time for ankle fractures, which ranged from 3.92 to 6.78, is similar to that reported by other authors.⁵ In a national study involving the DATA-SUS database, including 56,364 cases of ankle fractures from 2004-2013,⁵ ankle fractures remained, on average, 4.94 days hospitalized. Other authors report an average of 6.6 to 10.17 days of hospitalization for individuals with ankle fractures.^{15,18} When we analyzed the mean length of hospitalization of SIGTAP for these fractures, we found that, on average, patients stay longer than the recommended three days for ankle fractures and four days for distal tibia fractures,⁸ which indicated that the reimbursement table should be adjusted.

The main limitations of this study were its retrospective nature and the inadequate completion of some data such as race, ethnicity, and educational level of the treated patients, which had to be disregarded in the data collection. We must consider that several of these hospitals are training centers for doctors, and often the documents are filled out by residents who are not properly instructed or by doctors who do not pay attention to the data. It was impossible to access information such as trauma mechanism and synthesis material used in the treatment. Despite

these limitations, this is, to the best of our knowledge, the first study in the Brazilian literature that analyzed the data available on the TabNet platform of the Unified Health System of the City of São Paulo (DATASUS) using an innovative robotization technology for information collection.⁷ This data collection strategy is faster, more efficient, and more reliable than the manual collection of each studied item, and can encourage the epidemiological study of the main diseases in the city of São Paulo, ultimately producing a high quality national literature. The estimation of the cost for the SUS with the hospital treatment of these fractures can help public administrators in budget planning and in a homogeneous reimbursement policy by municipality region and by hospitalization code.

CONCLUSION

The incidence of distal joint fractures of the leg in the studied population was 28.8 fractures/10⁵ inhabitants-year. We noted statistically significant difference between gender and type of fracture, in which men show a younger peak incidence compared to women for the three types of fractures evaluated. The mean length of hospital stay of patients in the studied period decreased from 6 days in 2008 to 4.42 days in 2021, and showed differences according to the fracture pattern. The average amount paid by the public healthcare system (R\$ 783.04) was always lower than the average of other reimbursements for fracture treatment, and the adjustment over the years was lower than the accumulated inflation.

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RESULTS OF SURGICAL TREATMENT OF CARPAL TUNNEL SYNDROME USING TWO VARIATIONS OF OPEN TECHNIQUE

RESULTADOS DO TRATAMENTO CIRÚRGICO DA SÍNDROME DO TÚNEL DO CARPO POR MEIO DE DUAS VARIAÇÕES DA TÉCNICA ABERTA

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ABSTRACT

Transverse carpal ligament (TCL) opening is the treatment of choice for carpal tunnel syndrome. However, complications such as loss of grip strength and anterior displacement of the median nerve are described as common complications associated with this technique. Thus, techniques that reconstruct or extend TCL are described to reduce the incidence of these complications. Objective: To evaluate the effectiveness of TCL enlargement through Z-plasty and the reduction of complications by comparing it with the complete opening of the ligament. Materials and Methods: A prospective and randomized intervention study was conducted in 56 patients. They were divided into 2 groups: 1) complete opening of TCL 2) TCL enlargement via Z-plasty. We evaluated grip strength, sensitivity, and functional evaluation using the QuickDASH questionnaire. Results: There was no statistically significant difference in the improvement of scores with QuickDASH between the two techniques. The sensitivity test was better in patients subjected to TCL enlargement, whereas grip strength increased in the group subjected to complete TCL opening. Conclusion: According to the results of this study, the complete opening of the TCL showed no reduction in grip strength, although it showed inferior recovery to postoperative sensitivity. Both techniques were equivalent in functional improvement. Thus, Z-plasty showed no identifiable benefits for TCL enlargement. **Level of Evidence III, Randomized Clinical Trial.**

Keywords: Carpal Tunnel Syndrome. Median Nerve. Median Neuropathy.

RESUMO

A abertura completa do ligamento transverso do carpo (LTC) é o tratamento de escolha para a síndrome do túnel do carpo. No entanto, complicações como perda de força de preensão e deslocamento anterior do nervo mediano são complicações comuns associadas a essa técnica. Assim, descrevem-se técnicas que reconstruem ou alargam o LTC visando reduzir a incidência dessas complicações. Objetivo: Avaliar a efetividade do alargamento do LTC através de Z-plastia e a diminuição das complicações, comparando a técnica com a abertura completa do ligamento. Métodos: Realizou-se um estudo de intervenção, prospectivo e randomizado com 56 pacientes. Estes foram divididos em dois grupos: 1) abertura completa do LTC e 2) alargamento do LTC através de Z-plastia. Avaliamos força de preensão e sensibilidade e realizamos avaliação funcional por meio do questionário Quick Disabilities of Arm, Shoulder and Hand (QuickDASH). Resultados: Não houve diferença estatisticamente significativa na melhora dos escores entre as duas técnicas. O teste de sensibilidade teve melhores resultados nos pacientes submetidos ao alargamento do LTC, enquanto a força de preensão teve maior acréscimo no grupo submetido à abertura completa do LTC. Conclusão: A abertura completa do LTC não levou à redução da força de preensão, apesar de ter se mostrado inferior na recuperação da sensibilidade no pós-operatório. As duas técnicas foram equivalentes na melhora funcional. Dessa forma, não encontramos benefícios identificáveis na realização da Z-plastia para alargamento do LTC. **Nível de Evidência III, Ensaio Clínico Randomizado.**

Descritores: Síndrome do Túnel do Carpo. Nervo Mediano. Neuropatia Mediana.

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INTRODUCTION

Carpal tunnel syndrome is the most common compressive neuropathy of the upper limbs, affecting 4% to 5% of the general population.^{1,2}

Women are more affected than men, it is more prevalent in the 40 to 60 years age range, and is usually bilateral.³ Risk factors for

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

The study was conducted at Santa Casa de Misericórdia de Sao Paulo, Faculdade de Ciências Médicas, Departamento de Ortopedia e Traumatologia. Correspondence: Ana Carolina da Silva Lovato. Rua Peixoto Gomide, 596, apt 162a, Sao Paulo, SP, Brazil, 01409000. carol-ac@live.com

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the disease include obesity, repetitive wrist movements, pregnancy, family history, and rheumatoid arthritis.⁴

Conservative methods can be used for treatment and the most common is the use of orthotic devices and local injection of corticosteroids.^{5,6} More recently, exercises involving nerve excursion showed a reduction in the number of surgical interventions.⁷ Nerve excursion can be an option to speed up functional recovery.⁸ Other methods such as platelet-rich plasma injections⁹ and shock-wave therapy¹⁰ are being studied as options to treat this disease, but still lack data to prove their effectiveness.

The literature lacks consensus on the best time for surgical indication, but studies show that surgery is generally more effective than conservative treatment in terms of recurrence rate, improvement of symptoms, and hand function.¹¹ However, the best time for surgical treatment should be discussed with the patient as their symptoms are not always directly related to the findings of physical examination and electroneuromyography.¹²

Conservative treatment generates positive responses in 80% of patients. Relapse rates of symptoms after conservative treatment range from 8% to 80%.¹²⁻¹⁴ Surgical treatment can be performed by an open approach or endoscopically. Similar results and complication rates are observed in both techniques.^{15,16}

Regarding surgical treatment, the complete opening of the transverse carpal ligament (TCL) remains a treatment of choice in refractory cases. As common complications associated with this technique, we can mention the reduction of grip strength and pain on the thenar and hypothenar eminence, also called "pillar pain."¹⁷ Discomfort at the site of the scar is also a common complication, with incidence rates ranging from 19% to 61%.¹³

The reduction in grip strength is attributed by several authors to the loss of the pulley effect of the TCL on the flexor tendons.¹⁵ To avoid such a complication, several techniques of TCL reconstruction were postulated after its complete section,¹⁶ as well as techniques that only widen the ligament without completely sectioning it.¹⁷ Another complication described is the subluxation of the median nerve, observed intraoperatively, in 60% of the patients reoperated for recurrence of carpal tunnel syndrome.² To avoid these effects and maintain tendons and nerves within the TCL, some authors use Z-plasty for TCL enlargement and reconstruction.^{6,8}

This study aims to compare the results of grip strength, symptom improvement, and postoperative sensitivity of the technique of TCL widening by Z-plasty with the complete opening for the treatment of patients with carpal tunnel syndrome.

METHODS

Population studied

In total, 56 patients were evaluated, 20 men and 36 women, with clinical criteria for the disease in a prospective randomized intervention study. The Tinel's sign and the Durkan and Phalen tests were evaluated, as well as thenar atrophy, grip strength, and complaints of paresthesia in the median nerve. The electroneuromyography study was not used in the diagnostic criteria. Studies show that this method has limitations, including the inability to predict what patients will benefit most from surgery or conservative treatment.⁷

Patients with complaints of paresthesia and pain in the ulnar nerve path and patients with advanced thenar atrophy and loss of opposability were excluded; patients with signs of high compression of the median, associated diseases such as rheumatoid arthritis and other connective tissue diseases, malignancies, renal diseases, distal radius fractures, congenital neuropathies, spinal diseases, diabetes mellitus, fibromyalgia, pregnant women, or thyroid diseases were also excluded. Patients previously

operated on for median nerve decompression (reoperation) were also excluded.

This study was approved by the Research Ethics Committee of the School of Medical Sciences of Santa Casa de São Paulo under opinion No. 4985725.

Evaluation criteria

Patients who met the inclusion criteria of the study completed the informed consent form after the appropriate explanations. All data evaluated regarded the side to be operated on.

The patients completed the Quick Disabilities of the Arm, Shoulder and Hand Outcome Measure (QuickDASH) questionnaire, composed of eleven items that address symptoms and skills of daily living in people with any or several disorders involving the upper limb, with the advantage of providing the same quality of information with fewer items for the patient to complete, facilitating scoring for the clinician or researcher. Like the regular DASH, it provides a scale with scores of 0-100 points, with 100 indicating the highest deficiency. QuickDASH is comparable to regular DASH, and its construct validity and sensitivity suggest that QuickDASH scores should observe disabilities and symptoms that are relatively similar to those predicted by the full version.²

The patients were also subjected to the sensitivity test of the median nerve by the Semmes-Weinstein monofilaments. Six monofilaments (pocket model – "Sensikit") of nylons number 612, 38 mm in length, and different diameters that exert a specific force in the tested area corresponding to weight variation from 0.05 to 300 g was used. For filling out the disability degree form, the parameters used were those by the MS to record the degree of disability, in which the perception of monofilaments of 0.05 g (green), 0.2 g (blue), and 2.0 g (violet) indicate degree 0 of disability; whereas the non-perception of the monofilament of 2.0 g (violet) and the perception or not of the other monofilaments (4.0 g, 10.0 g, and 300.0 g) indicate grade I disability.

The grip strength was evaluated according to the recommendation of the American Society of Hand Therapists (ASHT), by using the Jamar dynamometer[®], in the second position (of five), referring to the size of the handle. The patients remained seated in an office chair (without arms) with their spine erect, keeping the knee flexion angle at 90°, the shoulder positioned in adduction and neutral rotation, the elbow flexed at 90°, with their forearms in half pronation and neutral wrist, which could be moved up to 30° of extension. Their arm was kept suspended in the air with their hand positioned on the dynamometer, which was supported by the evaluator. Grip strength measured by the dynamometer does not reflect all the situations encountered in the gestures of everyday life or at work. Therefore, this parameter was not used isolated in the evaluation of the results.

Follow-up

Patients were evaluated in the immediate preoperative period and with 30, 60, and 180 postoperative days. All patients were evaluated by the same examiner on all dates and criteria. Patients who could not be reevaluated at any of these intervals were excluded.

Surgical method

The patients were randomly divided into two groups: those subjected to the "open" method and another group to the "zetaplasty" method. The procedure was performed in a surgical environment, always by the same surgeon, and the type of anesthesia was determined by the anesthesiologist. The same classical volar access route to the TCL was performed in all patients, being an incision of approximately 3 cm, slightly ulnar to the thenar flexion fold. The TCL was cross-sectioned in the "open" group, and by zetaplasty in the group of the same name.

The complete release of the TCL was verified, being left open in patients of the open group. In the “zetaplasty” group, the TCL was sutured so as not to cause tension or new nerve compression, together with the tips of the “Z” formed by the incision, as Figure 1 exemplifies. All patients underwent early mobilization and occupational therapy in the postoperative period. Plastered immobilization or orthotic devices were not used in any case in the postoperative period since their use showed no beneficial effect when compared to simple compressive dressing. Moreover, this practice increases the total surgical time and can thus be safely abandoned.⁵

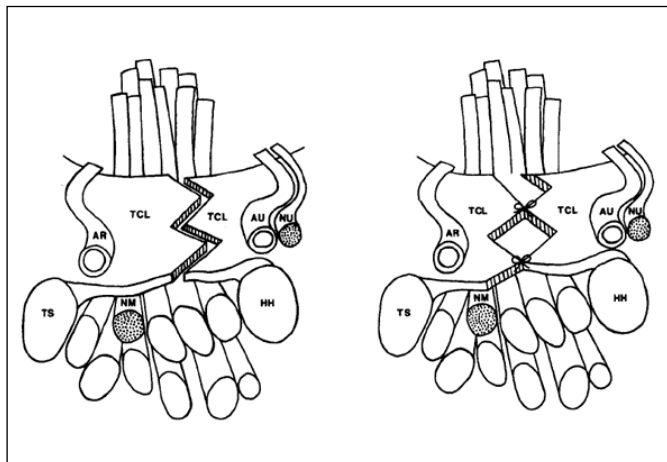


Figure 1. TCL incision in patients in the group subjected to TCL enlargement and reconstruction by Z-plasty.

Source: Karlsson et al.¹²
 TCL: transverse carpal ligament; TS: scaphoid tuberosity; HH: hamate hamulus; RA: radial artery, UA: ulnar artery; UN: ulnar nerve; MN: median nerve.

RESULTS

The statistical analysis used the Student’s *t*-test. The quantitative variables are described by their mean and 95% confidence interval for those considered normal. The two-sample *t*-test was used to compare whether the proportion of responses of two certain variables and/or their levels is statistically significant.

Our objective was to compare the results between the two types of surgery. We started with the mean of DASH and Jam in each of the four periods. We used the Student’s *t*-test.

- MF: Semmes-Weinstein monofilament test
- JAM: Jamar dynamometer®

Table 1 and Figure 2 show a comparison between the two surgical techniques and their outcome using the QuickDASH questionnaire as a parameter. Table 2 and Figure 3 use the grip strength measured by Jamar® to compare the two techniques.

Table 1. Comparison between the types of surgery in relation to functional recovery evaluated by the Quick Disabilities of Arm, Shoulder and Hand by follow-up time.

DASH		Mean	Median	Standard Deviation	VC	Min	Max	N	CI	p-value
T0	Open	38.9	35	19.9	51%	10	80	28	7.4	0.483
	Zeta	42.4	45	16.4	39%	15	80	27	6.2	
T30	Open	32.8	30.5	21.7	66%	7	75	28	8.0	0.592
	Zeta	35.8	35	20.4	57%	5	70	27	7.7	
T90	Open	26.0	20.5	19.7	76%	2	74	28	7.3	0.662
	Zeta	28.5	20	22.1	77%	4	73	27	8.3	
T180	Open	18.0	13.5	16.6	92%	0	58	28	6.1	0.193
	Zeta	24.9	17	21.5	87%	1	77	27	8.1	

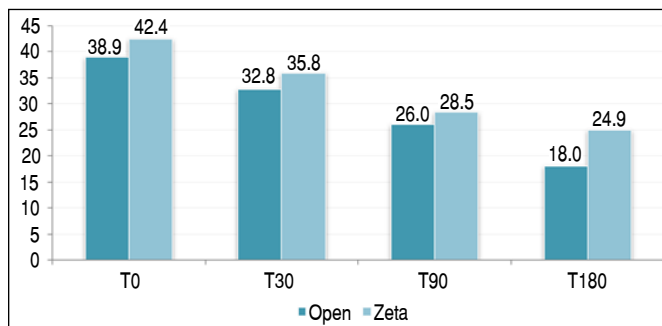


Figure 2. Comparison between the types of surgery in relation to functional recovery evaluated by the Quick Disabilities of Arm, Shoulder and Hand by follow-up time.

Table 2. Comparison between the types of surgery in relation to the grip strength measured by the Jamar dynamometer by follow-up time.

Jam	Mean	Median	Standard Deviation	VC	Min	Max	N	CI	p-value	
T0	Open	27.0	26	9.0	33%	12	44	28	3.3	0.002
	Zeta	20.5	18	4.9	24%	12	30	27	1.8	
T30	Open	24.2	22	9.3	38%	8	40	28	3.4	0.003
	Zeta	18.1	18	4.8	27%	12	30	27	1.8	
T90	Open	26.5	27	8.9	33%	10	40	28	3.3	<0.001
	Zeta	19.3	18	4.5	23%	10	28	27	1.7	
T180	Open	27.3	27	8.9	33%	10	40	28	3.3	0.004

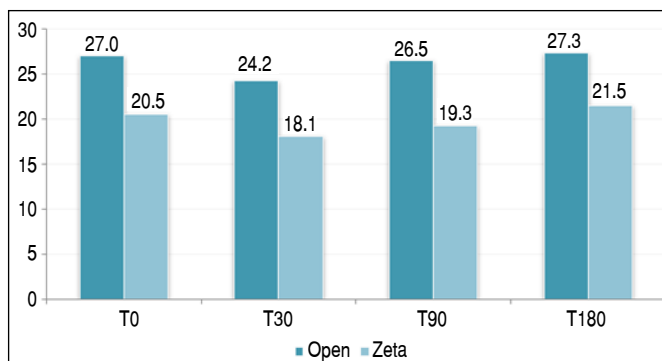


Figure 3. Comparison between the types of surgery in relation to the grip strength measured by the Jamar dynamometer by follow-up time.

When QuickDASH was evaluated as an isolated parameter, the types of surgeries, in all four follow-up moments, showed no statistically significant mean difference. Grip strength showed a mean difference between the types of surgery at all times of the follow-up. The mean was always higher in the group subjected to complete opening of the TCL compared with the Z-plasty group. The largest difference occurred in the T90, in which the mean of open surgery was 26.5 versus 19.3 of the Z-plasty group ($p < 0.001$).

In Table 3 and Figure 4, we compared the surgeries for the distribution of the relative frequency of the results of the sensitivity test using the monofilaments, in which we used the two-sample *t*-test. We found that there is only a statistically significant difference between the types of surgery in the distribution of the violet result in T180, in which in the open surgery group the index was 25.0% and in the Z-plasty was 51.9% ($p = 0.040$).

The gain/delta was also performed between the moments for QuickDASH and grip strength, whose results are shown in Table 4 and Figure 5 and Table 5 and Figure 6, respectively. This gain is

simply the simple mathematical difference between the times, in which a positive value indicates an increase in the value between the times involved and a negative value indicates a reduction. We reused the Student's *t*-test to compare the types of surgery as to the mean of the QuickDASH deltas and grip strength.

In the gain/delta analysis, we found only a mean difference between the types of surgery when we used QuickDASH in the T90-180 delta, with reduced values in both surgeries. For open surgery, the mean was -8.00 versus -3.67 in the Z-plasty group ($p = 0.030$).

Table 3. Comparison between the types of surgery in relation to the grip strength measured by the Jamar dynamometer by follow-up time.

MF	N	Open		Zeta		p-value
		%	N	%	N	
T0	Violet	22	78.6	19	70.4	0.485
	Blue	5	17.9	7	25.9	0.469
	Green	1	3.6	1	3.7	0.979
T30	Violet	20	71.4	17	63	0.504
	Blue	5	17.9	8	29.6	0.304
	Green	3	10.7	2	7.4	0.670
T90	Violet	20	71.4	17	63	0.504
	Blue	5	17.9	8	29.6	0.304
	Green	3	10.7	2	7.4	0.670
T180	Violet	7	25.0	14	51.9	0.040
	Blue	15	53.6	10	37.0	0.218
	Green	16	21.4	3	11.1	0.301

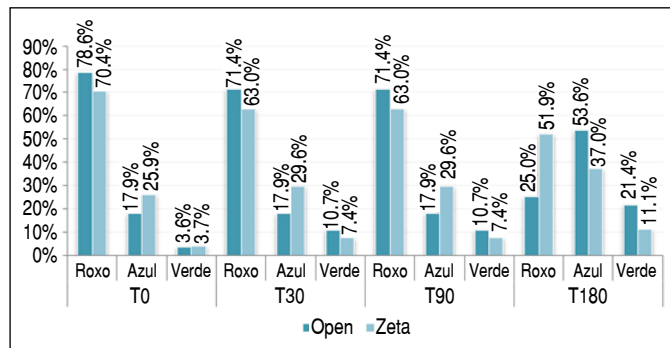


Figure 4. Comparison between the types of surgery in relation to the grip strength measured by the Jamar dynamometer by follow-up time.

Table 4. Comparison between the types of surgery for delta values of the Disabilities of Arm, Shoulder and Hand, in which: a positive value indicates functional improvement and a negative value indicates functional decrease.

DASH delta		Mean	Median	Standard Deviation	VC	Min	Max	N	CI	p-value
T0-30	Open	-6.18	-2.5	11.95	193%	-38	15	28	4.43	0.900
	Zeta	-6.59	-5	12.42	188%	-27	15	27	4.68	
T0-90	Open	-12.89	-13.5	14.02	109%	-43	17	28	5.19	0.808
	Zeta	-13.89	-15	16.21	117%	-48	18	27	6.12	
T0-180	Open	-20.89	-17	15.76	75%	-55	20	28	5.84	0.439
	Zeta	-17.56	-15	15.96	91%	-48	22	27	6.02	
T30-90	Open	-6.71	-5	8.33	124%	-29	5	28	3.08	0.810
	Zeta	-7.30	-5	9.47	130%	-31	6	27	3.57	
T30-180	Open	-14.71	-11.5	11.66	79%	-40	5	28	4.32	0.233
	Zeta	-10.96	-11	11.42	104%	-33	8	27	4.31	
T90-180	Open	-8.00	-6.5	8.07	101%	-30	3	28	2.99	0.030
	Zeta	-3.67	-3	6.16	168%	-21	5	27	2.32	

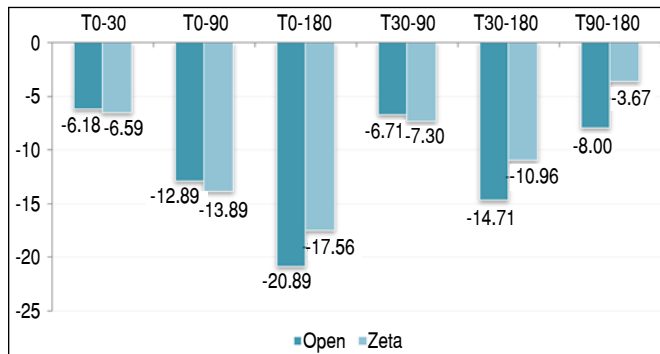


Figure 5. Comparison between the types of surgery for delta values of the Disabilities of Arm, Shoulder and Hand, in which: a positive value indicates functional improvement and a negative value indicates functional decrease.

Table 5. Comparison between the types of surgery for delta grip strength measured by the Jamar dynamometer, in which: a positive value indicates improvement in grip strength and a negative value indicates a decrease in it.

Jam delta		Mean	Median	Standard Deviation	VC	Min	Max	N	CI	p-value
T0-30	Open	-2.79	-2	3.78	136%	-12	4	28	1.40	0.722
	Zeta	-2	-2	3.25	133%	-8	2	27	1.23	
T0-90	Open	-0.50	0	3.95	790%	-8	8	28	1.46	0.509
	Zeta	-1.19	0	3.69	311%	-10	4	27	1.39	
T0-180	Open	0.29	0	4.54	1591%	-10	10	28	1.68	0.531
	Zeta	0.96	2	3.30	343%	-6	8	27	1.24	
T30-90	Open	2.29	2	3.21	140%	-2	8	28	1.19	0.229
	Zeta	1.26	0	3.05	242%	-2	8	27	1.15	
T30-180	Open	3.07	2	4.27	139%	-6	14	28	1.58	0.745
	Zeta	3.41	4	3.27	96%	-2	12	27	1.23	
T90-180	Open	0.79	0	2.39	305%	-4	6	28	0.89	0.051
	Zeta	2.15	2	2.66	124%	-2	8	27	1.00	

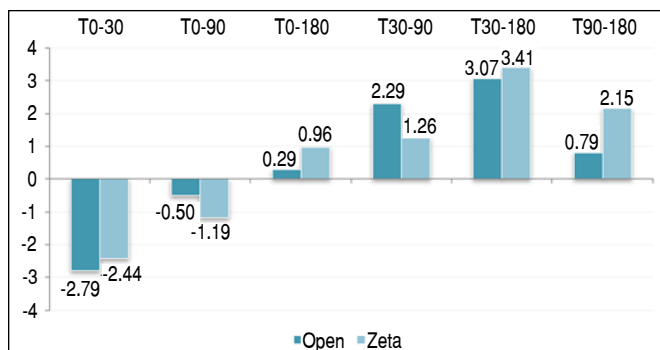


Figure 6. Comparison between the types of surgery for delta grip strength measured by the Jamar dynamometer, in which: a positive value indicates improvement in grip strength and a negative value indicates a decrease in it.

Finally, Table 6 and Figure 7 show a comparison between the types of surgery for the Delta in the sensitivity parameter. The two-sample *t*-test equality test was used.

We noticed a statistical significance in the T0-180, T30-180, and T90-180 delta values. Exemplifying the result in the delta from T0-180, we have statistical significance for results that held, in which we had 35.7% in the open surgery group and 66.7% in the Z-plasty group ($p = 0.022$). We also found significance for the change to the Improved 1 category, in which in the open surgery group the index was 46.4% compared with 18.5% of Z-plasty ($p = 0.027$).

Table 6. Comparison between the types of surgery for delta recovery of sensitivity measured by monofilaments, in which: a positive value indicates improvement in sensitivity and a negative value indicates its decrease.

MF delta		Open		Zeta		p-value
		N	%	N	%	
T0-30	Maintained	26	92.9	25	92.6	0.970
	Improved 1	0	0.0	1	3.7	0.304
	Improved 2	2	7.1	1	3.7	0.574
T0-90	Maintained	26	92.9	25	92.6	0.970
	Improved 1	0	0.0	1	3.7	0.304
	Improved 2	2	7.1	1	3.7	0.574
T0-180	Worsened 1	1	3.6	2	7.4	0.531
	Maintained	10	35.7	18	66.7	0.022
	Improved 1	13	46.4	5	18.5	0.027
	Improved 2	4	14.3	2	7.4	0.413
T30-90	Maintained	28	100	27	100	- x -
T30-180	Worsened 1	1	3.6	2	7.4	0.531
	Maintained	12	42.9	20	74.1	0.019
	Improved 1	13	46.4	4	14.8	0.011
	Improved 2	2	7.1	1	3.7	0.574
T90-180	Worsened 1	1	3.6	2	7.4	0.531
	Maintained	12	42.9	20	74.1	0.019
	Improved 1	13	46.4	4	14.8	0.011
	Improved 2	2	7.1	1	3.7	0.574

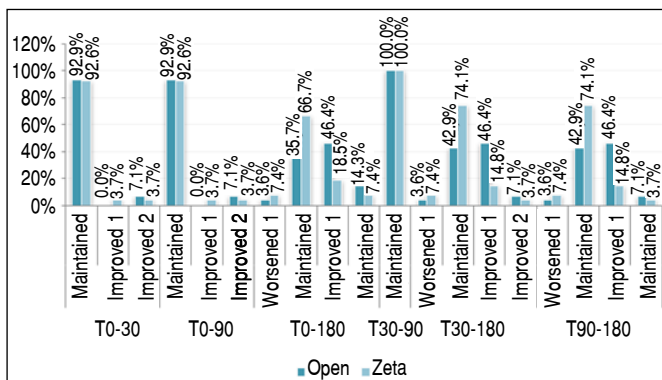


Figure 7. Comparison between the types of surgery for delta recovery of sensitivity measured by monofilaments, in which: a positive value indicates improvement in sensitivity and a negative value indicates its decrease.

DISCUSSION

We analyzed the postoperative results of TCL enlargement by Z-plasty compared with the complete opening of the TCL.

TCL is a strong anatomical structure, whose main function is to serve as a pulley to keep the flexor tendons close to the center of rotation of the wrist.⁹ If these tendons move anteriorly during wrist flexion, this reduces their contraction force. After the division of TLC, many surgeons observe an anterior displacement of the flexor tendons and median nerve. In this study, the authors concluded that the complete division of TLC leads to reduced grip strength and prolonged palmar pain in the scar region.

According to the results of this study, the increase in grip strength was higher in patients in the group that TCL was completely opened, contrary to Lluch's findings.¹⁰

In a study with 52 patients and more than 25 weeks of follow-up, Dias et al.¹¹ found no advantage over the technique of widening the TCL in Z-plasty over the complete opening. Recovery of neurological

symptoms, functional results, and postoperative pain were evaluated. Similar results were obtained by Karlsson et al.,¹² in which 99 patients were evaluated in a retrospective study comparing the two techniques. Patients subjected to enlargement in Z-plasty of the TCL presented longer time away from work. According to the authors, the probable explanations were the longer immobilization time in the postoperative period of patients in the Z-plasty group as well as a more extensive exploration of the volar tissues, leading to a longer period of local inflammation. Thus, there is no advantage in rebuilding the TCL.

Dias et al.,¹¹ in a randomized double-blind study, compared the two techniques in 52 hands in a follow-up of 25 weeks. Function questionnaires were used to evaluate the severity of the disease. Their study showed no identifiable benefits in performing TCL enlargement for carpal tunnel decompression.

Castro-Menéndez et al.,¹³ showed similar results in a study that evaluated 80 patients divided into two groups, a model similar to the previous study. In this study, the follow-up time was up to one year and no statistically significant differences were identified in the grip strength and presence of pillar pain between the two groups. The grip strength was also evaluated by Karlsson et al.¹² in a study in which the open technique for opening the TCL was compared with enlargement by Z-plasty. Patients subjected to TCL repair presented higher mean grip strength with the wrist at 45° extension, while the group subjected to the simple opening of the TCL had greater average grip strength when measured with the wrist at 45° of flexion. Another study in which grip strength in patients who had undergone TCL reconstruction was higher than in patients who had undergone simple opening was that of Gutierrez-Monclus et al.¹⁴ A total of 177 patients were evaluated in a model similar to our study, being 59 patients subjected to stretching and 59 being the control group subjected to the simple opening of the TCL. The conclusion was that TCL reconstruction resulted in greater improvement of grip strength than in the group subjected to simple retinaculotomy.

In our study, the two techniques were equivalent when performance on the QuickDASH questionnaire was evaluated in isolation. Among the three criteria evaluated, this is the most subjective; however, it is the one that most relates to the patient's perception regarding the improvement of symptoms and activities of daily living in the postoperative period. Regarding the sensitivity test by monofilaments, the group in which Z-plasty was used to widen the TCL showed greater recovery. In a similar study, Jakab, Ganos and Cook,¹⁵ performed the two-point discrimination test to evaluate the sensitivity of patients subjected to complete TCL opening compared with its enlargement by Z-plasty. Their study showed no relevant difference between the two techniques.

A commonly found complication in the literature related to the surgical opening of TCL is a pain in the thenar eminence region and in the region of the surgical scar, also called the "pillar pain". Seitz and Lal⁹ relate this pain to a combination of the complete opening of the TCL with exposure of nerve endings and loss of the anatomical covering of the carpal tunnel that would have a biomechanical function, acting as a pulley for the flexor tendons, and a neuroprotective function. Their study failed to find a significant difference with six months of follow-up between the two groups. In a similar study, Saravi et al.¹⁶ concluded that although both groups showed improvement in pain and normal grip strength 12 weeks after surgery, the group subjected to Z-plasty showed a significant reduction in hand pain, shorter duration of this pain, and a shorter period to achieve normal grip strength.

Comparing enlargement in TCL Z-plasty with the simple opening, Xu, Huang and Hou¹⁷ obtained an excellent improvement in function and patient satisfaction in the Z-plasty group. The authors cite this method as a more effective alternative to the conventional

method of surgery for the treatment of carpal tunnel syndrome. Castro-Menéndez et al.¹³ also compared these two techniques and showed no difference between the two groups regarding grip strength, pillar pain, and functional improvement assessed by a questionnaire. Thus, Z-plasty shows no identifiable benefits to reduce postoperative complications. In this study, as well as in most studies similar to ours, a recurrent and important bias is that the surgeries were performed by different surgeons. In the case of this study, this bias is not present, since all surgeries were performed by the same physician.

CONCLUSION

With the comparison of the conventional technique with the complete opening of the TCL in relation to the technique of its enlargement using Z-plasty, we conclude that both are equivalent in terms of functional improvement of the hand using QuickDASH as a questionnaire. This is the most subjective parameter that considers the

patient's perception of their symptoms, limitations for activities of daily living, and how much the disease interferes with their routine. The group subjected to complete opening of the TCL showed better progression of grip strength in relation to the group subjected to Z-plasty. This data contradicts the idea that the complete opening of the TCL would eliminate its pulley function for the flexor tendons, leading to reduced grip strength.

Regarding the sensitivity test using monofilaments, the Z-plasty group showed greater improvements than the other group.

Considering these parameters, we conclude that there is no significant advantage in extending the TCL through Z-plasty in relation to its simple opening.

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EVALUATION OF THE ANTEROLATERAL LIGAMENT OF THE KNEE IN MAGNETIC RESONANCE MRI: CASE SERIES

AVALIAÇÃO DO LIGAMENTO ANTEROLATERAL DO JOELHO EM EXAMES DE RESSONÂNCIA MAGNÉTICA: SÉRIE DE CASOS

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ABSTRACT

Objective: To evaluate the citation of the ligament in the magnetic resonance imaging (MRI) reports and confirm its presence and injury in the images of exams performed in the acute phase retrospectively. **Methods:** In total, 103 patients who underwent anterior cruciate ligament (ACL) reconstruction in 2019 were included. The images were reanalyzed by two radiologists. **Results:** In the first analysis, only one report mentioned the anterolateral ligament (ALL) and its injury (0.97%). On reanalysis, ALL was visualized in almost all cases (95% and 97%). An injury was found in 53 (51.5%) cases by radiologist A and in 56 (54.4%) cases by radiologist B. The injury was diagnosed by both in 39 (37.9%) cases ($p < 0.0001$). Radiologists disagreed regarding the injury ($Kappa = 0.411$). **Conclusion:** The reports failed to describe the ligament and diagnose a significant number of injuries. The analysis of conventional resonance images still presents divergences in the diagnosis of ALL injury associated with the ACL among radiologists. **Level of Evidence IV, Case Series.**

Keywords: Anterolateral Ligament. Anterior Cruciate Ligament. Ligaments Articular. Magnetic Resonance Imaging.

RESUMO

Objetivo: Avaliar, de forma retrospectiva, a citação do ligamento anterolateral (LAL) em laudos de ressonância magnética (RM) e confirmar sua presença e lesão nas imagens de exames feitos na fase aguda. **Métodos:** Foram incluídos 103 pacientes submetidos à reconstrução do ligamento cruzado anterior (LCA) em 2019, cujas imagens foram reanalisadas por dois radiologistas. **Resultados:** Em primeira análise, apenas um laudo citava o LAL e sua lesão (0,97%); enquanto na reanálise, o LAL foi visualizado em quase todos os casos (95% pelo radiologista A e 97% pelo radiologista B). Foi encontrada lesão em 53 (51,5%) casos pelo radiologista A e 56 (54,4%) pelo radiologista B. Lesão foi diagnosticada por ambos em 39 (37,9%) casos ($p < 0,0001$). Houve divergência entre os radiologistas com relação à lesão ($Kappa = 0,411$). **Conclusão:** Os laudos deixaram de descrever o ligamento e diagnosticar um número significativo de lesões. A análise das imagens convencionais de ressonância ainda gera divergências no diagnóstico da lesão do LAL associada ao LCA entre os radiologistas. **Nível de Evidência IV, Série de Casos.**

Descritores: Ligamento Anterolateral. Ligamento Cruzado Anterior. Ligamentos Articulares. Imageamento por Ressonância Magnética.

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most frequent injuries in orthopedics, affecting mainly active young people, which lead to reduced activity due to joint instability, with an incidence of 200,000 reconstructions per year in the USA.^{1,2} In the past, reconstructions were exclusively extra-articular, becoming openly intra-articular, arthroscopically intra-articular. Today, extra-articular reinforcement associated with arthroscopic intra-articular reconstruction is discussed.³ The surgical method must be reconsidered due to the high rate of new ACL injury, which ranges from 6 to 28%, even with proper

technical performance.³ Thus, the reinforcement or reconstruction of the anterolateral ligament (ALL) was proposed to cases of re-rupture.^{4,5} The ALL is considered a distinct ligament structure in the third layer of the lateral compartment of the knee, being posterior and proximal to the lateral femoral epicondyle and with insertion in the anterolateral face of the tibia, halfway between the fibular head and Gerdy tubercle.⁶ Poor healing of the ALL injury occurs in 70% of patients undergoing isolated ACL reconstruction after one year.^{5,7} Biomechanical studies show that in the combined injury of ACL and ALL, isolated ACL reconstruction does not reestablish normal

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knee biomechanics.⁸ In a clinical study, the combined ACL and ALL injuries were associated with significantly unfavorable results in isolated ACL reconstruction.⁵

Despite the improvement proven when undergoing combined surgery, the indications for extra-articular procedure are currently based on clinical parameters, such as pivot shift severity, patient activity level, and the surgeon's personal experience.⁹ However, studies based on routine preoperative magnetic resonance imaging (MRI) show that MRI is highly sensitive, specific, and accurate for detecting ALL abnormality in adults.^{10,11} In pediatric patients, this detection may be inaccurate due to knee size.¹²

Based on this evidence, the appropriate diagnosis of this injury becomes essential in the routine analysis of knee magnetic resonance imaging. Thus, this study questions the efficiency of conventional MRI in orthopedics for this evaluation. The hypothesis is that anterolateral ligament injuries are not being properly visualized and are not being reported by radiologists.

Objectives

To evaluate the citation of the ligament in MRI reports, to evaluate the presence of the anterolateral ligament actively and retrospectively in MRI images by two different radiologists, and to evaluate the number of injuries associated with anterolateral ligament in cases subjected to surgery for ACL reconstruction.

METHODS

This study was conducted after approval by the Research Ethics Committee (CEP) of the institution, according to opinion no. 4,811,548. This is an observational cross-sectional study. Patients of both sexes, over 18 years of age, operated for primary anterior cruciate ligament injury without correlation with associated ligament reconstruction and who underwent surgical treatment in 2019 were included; with preoperative MRI performed within one month after sprain with ACL injury (acute phase). Patients without MRI within one month after sprain with ACL injury (acute phase) were excluded.

In a single stage, two radiologists reanalyzed separately the MRI images, in search of visualization and injuries in the ALL. The definition of injury was previously described as changes in thickness, course, and/or edema around the ligament region.^{10,11} No examination was considered poor quality or excluded.

For statistical analysis, the number of ALL in the reports was compared before the study to those reported by radiologists during the reanalysis. The diagnoses of ALL injury before and after reanalysis were compared, considering injury the case reported in the resonance report before the study and the cases of agreement between the two radiologists in the reanalysis. Agreement in the diagnosis between the two radiologists in the reanalysis was also compared by estimating the kappa coefficient with the Software SPSS 23.0 (IBM Corp., Armonk, NY, USA). Categorical data were evaluated using McNemar's test with continuity correction to compare samples paired by GraphPad's free web QuickCale.

RESULTS

From the initial sample of 221 patients operated in 2019 by the group, 103 were included; 118 were excluded since MRI was not performed one month after sprain with ACL injury (Figure 1).

The participants were classified according to the citation of ALL in the report and its presence in images reanalyzed by radiologists. Among all the reports analyzed, only one cited description and ALL injury. However, with the reevaluation of the images by two radiologists in an active search for the ligament, this was visualized

in 98 (95%) images by radiologist A and 100 (97%) images by radiologist B (Table 1). Among these, injury was found in 53 situations by radiologist A and in 56 by radiologist B (Table 2). They agreed in the diagnosis and considered a ligament injured in 39 cases (37.9%), one of which was already observed in the report made before the study (Table 3).

Moreover, a significant divergence was found in the injury observation among radiologists. Among the 96 cases in which both radiologists identified the ligament on the images, only the kappa coefficient of 0.411 presented a moderate agreement between them (Table 4).

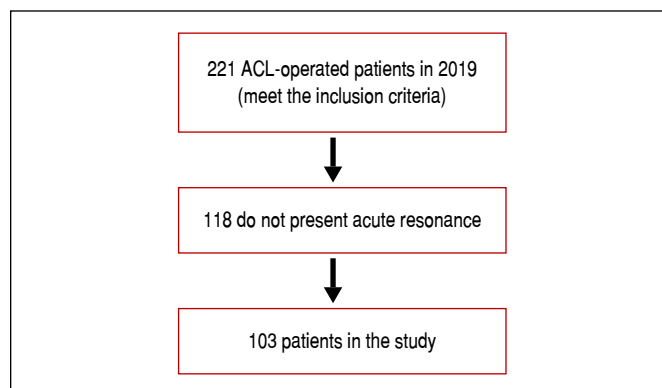


Figure 1. Study flowchart.

Table 1. ALL visualization.

	Previous analysis (N = 103)	Reanalysis - radiologist A (N = 103)	Reanalysis - radiologist B (N = 103)
ALL visualization - N (%)	1 (0.97)	98 (95)	100 (97)

Table 2. Diagnosis of ALL injury.

	Previous analysis (N = 103)	Reanalysis - radiologist A (N = 103)	Reanalysis - radiologist B (N = 103)	p-value
Injury visualization in ALL - N (%)	1 (0.97)	53 (51.5)	56 (54.4)	< 0.05

Table 3. Analysis of diagnoses in agreement among radiologists.

	Previous analysis (N = 103)	Reanalysis - radiologists (N = 103)	p-value
Diagnosis of ALL injury - N (%)	1 (0.97)	39 (37.9)	< 0.0001

Table 4. Agreement in the diagnosis among radiologists.

	Value	Standardized asymptotic error ^a	Approximate T ^b	Approximate significance
Kappa measure agreement	0.411	0.093	4.026	0.000
Number of valid cases	96	-	-	-

^aNot assuming the null hypothesis; ^bUse of standard asymptotic error considering the null hypothesis.

DISCUSSION

ALL is identified by MRI in 11-72% of cases, according to the sixth edition of Insall and Scott.¹³ On knees without injuries, Helito et al.¹⁴ identified the structure with magnetic resonance imaging of 1.5 T in

81.8% of the cases in 2015. Another observational study on knees without injuries shows high sensitivity for ligament visualization and discusses the impasse of standardization of injury detection due to the difficulty in observing its entire extent due to the presence of accessory structures.¹⁵ Furthermore, studies present controversies about the location of frequent ligament abnormalities alongside the non-efficacy of the standard MRI sequence for such visualization, which also hinders diagnosis.¹⁶ When we evaluated knees with acute ACL injury, the ligament was present in 95-97% of radiologists' evaluations only during reanalysis. In agreement with a retrospective comparative assay,¹⁷ the divergence in the visualization of anterolateral ligament injury among specialists in evaluations of images of the injured knee in the acute phase was also present in our study (Table 4). The concomitant ACL injury makes it difficult to observe the injury in ALL and suggests susceptibility to false results – positive and negative.¹⁷

Regarding the injury, both radiologists agreed on its diagnosis in 39 cases (37.9%). One of the first publications on the subject shows 32.6% of associated injuries in MRI images.¹⁶ More recently, three studies show rates of associated injuries close to 90%.^{10,11,18} In one of them, three-dimensional MRI images were used (3D),¹⁸ in the other, MRI images of the contralateral knee without injury were used as a comparison standard,¹⁰ and in the last, the evaluations were made by three scholars of the subject always using MRI of 1.5 Tesla.¹¹ The evaluation with 3D MRI and the use of a contralateral knee resonance examination as a reference were scientifically effective, but difficult to apply during usual clinical practice. However, the most careful and rigorous evaluation, as in the last example, seems to be more feasible in daily clinical practice considering the variability of the ligament aspect among individuals and the presence of accessory structures.¹⁶

Despite several publications on the subject in the past decade worldwide and several publications by Brazilian authors on the subject¹⁹ in this series of cases, we found only one report (0.97%) containing information on ALL. Thus, we understand that it would be appropriate to increase the active search for ALL during the evaluation of images by radiologists in orthopedics, enabling other data for the surgeon to define if the associated reconstruction between the ACL and ALL in the acute phase will be made and facilitate the authorization of the procedures and materials necessary by healthcare insurers. Today, radiologists consider it essential to report the presence of LAL and changes in thickness, course, and edema around, when present, showing the probable injury.^{10,11} This study presented some limitations and biases. First, the retrospective analysis of images were performed in several radiology services with different resonance devices and with resolutions ranging from 0.5 to 1.5 Tesla. Second, the series of cases encompassed only a single medical center. Finally, this study included a large number of patients operated with ACL injury, but many had not undergone acute phase imaging and, therefore, were excluded from the analysis.

CONCLUSIONS

In this series of cases, we show that the reports no longer describe the ALL and diagnose a significant number of injuries. The analysis of conventional resonance images still presents divergences in the diagnosis of ALL injury associated with ACL among radiologists.

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S. AUREUS IS ASSOCIATED WITH A GREATER NEED FOR REOPERATION IN SEPTIC ARTHRITIS OF THE KNEE

S. AUREUS ESTÁ ASSOCIADA COM MAIOR NECESSIDADE DE REABORDAGEM NA ARTRITE SÉPTICA DO JOELHO

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ABSTRACT

Objective: To determine the frequency of reoperations in the treatment of adult patients diagnosed with septic arthritis of the knee, the average number of debridements needed to control the infection, the mortality rate, and to assess factors associated with a greater need for reoperation and mortality. **Methods:** Retrospective cohort study evaluating 38 adult patients diagnosed with septic arthritis who underwent arthrotomy via a medial parapatellar approach for joint cleaning and debridement. Demographic, clinical, surgical, and microbiological variables of the cases were analyzed by review of medical records. Tests for equality of two proportions, chi-square, and multivariate logistic regression analysis were performed, defining a significance level at 0.05, with 95% confidence interval. **Results:** A total of 50% of the cases underwent reoperation, with an average number of required debridement of 2.02 and a mortality rate of 10.5%. Patients with infection caused by *Staphylococcus aureus* were more likely to need a reoperation compared to patients with positive cultures for other agents (OR 6.0). **Conclusion:** In 50% of cases, an average of 2.02 debridements were necessary and the mortality rate was 10.5%. *Staphylococcus aureus* infection is associated with a 6 times greater chance of additional surgeries. **Level of Evidence IV, Case Series.**

Keywords: Arthritis. Infectious. Knee. *Staphylococcus aureus*. Infections.

RESUMO

Objetivo: Determinar a frequência de reabordagens cirúrgicas no tratamento de pacientes adultos com diagnóstico de artrite séptica do joelho, a média de desbridamentos necessários para o controle da infecção e a taxa de mortalidade, assim como avaliar os fatores associados à maior necessidade de reabordagem e mortalidade. **Métodos:** Estudo retrospectivo tipo coorte que avaliou 38 pacientes adultos com diagnóstico de artrite séptica submetidos à artrotomia por via parapatelar medial para limpeza e desbridamento da articulação. Foram analisadas variáveis demográficas, clínicas, cirúrgicas e microbiológicas dos casos, por revisão de prontuário médico, e realizados testes de igualdade de duas proporções, qui-quadrado e análise multivariada de regressão logística, sendo definido um nível de significância de 0,05, com 95% de confiança estatística. **Resultados:** 50% dos casos foram submetidos à reabordagem cirúrgica, sendo a média de desbridamentos necessários de 2,02 e a taxa de mortalidade de 10,5%. Pacientes com infecção causada por *Staphylococcus aureus* apresentaram mais chances de necessitar de reabordagem quando comparados aos pacientes com culturas positivas para outros agentes (OR 6,0). **Conclusão:** Em 50% dos casos foram necessários, em média, 2,02 desbridamentos e a taxa de mortalidade foi de 10,5%. A infecção por *Staphylococcus aureus* está associada com seis vezes mais chances de cirurgias adicionais. **Nível de Evidência IV, Série de Casos.**

Descritores: Artrite Infecçiosa. Joelho. *Staphylococcus aureus*. Infecções.

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INTRODUCTION

Septic arthritis of the knee is a frequent condition and is associated with high morbidity, since the delay in the diagnosis and treatment of infection can lead to irreversible joint damage, with loss of permanent function and even death due to the spread of the infectious process.^{1,2}

Septic arthritis enters into the differential diagnoses of patients admitted to the emergency department with pain, joint effusion, and local heat in the knees, which includes osteoarthritis, rheumatoid arthritis, gouty arthritis, other nonspecific arthritis, and septic arthritis itself.³ As the treatment of infectious arthritis

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The study was conducted at the Santa Casa de Misericórdia de São Paulo, Faculdade de Ciências Médicas, Departamento de Ortopedia e Traumatologia. Correspondence: Ricardo de Paula Leite Cury. Rua Doutor Cesário Motta Junior, 112, São Paulo, SP, Brazil, 01221020. rcury1@me.com

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is based on cleansing and debridement of the joint, in addition to antibiotic therapy, early diagnosis is essential.⁴ Arthrocentesis should be performed for cytological and biochemical evaluation of the synovial fluid, in addition to microbiological analysis with bacterioscopy and culture.⁵ Since culture results are not obtained in the emergency room, and positivity is low even during infection bacterioscopy, cytological evaluation of the synovial fluid is the most important test in the emergency evaluation of these patients.⁶ A synovial fluid white cell count greater than 50,000 cells/mm³ is the cutoff number most often used for the diagnosis of septic arthritis.⁶⁻¹⁰

The best surgical treatment technique for septic arthritis of the knee is still controversial.^{4,6} Options include serial aspirations with needles, cleaning, and open debridement (arthrotomy) or arthroscopic.⁴ The superiority of any of the methods has not yet been established in the literature, but there is a current tendency to clean and debridement by arthroscopic approach as it allows a wide access to the joint, performs an adequate debridement of synovia, and dilute inflammatory enzymes during the intraoperative period.⁴ Even so, it is often necessary to perform more than one cleansing and debridement of the joint to obtain healing of the infectious process.⁵

The presence of comorbidities associated with immunosuppression, *Staphylococcus aureus* infection, and high cellularity in the synovial fluid are some of the factors described as having a worse prognosis in septic arthritis of the knee, being related to a greater need for surgical reoperations to control the infectious process, but without consensus in the literature.¹¹⁻¹⁴

Thus, this study aims to evaluate the frequency of the need for surgical reoperation to new debridement in the treatment of septic arthritis of the knee of adult individuals, the average debridement necessary to control the infection, the mortality rate of cases, and possible risk factors for greater need for reoperation or higher risk of mortality.

METHODS

This is a retrospective cohort study that, after approval by the Ethics Committee on Research in Human Beings of the Irmandade da Santa Casa de Misericórdia de São Paulo (CAAE: 45469121.0.0000.5479), evaluated the cases of patients diagnosed with septic arthritis of the knee treated surgically in the Department of Orthopedics and Traumatology of the *Santa Casa de Misericórdia de São Paulo* from May 2015 to January 2021.

The diagnosis of septic arthritis was suspected in clinical and laboratory evaluation, and confirmed by analysis of the synovial fluid. Inclusion criteria were patients with clinically suspected septic arthritis of the knee (knee with acute pain, hot, and swollen) and more than 50,000 cells/mm³ on synovial fluid evaluation, or positive bacterioscopy, or positive synovial fluid culture, or positive blood culture. All patients underwent medial parapatellar arthrotomy for joint cleaning and debridement.

Cases of polyarticular septic arthritis, skeletal immaturity, post-surgical infection, and cases in which no arthrocentesis (joint aspiration) was performed in the initial care were excluded.

The demographic, clinical, surgical, and microbiological variables of the cases were analyzed, through a review of medical records, in order to obtain the following data: Identification: gender, age, and comorbidities associated with immunosuppression (diabetes, chronic kidney disease, smoking, rheumatoid arthritis, alcoholism, substance-related disorders, active cancer, and HIV infection); Laboratory analysis of joint aspiration: global cell count, percentage of neutrophils, bacterioscopy, and synovial fluid culture; Complications: need for surgical reoperation and death.

The equality test of two proportions was applied to analyze the prevalence (relative frequency) of some qualitative covariates. A chi-square test was also used to measure the relationship between positive culture and cell count in the synovial fluid, as well as between the positive cultures for *Staphylococcus aureus* and the positive cultures for the other germs for prediction of reoperation and death. Finally, multivariate logistic regression analysis was applied to identify the independent factors (age, comorbidity, cellularity, and fluid culture) to the need for reoperation and death. Prevalence was estimated for the total valid answers of each variable. To evaluate the objectives of this work, the collected data were grouped into tables and subjected to statistical analysis using the programs SPSS V20, Minitab 16, and Excel Office 2010. A significance level of 0.05 (5%) was defined for this study. The confidence interval was defined as 95% statistical confidence.

RESULTS

In the period analyzed, 49 cases of septic arthritis of the knee treated surgically in our service were identified, and 38 of them were eligible for this study. A total of five cases with skeletal immaturity and five cases of post-surgical infection were excluded. The age of the patients ranged from 19 to 81 years, with an average of 49.1 years. Men were the most affected, with 29 cases (76.3%). Regarding the presence of comorbidities, 13 patients (34.2%) had no comorbidity, 10 (26.3%) had one, and 15 (39.4%) had two or more. Regarding synovial fluid cellularity, the number of nucleated cells varied from 6,800 to 720,000 cells/mm³, and 23 patients (60.5%) had more than 50,000 cells/mm³ in the liquid. The percentage of neutrophils ranged from 75% to 99%, being higher than 90% in 32 patients (84.2%).

Bacterioscopy was positive in 45% of the cases, all for gram-positive cocci, and synovial fluid culture was positive in 73% of the cases. As for the pathogens identified, 64% of the infections were caused by *Staphylococcus aureus* (Figure 1).

Regarding the number of surgical debridements necessary for controlling the infectious process, in 50% of the cases only one surgical approach was performed and in the other 50% at least one more surgical debridement after the initial operation was necessary. In our sample, the average number of debridements to control the infectious process was 2.02. Mortality during hospitalization was 10.5% (four cases).

Higher synovial fluid cell count and higher culture positivity showed no correlation, and 44% of patients with positive synovial fluid culture had less than 50,000 cells/mm³ in the synovial fluid (Table 1).

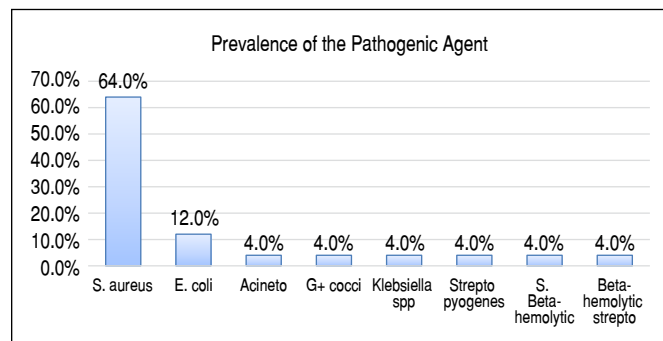


Figure 1. The most frequently identified infectious agent in synovial fluid cultures was *Staphylococcus aureus*.

S. aureus: *Staphylococcus aureus*; *E. coli*: *Escherichia coli*; multi-R *Acineto*: Multidrug-Resistant *Acinetobacter*; G+ cocci: Gram-positive cocci; *S. Beta-hemolytic*: beta-hemolytic *Staphylococcus*; *Strepto pyogenes*: *Streptococcus pyogenes*; Beta-hemolytic strepto: beta-hemolytic *Streptococcus*.

A significant correlation between the need for reoperation and isolation of *S. aureus* in cultures was observed ($p = 0.041$). We estimated the odds ratio, in which in the analysis with re-ordering it was 6.00. This value was important because the 95% confidence interval does not contain the value 1.00 in it, indicating that patients with positive cultures for *S. aureus* were six times more likely to require reoperation to joint cleansing and debridement compared to patients with positive cultures for other agents (Table 2).

No other isolated factor evaluated can be considered as a risk predictor, since none of them was statistically significant for a higher need for reoperation or higher risk of mortality (Table 3).

DISCUSSION

In this study, 50% of patients with infectious arthritis required reoperation, the mortality rate of the cases was 10.5%, and the average number of debridements needed to control the infection was 2.02. The presence of positive synovial fluid culture and the cell count in the liquid showed no relationship. Patients with infection caused by *S. aureus* were six times more likely to

undergo reoperation compared to patients with positive cultures for other infectious agents.

Risk factors for pyogenic arthritis are the presence of comorbidities such as advanced age, diabetes mellitus, renal failure, and other conditions associated with impaired immunity.¹¹⁻¹³ A total of 65.8% of our patients had some type of comorbidity associated with immunosuppression; however, the presence of these comorbidities showed no association with a higher risk for reoperation or death.

The most commonly identified pathogenic agent in cases of septic arthritis of the knee is *Staphylococcus aureus*,^{12,15} and some studies associate the isolation of this agent in cultures with a worse prognosis, with a higher risk of needing reoperations to new cleaning and debridement of the joint.¹² In our sample, *Staphylococcus aureus* was identified in 64% of positive cultures, being the most prevalent agent and associated with the worst prognosis. In cases in which this pathogen was isolated, there was a greater need for reoperation, with statistical significance, compared to cases in which other germs were identified in cultures. Patients with cultures positive for *Staphylococcus aureus* were six times more likely to require reoperation for joint cleansing and debridement compared to patients with positive cultures for other agents.

The evaluation of synovial fluid is essential for the diagnosis of septic arthritis. In the literature, bacterioscopy is positive in 30 to 50% of cases of infection,^{6,7} and in our series it was positive in 44.8% of the cases, hence the importance of evaluating the cytology of the synovial fluid for diagnosis in urgency.

The most commonly used cutoff number for the number of white cells in the synovial fluid in the diagnosis of septic arthritis is a count greater than 50,000 cells/mm³.⁶⁻¹⁰ However, Bell et al.¹⁶ identified that only 31.2% of patients with positive cultures had white cell counts $\geq 50,000$ cells/mm³. In our series, 44% of patients with positive synovial fluid culture had less than 50,000 cells/mm³ in the synovial fluid. These findings suggest that the cutoff value of more than 50,000 cells/mm³ for the diagnosis of septic arthritis may be a very high value. Further studies, however, are needed to elucidate this hypothesis.

Stake et al.¹³ described that high cellularity in the synovial fluid is related to the increase in the rate of reoperation, and an increase of 1,000 cells/mm³ is related to a 1% increase in the chance of reoperation. In our study, patients with cell counts $\geq 50,000$ cells/mm³ tended to present a higher risk of need for reoperation, but without statistical significance ($p = 0.059$).

The most commonly used options for surgical treatment of septic arthritis of the knee are open or arthroscopic cleansing and debridement. The literature lacks consensus; however, a trend in favor of using the arthroscopic technique is observed.⁶ In our series, we performed the surgical treatment of septic arthritis of the knee by open approach, through arthrotomy. This was due to the unavailability of arthroscopic material for urgent surgical procedure in our service.

The rate of reoperation in cases of septic arthritis of the knee varies, ranging from 0 to 71% in the literature.^{1,12} In our series, reoperation was required in 50% of cases. In the literature, the series of septic arthritis treated arthroscopically tend to have a lower rate of reoperation than the series treated by arthrotomy. In the series of Peres et al.,¹⁷ no case treated by arthroscopy required more than one surgical procedure. Böhler et al.¹⁸ needed reoperation in only 5% of the cases treated by arthroscopy. On the other hand, Johns et al.¹⁹ showed a reoperation rate of 50% in cases treated by arthroscopy, and 71% in cases treated by arthrotomy; the average number of procedures necessary to control the infection was 1.79 in arthroscopic treatment,

Table 1. Correlation between cultures with synovial fluid pathogen identification and global cell count.

	Negative culture		Positive culture		Total		p-value
	N	%	N	%	N	%	
> 50 thousand/mm	7	77.8%	14	56.0%	21	61.8%	0.249
≤ 50 thousand/mm	2	22.2%	11	44.0%	13	38.2%	
Total	9	26.5%	25	73.5%	34	100.0%	

thousand/mm³: thousand units per cubic millimeter; N: total number. %: percentage; p-value: probability of significance.

Table 2. Relationship of infections caused by *Staphylococcus aureus* and other agents with the number of reoperations and deaths.

Reoperations	Culture (+) <i>S. aureus</i> (n = 16)	Culture (+) other agents (N = 9)	p-value	Odds ratio
	N	N		
Yes	12 (75%)	3 (33.3%)	0.041	6 (1.01 to 35.91)
No	4 (25%)	6 (66.6%)		
Deaths				
Yes	2 (12.5%)	1 (11.1%)	0.918	1.14 (0.09 to 14.68)
No	14 (87.5%)	8 (88.8%)		

N: total number; %: percentage; p-value: probability of significance.

Table 3. Logistic regression model to evaluate factors associated with higher risk of reoperation and death.

		p-value	Odds ratio 95%CI		
			OR	Inferior Limit	Superior Limit
Reoperation	Constant	0.032	0.03		
	Age	0.395	1.02	0.97	1.07
	Comorbidities	0.226	2.9	0.52	16.22
	Cells/mm > 50,000	0.059	5.44	0.94	31.5
	Liquid culture	0.166	3.76	0.58	24.46
Death	Constant	0.998	0		
	Age	0.754	1.01	0.93	1.11
	Comorbidities	0.999			
	Cells/mm > 50,000	0.998			
	Liquid culture	0.917	1.18	0.05	25.38

OR: Odds ratio; cells/mm³: cell count per cubic millimeter; p-value: probability of significance.

and 2.42 in open approach. In our series of cases treated by arthrotomy, 2.02 procedures were needed on average to control the infectious process.

The mortality rate of our sample was 10.5%. Ferrand et al.,²⁰ in a study with 109 patients, had 5.6% of deaths. Balalaud et al.² in a literature review, showed a mortality rate of 3 to 29%.

Our sample, relatively small, represents a limitation of our study. It was a convenience sample based on the number of cases that were admitted to the hospital over the collection period. Additionally, surgical procedures were performed by more than one surgeon, as it is a teaching hospital. However, the use of a standardized

technique, medial parapatellar arthrotomy, allowed an effective debridement of the joint.

CONCLUSION

In 50% of the cases of septic arthritis of the knee of adult individuals, treated with surgical cleaning and open debridement, a new surgical approach was necessary. The average number of debridement was 2.02 and the mortality rate during hospitalization was 10.5%. Patients with cultures positive for *Staphylococcus aureus* were six times more likely to require reoperation compared to patients with positive cultures for other agents.

AUTHORS'S CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. LSF, AJY: data collection and interpretation, writing of the article; ASN: study elaboration and conception, data collection and interpretation, writing of the article; MJS, VMO, RPLC: study elaboration and conception, critical review of the article.

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POSTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: ARE THE RESULTS SIMILAR TO ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION?

RECONSTRUÇÃO DO LIGAMENTO CRUZADO POSTERIOR: OS RESULTADOS SÃO SIMILARES À RECONSTRUÇÃO DO LIGAMENTO CRUZADO ANTERIOR?

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ABSTRACT

Objective: To report and compare the results of posterior cruciate ligament (PCL) and anterior cruciate ligament (ACL) reconstructions. **Methods:** In total, 42 patients were retrospectively evaluated, 20 with isolated PCL injuries (group 1) and 22 with isolated ACL ones (group 2) who were subjected to arthroscopic ligament reconstruction with autologous grafts and followed up for at least two years. To evaluate the results in group 1, objective IKDC and Lysholm scores, posterior drawer tests, and evaluations by a KT-1000 arthrometer were used, whereas for group 2, subjective IKDC and Lysholm score and the Lachman test were employed. To compare groups, objective IKDC and Lysholm scores and assessment via a KT-1000 arthrometer were considered. **Results:** Intragroup analysis showed improved results for all variables ($p < 0.001$) in both groups. Comparisons between groups showed a significant difference in objective IKDC scores ($p < 0.001$), but no such disparities for Lysholm ones ($p = 0.052$), clinical tests ($p = 0.058$) or evaluation by KT-1000 ($p = 0.129$). **Conclusion:** Treatment restored knee stability and function in both groups. Comparisons between groups showed that PCL reconstructions had inferior results than ACL ones according to patients' objective IKDC scores. **Level of Evidence II, Retrospective Study.**

Keywords: Posterior Cruciate Ligament. Posterior Cruciate Ligament Reconstruction. Anterior Cruciate Ligament. Anterior Cruciate Ligament Reconstruction. Knee.

RESUMO

Objetivo: Reportar e comparar os resultados da reconstrução do ligamento cruzado posterior (LCP) e do ligamento cruzado anterior (LCA). **Métodos:** Foram avaliados retrospectivamente 42 pacientes: 20 com lesão isolada do LCP (grupo 1) e 22 com lesão isolada do LCA (grupo 2), submetidos à reconstrução ligamentar artroscópica com enxertos autólogos e acompanhados por pelo menos dois anos. Para avaliação dos resultados no grupo 1, foram utilizados o escore do International Knee Documentation Committee (IKDC) objetivo, escore de Lysholm, teste da gaveta posterior e avaliação pelo artrômetro KT-1000; e, para o grupo 2, foram utilizados o IKDC subjetivo, escore Lysholm e teste de Lachman. Para comparação entre os grupos, foram considerados o IKDC objetivo, escore Lysholm e avaliação pelo artrômetro KT-1000. **Resultados:** Ambos os grupos demonstraram melhora dos resultados na análise intragrupo em todas as variáveis ($p < 0,001$). Na comparação intergrupos, observou-se diferença significativa no IKDC objetivo ($p < 0,001$), não sendo observada diferença no escore Lysholm ($p = 0,052$), nos testes clínicos ($p = 0,058$) ou na avaliação pelo KT-1000 ($p = 0,129$). **Conclusão:** A estabilidade e função do joelho foram restauradas em ambos os grupos. Na comparação intergrupos, a reconstrução do LCP apresentou resultados inferiores à reconstrução do LCA no critério IKDC objetivo. **Nível de Evidência II, Estudo Retrospectivo.**

Descritores: Ligamento Cruzado Posterior. Reconstrução do Ligamento Cruzado Posterior. Ligamento Cruzado Anterior. Reconstrução do Ligamento Cruzado Anterior. Joelho.

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INTRODUCTION

Most posterior cruciate ligament (PCL) injuries are composite and generate significant instability, functional impotence, and future degenerative changes. Research has well established the indication of surgery for this group of patients.¹

Currently, doubts in the literature relate more to the much less frequent isolated PCL injuries, usually indicating surgical treatment for cases of grade III lesions, which, even if isolated, can cause disabling outcomes such as instability and anterior pain. Grade II chronic injuries can bring the same symptoms in young and active patients if conservative treatment fails.¹ However, as PCL reconstruction techniques have evolved, including the advent of double-bundle reconstruction and better fixation methods, graft options, and rehabilitation protocols, the surgical treatment of isolated injuries has vastly improved, and the literature often reports superior results to those of conservative treatment.²⁻⁴

PCL reconstruction generally shows inferior results than those for anterior cruciate ligament (ACL).^{5,6} However, via the aforementioned surgical advances, in 2018, LaPrade et al.,⁷ performed double-bundle PCL reconstructions with homologous grafts, obtaining comparable results for their isolated reconstruction of both ligaments.

Homologous grafts (or allografts) have been the preference for reconstructing PCL, especially for combined injuries due to their shorter procedure time, lower surgical morbidity, and possibility of obtaining longer and more robust grafts.^{1,8,9} However, the Brazilian reality does not allow their wide use, often leaving autologous grafts as the only available option. Nevertheless, studies have successfully reconstructed PCL with autografts, often obtaining comparable results to allografts.¹⁰⁻¹²

We found only one study has compared the results of PCL and ACL reconstruction with autografts,⁶ unlike LaPrade et al.,⁷ who used allografts. This study employed a simple bundle technique in most cases. Thus, as far as we know, this is the first study comparing the results of PCL and ACL reconstructions with autografts associated with double-bundle PCL reconstruction. We hypothesized that both can effectively restore knee stability and function and that their results would resemble each other even if we used autografts to reconstruct PCL.

METHODS

This retrospective longitudinal study was approved by the research ethics committee of our institution (CAAE 40713720.1.0000.5479). From April 2002 to January 2017, results from two groups were reviewed: from patients who had been subjected to isolated double-bundle PCL reconstruction and those subjected to isolated ACL reconstruction who were followed up in our institution. All interventions were performed by a single surgeon (RPLC).

Skeletally mature patients of all genders with isolated and complete central ligament (PCL or ACL) injuries without associated ligament lesions who underwent outpatient follow-up for at least two years were included. Patients with clinical and/or radiographic signs of gonarthrosis, poor lower limb alignment, history of previous knee injuries or surgeries or who failed to follow our rehabilitation protocol were excluded.

From April 2002 to January 2017, 172 PCL injury cases were treated in our service, including combined or isolated injuries and cases of fracture-avulsion. From the criteria above, 20 patients were considered eligible for this study (group 1). Given that number, a random sample of 22 patients with isolated ACL injuries who were treated in the same period were selected (group 2).

Outcome diagnosis and evaluation

Patients' physical condition was thoroughly examined by two experienced orthopedists to diagnose ligament injuries. The anterior and

posterior drawer, Lachman, Godfrey, pivot-shift, reverse pivot-shift, dial, varus and valgus opening (both at 0 and 30°), and external rotation recurvatum tests were performed.

Imaging tests were used to confirm patients' diagnosis: radiography (frontal, profile, and panoramic images of participants' lower limbs) – to evaluate their mechanical axes and the incidence of gonarthrosis and magnetic resonance imaging to assess ligament, chondral and/or meniscal lesions.

The following criteria were considered to assess stability and functionality preoperatively and postoperatively (within two years of follow-up) in group 1 (PCL): Lysholm and objective IKDC scores; posterior drawer test; and evaluation via a KT-1000 arthrometer; whereas for group 2 (ACL), Lysholm and subjective IKDC scores and the Lachman test.

To postoperatively compare groups, the available data common to both were considered and the following postoperative variables, compared after at least two years of follow-up: Lysholm and objective IKDC scores and evaluation via a KT-1000 arthrometer.

Surgical technique

All cases included were operated by the same surgeon (R.P.L.C.). The transtibial technique in femoral double bundle¹¹⁻¹³ with autologous quadriceps and semitendinosus grafts from patients' ipsilateral knees or bilateral flexor tendons were used in PCL reconstructions (group 1), whereas the "outside-in"¹⁴ technique with autografts from ipsilateral flexor tendons was used in ACL reconstructions (group 2). If grafts only included flexor tendons, anterolateral bundles were reconstructed with two semitendinosus grafts and posteromedial ones with two gracilis ones. In cases treated with quadriceps and semitendinosus tendons, the former were used to reconstruct anterolateral bundles and the latter, posteromedial ones.

The anterolateral bundles in group 1 showed a 9-mm mean diameter in reconstructions with quadriceps tendons and a 8-mm mean diameter in those with double semitendinosus grafts. Posteromedial bundles treated with two gracilis grafts or a single semitendinosus ones showed a 7-mm average diameter. In group 2, both flexor tendons showed a 8-mm mean diameter.

Meniscal lesions were treated by partial meniscectomy and chondral lesions, by microfractures. Rehabilitation was standardized according to previous protocols.^{14,15}

A 5% statistical significance was defined and confidence intervals, constituted with 95% statistical confidence. The chi-squared test was used to compare the evaluated parameters within groups and between them.

RESULTS

Table 1 shows both groups' demographic distribution and associated lesions.

Tables 2 and 3 show the results of each group separately (intragroup evaluation). We found that all variables showed significant statistical evolution when we compared patients before and after surgery.

Table 4 shows our comparison of postoperative outcomes between groups (intergroup evaluation) for the variables which enabled analysis (Lysholm, objective IKDC, and evaluation by KT-1000). We only found a significant difference in objective IKDC scores

Table 1. Sample characterization.

Group	Gender		Age (average)
	M	F	
1 (PCL)	17 (85%)	3 (15%)	18-44 (32.64)
2 (ACL)	11 (50%)	11 (50%)	15-43 30.15

PCL: posterior cruciate ligament; ACL: anterior cruciate ligament; M: male; F: Female.

(four patients classified as “A” in group 1 (20%) vs 19 in group 2 (86.4%) – $p < 0.001$). The Lysholm score failed to show statistical significance ($p = 0.052$), despite considerable numerical differences among patients deemed “excellent.”

Finally, we found three cases of stiffness in group 1 (15%). Patients received additional manipulation under narcosis. We observed no complications in group 2.

DISCUSSION

This study shows that the employed techniques were efficient, showing a high success rate in subjective and objective criteria after we compared patients before and after surgery. Nevertheless, postoperative intergroup comparisons showed that 86.4% of group 2 participants had “normal” operated knees, whereas only 20% of group 1 participants did. The other two variables showed no such situation, but we found a considerable difference in absolute Lysholm scores ($p = 0.052$, 86.4% and 60.0% “excellent” patients in group 2 and group 1, respectively).

Table 2. Intragroup comparison of variables in group 1 – Posterior cruciate ligament reconstruction.

Outcomes	N	Preop.		Post-p		p-value
		%	N	%		
Lysholm	Poor	7	35.0%	0	0.0%	< 0.001
	Average	9	45.0%	0	0.0%	
	Good	4	20.0%	8	40.0%	
	Excellent	0	0.0%	12	60.0%	
Objective IKDC	D	12	60.0%	0	0.0%	< 0.001
	C	8	40.0%	1	5.0%	
	B	0	0.0%	15	75.0%	
	A	0	0.0%	4	20.0%	
Posterior drawer test	3+	14	70.0%	0	0.0%	< 0.001
	2+	6	30.0%	1	5.0%	
	1+	0	0.0%	7	35.0%	
	Negative	0	0.0%	12	60.0%	
KT-1000	> 10	15	75.0%	0	0.0%	< 0.001
	6 to 10	5	25%	1	5.0%	
	3 to 5	0	0.0%	7	35.0%	
	0 to 2	0	0.0%	12	60.0%	

PCL: posterior cruciate ligament; IKDC: International Knee Documentation Committee score; Preop: preoperative; Postop: postoperative; A: normal; B: almost normal; C: abnormal; D: Very abnormal.

Table 3. Intragroup comparison of variables in group 2 – Anterior cruciate ligament reconstruction.

Outcomes	N	Preop.		Postop		p-value
		%	N	%		
Lysholm	Poor	12	54.5%	0	0.0%	< 0.001
	Average	7	31.8%	0	0.0%	
	Good	3	13.6%	3	13.6%	
	Excellent	0	0.0%	19	86.4%	
Subjective IKDC	Poor	19	86.4%	0	0.0%	< 0.001
	Average	3	13.6%	0	0.0%	
	Good	0	0.0%	5	22.7%	
	Excellent	0	0.0%	17	77.3%	
Lachman Test	3+	4	18.2%	0	0.0%	< 0.001
	2+	9	40.9%	0	0.0%	
	1+	9	40.9%	2	9.1%	
	Negative	0	0.0%	20	90.9%	

ACL: anterior cruciate ligament; IKDC: International Knee Documentation Committee score; Preop: preoperative; Postop: postoperative.

Table 4. Intergroup comparison of postoperative variables.

Outcomes	Group 1 (PCL)		Group 2 (ACL)		p-value	
	N	%	N	%		
Lysholm	Poor	0	0.0%	0	0.0%	0.052
	Average	0	0.0%	0	0.0%	
	Good	8	40.0%	3	13.6%	
	Excellent	12	60.0%	19	86.4%	
Objective IKDC	D	0	0.0%	0	0.0%	< 0.001
	C	4	5.0%	0	0.0%	
	B	15	75.0%	3	13.6%	
	A	4	20.0%	19	86.4%	
Clinical trials (Lachman/PD)	3+	0	0.0%	0	0.0%	0.058
	2+	1	5.0%	0	0.0%	
	1+	7	35.0%	2	9.1%	
	Negative	12	60.0%	20	90.9%	
KT-1000	> 10 mm	0	0.0%	0	0.0%	0.129
	6 to 10 mm	1	5.0%	0	0.0%	
	3 to 5 mm	7	35.0%	3	13.6%	
	0 to 2 mm	12	60.0%	19	86.4%	

PCL: posterior cruciate ligament; ACL: anterior cruciate ligament; PD: posterior drawer test; IKDC: International Knee Documentation Committee score; A: normal; B: almost normal; C: abnormal; D: very abnormal.

Currently, the literature shows consensus on the need to surgically treat cruciate ligament injuries to reestablish knee stability and biomechanics and avoid secondary injuries and long-term joint degeneration.¹⁶⁻¹⁸ Thus, ligament reconstruction techniques have been improved, especially for PCL, showing better subjective and objective results.^{1,3} However, PCL reconstruction results remain, in general, incomparable to those for ACL.^{5,6}

Our results disagree with LaPrade et al.,⁷ who showed a clear similarity between their isolated ACL and PCL reconstruction results. However, some important differences must be considered, the first of which includes grafts. LaPrade et al.⁷ used allografts (calcaneal tendons with bone blocks associated with anterior tibial tendons) to reconstruct PCL (including due to isolated injuries), whereas we used autografts, which demand a longer surgical time as they require surgical removal and show higher morbidity during collection. We believe that this may have interfered with our postoperative functional results.

Moreover, LaPrade et al.⁷ used a different graft fixation method. Although they also employed femoral interference screws, they performed tibial fixation by a screw with a toothed washer directly on the graft.⁷ Allografts are generally longer than autografts, enabling direct fixation to the anterior portion of patients' tibiae.

We inserted interference screws into tibial tunnels in 20% of our cases (those in which grafts consisted only of flexor tendons). In the remaining 80%, we employed a “on-post” fixation technique: we tied and tensioned the wires attached to the graft around a conventional screw and washer we had inserted more distally, creating a double interface — “screw-wires” and “graft-wires” — instead of more proximally and directly fixating the graft on the tibial anterior portion. This technique was necessary as quadriceps tendons produce shorter grafts which prohibit direct fixation. The “direct” method in LaPrade et al. may produce more stable and resistant fixations than the “post” fixation of autologous quadriceps tendon grafts, especially considering the great mechanical stress exerted on PCL reconstruction.¹⁹ A biomechanical study has shown that proximal fixation in patients' tibial tunnels with or without distal fixation generated more stable results than the latter alone.²⁰

Outcome evaluation methods also differed between studies: LaPrade et al.⁷ used SF-12, WOMAC, Tegner, and Lysholm scores. We only included the latter, and both studies showed no statistical difference. We found that the objective IKDC score was the only method showing a clear difference between our experimental groups, which LaPrade et al. ignored.

Differences in rehabilitation must also be considered. PCL cases require even more careful and intensive rehabilitation than ACL ones.¹⁵ In this study, although all patients underwent rehabilitation in the same institution under a standardized protocol, we must consider the difficulties of intensive follow-up due to socioeconomic limitations and the local public health system. Moreover, LaPrade et al.⁷ report routine dynamic orthosis in all patients who underwent PCL reconstruction, absent in Brazil due to economic limitations. This may also explain our treatment of patients' associated injuries (meniscal and/or chondral) as the Brazilian public health system lacks the more advanced techniques to repair chondral lesions and suture menisci.

Finally, our results evade comparison with those in Owensen et al.,⁶ who, despite their similar goal and use of autografts in most cases, only employed KOOS subjective scores to compare PCL and ACL reconstructions. They concluded that, although both groups show evident and comparable subjective improvements, patients

subjected to PCL reconstruction show lower preoperative and postoperative KOOS scores.

This study has limitations. Its retrospective nature and convenience sample limit the interpretation of the effects of its interventions, especially considering its relatively small sample due to the infrequency of isolated PCL injuries. Moreover, we compared distinct lesions treated with different surgical techniques to evaluate similarities between the evolution of the two surgically treated injuries. We know that lesions and associated procedures can generate bias in result assessments, but it would be extremely difficult to obtain a "pure" sample – i.e., without any associated meniscal or chondral lesions – of an injury as rare as isolated PCL ones. To minimize this bias — exclusive to group 1 (PCL) —, we chose to pair both set of patients to avoid excluding those with associated meniscal injuries from group 2 (ACL), thus randomly distributing this possible bias across groups.

CONCLUSION

Both PCL and LCA reconstructions managed to restore knee stability and function, showing significant improvement in our intragroup comparison. However, PCL reconstruction with autografts showed poorer results in objective IKDC scores than those for ACL. Intergroup analysis showed no statistically significant difference for our other variables.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. MBM, FEH: evaluation of patients, bibliographic research, and writing of the article; NDAR: statistical analysis and table making; ASN: bibliographic research and text review; VMO: scientific orientation and revision of the text; RPLC: surgeon in the cases included in this study.

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UNDIFFERENTIATED PLEOMORPHIC SARCOMA: PROGNOSTIC FACTORS IN 42 EXTREMITY CASES

SARCOMA PLEOMÓRFICO INDIFERENCIADO: FATORES DE PROGNÓSTICO EM 42 CASOS EM EXTREMIDADES

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ABSTRACT

Introduction: Soft tissue undifferentiated pleomorphic sarcoma (UPS) in extremities is considered a rare neoplasm, corresponding to 5% of soft tissue sarcomas (STS) today. The objective was to evaluate prognostic factors related to death, local recurrence (LR), and impact on survival rates. **Methods:** A retrospective study including 42 patients with UPS in extremities treated surgically in a single center. Comparisons were made between demographic data, characteristics of the neoplasia, and treatment. Between the variables with statistical significance, logistic regression analysis was used. Survival rates were evaluated using Kaplan-Meier plots. To compare the effect of variables on survival rates, the Log-Rank test was used. **Results:** Age group of patients was from 25 to 85 years (mean 58 years), with a mean follow-up of 29.6 months. The variables with the highest effect on survival rates were sizes larger than 15 cm (T4) with $p = 0.01$, presence of metastatic lesions, and prognostic stage IV according to the American Joint Committee of Cancer (AJCC) with $p < 0.001$. The mean survival was 25.9 months. Metastasis and stage IV of AJCC were associated with a reduction in patient survival (17.8 months) with Log-Rank test $p < 0.001$. **Conclusion:** The main factors of poor prognosis related to mortality and reduction of survival of UPS in extremities were metastatic lesions and stage IV of AJCC. **Level of Evidence III, Retrospective Study.**

Keywords: Histiocytoma, Malignant Fibrous. Sarcoma. Prognosis. Recurrence. Death. Survival.

RESUMO

O sarcoma pleomórfico indiferenciado (SPI) de tecidos moles em extremidades, neoplasia rara, correspondente a 5% dos sarcomas de tecidos moles (STM). Objetivo: Avaliar fatores de prognóstico relacionados a óbito, recorrência local (RL) e impacto na sobrevida geral. **Métodos:** Estudo retrospectivo de 42 pacientes com SPI tratados cirurgicamente em centro único. Foram comparados dados demográficos, características da neoplasia e de tratamento; e para as variáveis com significância estatística, foi realizada análise de regressão logística. A sobrevida foi avaliada através de gráficos de Kaplan-Meier; e os efeitos das variáveis sobre a sobrevida, por meio do teste de log-rank. **Resultados:** Os pacientes tinham idades entre 25 e 85 anos (média de 58 anos), com seguimento ambulatorial médio de 29,6 meses. As variáveis com maior relação com o desfecho óbito foram tamanho maior que 15 cm (T4), com $p = 0,01$, metástases e estágio IV de prognóstico da American Joint Committee on Cancer (AJCC), com $p < 0,001$. A sobrevida média dos pacientes foi de 25,9 meses. Presença de metástase e estágio IV da AJCC foram associados à redução na sobrevida dos pacientes (17,8 meses; $p < 0,001$). **Conclusão:** Os principais fatores de mau prognóstico relacionados ao óbito e à redução da sobrevida dos pacientes com SPI foram doença metastática e estágio IV da AJCC. **Nível de Evidência III, Estudo Retrospectivo.**

Descritores: Histiocitoma Fibroso Maligno. Sarcoma. Prognóstico. Recidiva. Morte. Sobrevida.

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INTRODUCTION

Undifferentiated pleomorphic sarcoma (UPS) of soft tissues was initially described in the 1960s in case reports developed by Kaufman and Stout¹ and Ozzello, Stout, and Murray.² In the 1970s, Weiss and Enzinger³ conducted an extensive analysis of cases, describing the neoplasm in detail and establishing it as a primitive mesenchymal lesion with partially fibroblastic and histiocytic differentiation. UPS usually presents in men over 50 years old,

affecting the lower limbs in most cases. Due to its deep structure origin, there is difficulty in early diagnosis and management, with approximately 5% of cases diagnosed with metastatic lesions, the lungs being the main site.^{4,5}

Identifying prognostic factors is one of the main approaches used to improve the efficacy of cancer treatments. These factors are important both in practice and in conducting trials and clinical studies. On the one hand, to select and plan the most appropriate

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treatment, and on the other hand, to enable the analysis of differences in possible study outcomes and identify subgroups for new treatment possibilities.⁶

Due to the various phases related to the evolution of UPS diagnosis since 1960, much of the published data regarding prognostic factors are still associated with the period prior to 2002 when it was still considered as Malignant Fibrous Histiocytoma (MFH) and accounted for virtually 60-70% of soft tissue sarcoma (STS) diagnoses, making the application of these factors inadequate, when considering only UPS cases.⁷

Given the lack of studies available in the Brazilian literature and elaborated by orthopedists involving prognostic factors of UPS, this research focuses on conducting a retrospective analysis of these factors over a period of 30 years. Therefore, the objectives of the study were to identify possible prognostic factors related to death or local recurrence and to identify possible factors that may have an impact on the survival rates of these patients.

METHODS

A retrospective study, conducted at a single center (Institute of Orthopedics and Traumatology of the Hospital das Clínicas of the Universidade de São Paulo [IOT HC FMUSP]) from January 1988 to December 2018. The study was approved by the local ethics committee (CAAE 80667617.2.0000.0068).

Patient-related factors

A total of 202 cases of patients with the diagnosis of MFH or UPS were selected from the institution. All cases were evaluated and classified by two pathologists from the institute, both specialists in musculoskeletal sarcoma cases. Cases considered inoperable (1), located in the head and/or neck, chest, trunk, bones (2), and with any type of cellular differentiation reported in the postoperative pathological report (3) were excluded. Thus, 42 patients were included in the study.

Treatment-related factors

All patients underwent surgical treatment at the institution, with wide and/or radical resection. Surgical margins were classified as negative (the narrow margin was considered negative) or positive, according to the Enneking's stages.⁸ Cases requiring surgical reapproach (debridement, margin enlargement, amputations, and disarticulations) and those who received any type of clinical treatment (radiotherapy or chemotherapy) were also listed.

Variables and outcome measures

All included UPS were considered to be of high histological grade according to the criteria of the French Federation of Cancer Centers (FNCLCC).⁹ Follow-up time was measured in months, within the period between the first and last consultation recorded in the medical records. Lesion size was in accordance with the pathological report, (greater axis in cm macroscopically) and classified according to the soft tissue sarcoma classification from the American Joint Committee on Cancer (AJCC – T1 up to 5 cm, T2 from 6 to 10 cm, T3 from 11 up to 15 cm, and T4 greater than 15 cm).¹⁰ Local recurrence (LR) and distant metastases or lymph node involvement were also reported. Survival rates were estimated from the date of surgical treatment until the date of death or last consultation recorded in the medical records or online system.

Statistical analysis

The data were analyzed using R software version 4.2.0. Continuous variables were described using mean, median, standard deviation, interquartile range, minimum and maximum values. Categorical variables were described using counts and percentages.

The normal distribution of continuous variables was measured using the Shapiro-Francia test. For comparison of continuous variables between two groups, either the T-test or the Wilcoxon test was used depending on the distribution of the variable. Categorical variables were analyzed using Fisher's exact test for two groups, whereas the chi-square test was used for three or more groups. In addition, logistic regression was used to identify the effect of candidate variables on death or local recurrence. Finally, actuarial tables and Kaplan-Meier graphs were used for survival rates analysis of the patients, and the Log-rank test was used to compare the effect of a variable on patient survival. P values lower than 0.05 were considered significant.

RESULTS

Table 1 presents clinical and demographic characteristics of patients.

Deaths

A total of 31 patients died during the study period (74%). The variables that showed some relation with a higher chance of death outcome were: having a size larger than 15 cm (T4) ($p = 0.01$), having stage IV of AJCC prognosis ($p < 0.001$), and having metastasis ($p < 0.001$) (Table 2).

To identify which factors have a greater effect on the risk of death, a logistic regression was performed, which showed that the presence of metastasis and the stage of the lesion were related to an increased risk of death in patients (Table 3). Note that due to the perfect correlation between the presence of metastasis and the occurrence of grade IV tumors, two models were made to demonstrate that both variables had identical coefficients.

Local recurrence

Six patients presented tumor recurrence (14%). None of the studied variables presented statistical significance with the recurrence outcome, however male patients showed a higher tendency to LR (Table 4).

General survival rates

In addition, patient survival rates were demonstrated using a Kaplan-Meier chart, in which it was found that the mean survival rate of patients was 25.9 months (Table 5 and Figure 1).

Finally, we observed the presence of metastasis or of stage IV lesion were significantly associated with a reduction in patient survival rate (Table 5 and Figures 2 and 3).

DISCUSSION

Aggressive clinical behavior is the only aspect of MFH/UPS that remained unchanged since its initial descriptions by Kauffman and Stout;¹ Ozello, Stout, and Murray;² and Kempson and Kyriakos.¹¹ This pathology usually presents with high-grade histological lesions, deep location, and the capacity to reach dimensions larger than 10-15 cm. Unfortunately, it also has high rates of metastatic disease and recurrences, which directly influence disease-free survival and overall survival.^{3,9,12} As MFH/UPS was a leading diagnosis for STS during much of the 1990s, it influenced a whole generation of studies (Figure 4).^{13,14}

With the evolution of auxiliary techniques within the surgical field, MFH/UPS has been gradually losing relevance and, today, it is considered a diagnosis of exclusion that corresponds to approximately 5% of STS.⁴ Thus, being a relatively "new" diagnosis, our study evaluated the main prognostic factors chronologically to compare and analyze possible divergences.

Of the patients involved in the study, 74% died. Using univariate analysis, the variables that showed some relation with a higher

chance of death outcome were having a size larger than 15 cm (T4) ($p = 0.01$), ($p < 0.001$), having metastasis ($p < 0.001$), and having stage IV of AJCC prognosis. Since all stage IV lesions present metastasis, it can be affirmed that they are related variables, a fact that is confirmed through two logistic regression models (Table 3), with identical coefficients. Lesion size and gender showed no relationship after multivariate analysis.

Table 1. Demographic, pathological, and treatment characteristics of 42 patients with UPS.

Variables	Total (%)
Gender	
Men	(20) 47
Women	(22) 53
Age	
Mean	58
Standard deviation	14
Age group	25-85
Site	
Upper limb	12 (29)
Lower limb	(30) 71
Laterality	
Left	(30) 71
Right	12 (29)
Follow-up (months)	
Medium	29.6
Minimum	0.6
Maximum	165.9
Size (cm)	
T1 (0-5)	1 (2)
T2 (6-10)	10 (24)
T3 (11-15)	10 (24)
T4 (> 15)	21 (50)
Size (cm)	
Mean	9
Variation	2-23
Surgery	
Wide resection	(30) 71
Amputation/disarticulation	12 (29)
Margin	
Marginal or intralesional	37 (88)
Affected	5 (12)
Radiotherapy	
Yes	26 (62)
Preoperative	10 (38)
Postoperative	16 (62)
No	16 (38)
Chemotherapy	
Yes	25 (59)
Neoadjuvant	10 (40)
Adjuvant	15 (60)
No	17 (41)
Local recurrence	
Yes	6 (14)
No	36 (86)
Resurgery (two or more surgical procedures)	
Yes	9 (22)
No	33 (78)

These results are similar to the findings of the “new” concepts about the UPS classification.

Before 2002, when there was a change of nomenclature from MFH to UPS, Markhede, Angervall, and Stener¹⁵ analyzed the STS in a multivariate way and pointed out that there is an increased risk of death in patients with recurrence of injury ($p < 0.01$), especially in cases of recurrence in the first two years after surgical treatment. In the post-reclassification phase of MFH, Vodanovich et al.¹⁶ in a multivariate analysis of 266 UPS defined that each passed year since lesion and metastasis diagnosis increased the death chance

Table 2. Variables with statistical significance regarding the occurrence of death.

Variable	Items	Death		Total	Test
		Yes	No		
Stage of injury	IIIA	0 (0%)	5 (100%)	5 (11.90%)	P < 0.0001 (Pearson's Chi-Square Test)
	IIIB	3 (50%)	3 (50%)	6 (14.29%)	
	IV	28 (90.32%)	3 (9.68%)	31 (73.81%)	
	Total	31 (73.81%)	11 (26.19%)	42 (100%)	
Size of injury	T1-T3	12 (57.14%)	9 (42.86%)	21 (50%)	P = 0.0140 (Fisher's Exact Test)
	T4	19 (90.48%)	2 (9.52%)	21 (50%)	
	Total	31 (73.81%)	11 (26.19%)	42 (100%)	
Presence of metastasis	No	3 (27.27%)	8 (72.73%)	11 (26.19%)	P = 0.002 (Fisher's Exact Test)
	Yes	28 (90.32%)	3 (9.68%)	31 (73.81%)	
	Total	31 (73.81%)	11 (26.19%)	42 (100%)	

Table 3. Logistic regression models regarding the occurrence of death and their respective coefficients.

	Metastasis	Tumor grade
(Intercept)	-1.74	-1.74
	-1.08	-1.08
Gender (men)	0.23	0.23
	-1.01	-1.01
Metastasis (yes)	3.14*	N/A
	-1.01	
Lesion size (T4)	1.74	1.74
	-1.05	-1.05
Stage of injury (IV)	N/A	3.14*
		-1.01
N	42	42
Pseudo R2	0.53	0.53

* $p < 0.01$; (): standard deviation.

Table 4. Demographic data of the population in relation to the occurrence of local recurrence of the lesion.

Variable	Items	Local Recurrence		Total	Test
		Yes	No		
Older than 60 years	No	3 (14.29%)	18 (85.71%)	21 (50.00%)	p = 1.0000 (Fisher's Exact Test)
	Yes	3 (14.29%)	18 (85.71%)	21 (50.00%)	
	Total	6 (14.29%)	36 (85.71%)	42 (100.00%)	
Age	Min/Max	36.0/74.0	25.0/85.0	25.0/85.0	p = 0.7322 (T test)
	Med [IQR]	62.5 [56.5;69.2]	59.5 (-51.2;67.5)	59.5 [52.0;69.2]	
	Average (SD)	60.2 (13.7)	57.9 (15.0)	58.2 (14.6)	
	N	6 (14.29%)	36 (85.71%)	42 (100.00%)	
Gender	Men	5 (25.00%)	15 (75.00%)	20 (47.62%)	p = 0.0866 (Fisher's Exact Test)
	Women	1 (4.55%)	21 (95.45%)	22 (52.38%)	
	Total	6 (14.29%)	36 (85.71%)	42 (100.00%)	

Med: median; IQR: interquartile range; SD: standard deviation.

Table 5. Table containing the results of survival tests for death.

Item	Time up to 50% survival	LOGRANK Test
General	25 months	--
Presence of metastasis	Yes: 17.8; No: N/A	p < 0.001
Stage of injury	IIIA-B: N/A; IV: 17.8	p < 0.001

N/A: not applicable (population did not reach values less than 50% survival).

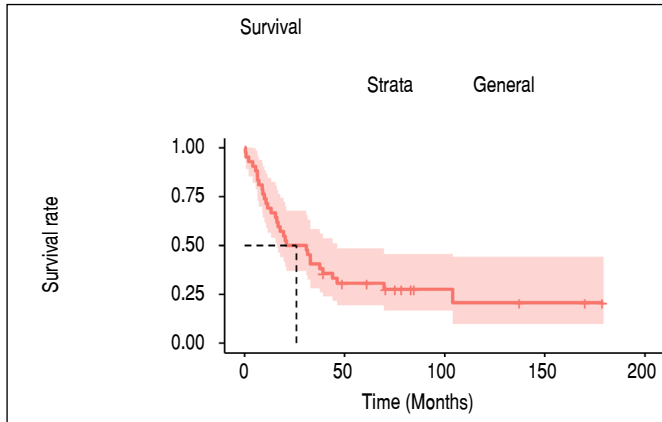


Figure 1. Survival time without death of the cohort studied. Dotted line indicates median survival time of the population.

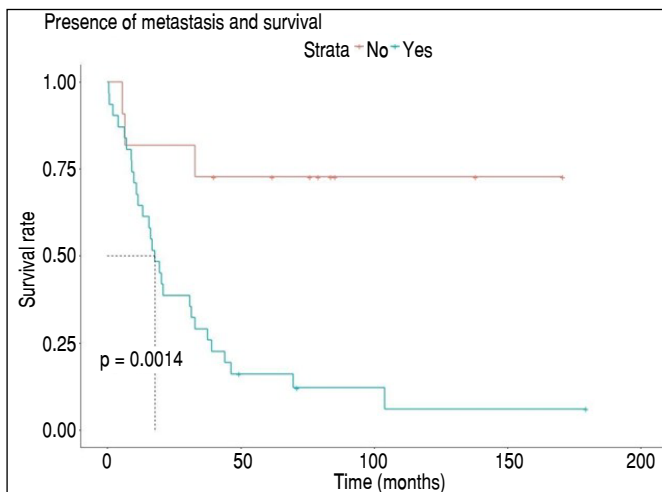


Figure 2. Survival time without death of the cohort studied in relation to the presence of metastasis. Dotted line indicates median survival time of the subpopulation. Dotted line indicates median survival time of the subpopulation.

(risk ratio 1.03 and 2.89, $p < 0.001$ and $p = 0.001$ respectively) and that lesions in the upper limbs have a lower chance of death (risk ratio 0.57 and p value = 0.043).

Around 15% of the sample presented LR. Among the variables analyzed, none presented statistical significance, but men showed a tendency to have LR of the lesions ($p = 0.086$). Age and stage of injury did not show statistical significance.

Kearney, Soule, and Ivins¹² evaluated 167 cases of STS retrospectively, with an LR rate of 51% and more than half with more than one episode. Among patients with fascia superficial tumors, 71% presented LR after “complete excision”; high rates are apparently associated with less aggressive resections, longer survival (therefore, more timely for recurrence), and greater ease for detection of palpation. In addition, of the superficial cases, 31% were diagnosed as deep lesions to the fascia. Markhede, Angervall, and Stener,¹⁵ Pisters et al.¹⁷ and

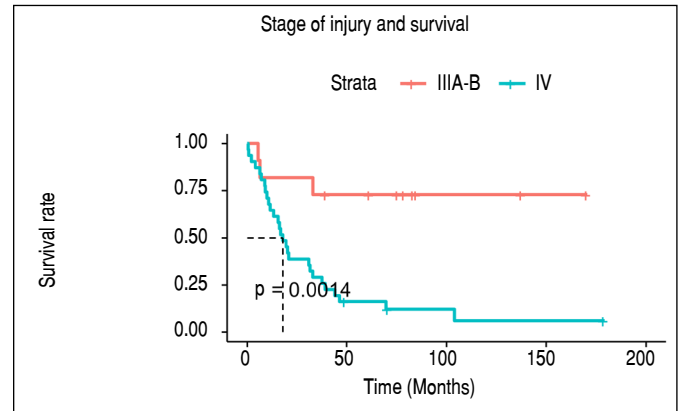


Figure 3. Survival time without death of the cohort studied in relation to the stage of the lesion. Dotted line indicates median survival time of the subpopulation.

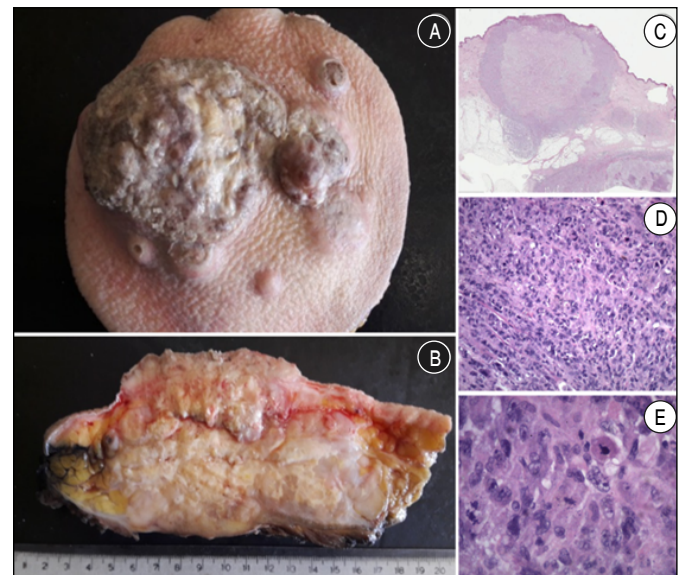


Figure 4. A and B: Macroscopy; soft tissue tumor in the hip, surface with ulcerated center. Affects a deep margin; C, D and E: Microscopy (H&E) revealing cytological and nuclear pleomorphism. The tumors often contain giant cells, spindle cells, and histiocyte-like round cells in varying proportions. Storiform cell patterns and chronic inflammatory stroma are also common. The spindle component resembles fibroblasts, myofibroblasts, or smooth muscle patterns.⁴

Source: A courtesy from pathology IOT HC FMUSP/CEDAP Joinville.

Gibbs et al.¹⁸ presented statistically relevant results, relating LR with inadequate surgeries or margin of the affected lesion in up to 76.2% of the relapsed disease in patients.

Considering recent evaluations (after 2002), Vodanovich et al.¹⁶ and Ozcelik et al.¹⁹ also showed results associating RL with affected margins in univariate and multivariate analyses, a fact that does not corroborate with the data shown in the present study.

The recurrence variable also correlates with radiotherapy treatment. Ozcelik et al.¹⁹ reported good results considering perioperative radiotherapy ($p = 0.009$ and $p = 0.000$ respectively).

Although it is a variable without impact in our cohort, advanced age showed statistical significance in the prospective study of Pisters et al.¹⁷ for patients ≥ 50 years. Vodanovich et al.¹⁶ also presented statistical significance in multivariate analysis for patients ≥ 70 years ($p < 0.016$, RR 1.6; $p = 0.046$, HR 1.03).

The authors speculate that such differences may occur due to the small sample size added to the high mortality rate of the disease causing few patients in the sample to present LR.

The mean survival of the patients in this study was demonstrated through the Kaplan-Meier graph (Figure 2), with an average of 25.9 months. Presence of metastasis or stage IV AJCC prognosis presented close relationship with the reduction of survival rates, with a mean of 17.9 months ($p < 0.001$).

Among the analyses that precede the reclassification of MFH, Kearney, Soule, and Ivins,¹² Pisters et al.,¹⁷ and Gibbs et al.¹⁸ demonstrated that proximal tumors that affect the pelvis and proximal region of the thigh, are of worse prognosis, affecting the survival rates of these patients; the last two authors consider them as independent prognostic factors.

The size of tumors was also associated with worse survival by some authors. Pezzi et al.¹³ described that survival rates were 82% in patients with lesions up to 5 cm, 68% in cases of 5-10 cm, and 51% for lesions greater than 10 cm with $p < 0.05$. Pisters et al.¹⁷ and Gibbs et al.¹⁸ corroborate with the finding through multivariate analysis, in which tumors ≥ 10 cm showed a high correlation with worse survival rates (risk ratio 1.5 and $P < 0.001$, respectively). However, in the studies by Kearney, Soule, and Ivins¹² and Markhede, Angervall and Stener,¹⁵ tumor sizes had no impact on survival, a fact that aligns with the results of our study.

The histological grade of tumors was another constant variable in survival analyses, considered a poor prognostic factor.^{15,17,18} Gibbs et al.¹⁸ and Pisters et al.¹⁷ also evaluated patients at the time of lesion diagnosis and patients who already presented metastatic lesions or local recurrence to measure their effects on survival rates ($p = 0.0002$ and risk of 1.5, respectively).

Correlating studies from different periods, the main prognostic factors related to worsening of survival rates were size ($p = 0.02$) and presence of metastasis at diagnosis ($p = 0.001$) increasing

the risk of mortality by almost 500% compared to patients without metastasis.¹⁷ The presence of metastatic lesions during the disease showed a negative correlation with survival in our study and in the analyses of Ozcelik et al.¹⁹ with $p < 0.001$ and $= 0.004$, respectively.

Study limitations

The short time to conduct the project and the rare diagnosis (small sampling) studied requires a retrospective design study. This design brings disadvantages, mainly due to systematic errors. Selection bias occurred since it is a single reference center for cancer cases, so there is a higher incidence of severe cases. Confusion bias can also end up influencing outcomes, such as survival rates. Since not every case has the defined cause of death (related to the disease itself or another secondary cause), comorbidities may end up influencing outcomes. The fact that patients received orthopedic and clinical care in independent sectors also generates limitations since it restricts information, such as the chemotherapy and radiotherapy protocols and the exact date of occurrence or recurrence of metastasis. Immunohistochemical reassessment of each case became financially unfeasible since it is a study with independent funding.

CONCLUSIONS

This study demonstrated that the main factors of poor prognosis related to death were size larger than 15 cm (larger diameter), metastatic disease, and stage IV of AJCC prognosis; for recurrence, no variable studied presented statistical relevance, although male patients showed a higher tendency to LR. In terms of survival rates, the main factors related were the presence of metastatic lesions and the stage IV of prognosis.

Despite this study being relevant to assist medics in the development of strategies for the treatment of patients, new studies with larger cohorts and with the possibility of immunohistochemical reassessment are necessary to confirm our findings.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. CHMJ: activity planning, data collection, article writing, interpretation of results; AMB: interpretation of study results, review and approval of the final version; OPC: conception and planning of the activities that led to the study, approval of the final version; RZF, ETO: data collection and analysis.

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EVALUATION OF EARLY TREATMENT OF IDIOPATHIC CLUBFOOT USING THE PONSETI METHOD

AVALIAÇÃO DO TRATAMENTO PRECOCE DO PÉ TORTO CONGÊNITO IDIOPÁTICO PELO MÉTODO DE PONSETI

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ABSTRACT

Congenital clubfoot is one of the most common congenital deformities of the lower limbs, with an estimated incidence of 1 for every 1,000 live births. Its treatment is controversial, and currently the Ponseti method has been widespread, showing promising results and decreasing the need for extensive surgical releases, as was usually done until the introduction of the technique. Currently used in approximately 55 countries, the method has changes and scopes that vary according to the society in which it is applied, with the results and peculiarities of the method molded according to the sample studied. Objective: To evaluate the clinical outcome of clubfoot treatment using the Ponseti method under local conditions. Methods: The clinical evaluation will include a descriptive analysis of the sample, as well as radiographic evaluation and family satisfaction with the treatment. Results: In total, 46% of the patients had good results and no family was dissatisfied with the treatment results. No statistically relevant relationships were found between the studied variables. Conclusion: The results are good and generally similar to those in the literature. Our epidemiological data generally agree with those reported by other authors. **Level of Evidence IV, Case Series.**

Keywords: Congenital Abnormalities. Foot Deformities. Clubfoot.

RESUMO

O pé torto congênito (PTC) é uma das deformidades congênitas mais comuns dos membros inferiores, com incidência estimada de um para cada 1.000 nascidos vivos. Seu tratamento é motivo de controvérsia, mas, atualmente, o método de Ponseti tem sido difundido, mostrando resultados promissores e diminuindo a necessidade das liberações cirúrgicas extensas, como geralmente se fazia até a introdução da técnica. Utilizado em aproximadamente 55 países, o método apresenta alterações e alcances que variam de acordo com a comunidade em que é aplicado, sendo o resultado e as peculiaridades do método moldados de acordo com a amostra estudada. Objetivo: Avaliar o resultado clínico do tratamento do PTC através do método de Ponseti em condições locais. Métodos: A avaliação clínica incluiu uma análise descritiva da amostra, além de avaliação radiográfica e satisfação da família com o tratamento. Resultados: 46% dos pacientes apresentaram bons resultados e nenhuma família se mostrou insatisfeita. Não foram encontradas relações estatisticamente relevantes entre as variáveis estudadas. Conclusão: Os resultados são bons e, de maneira geral, semelhantes àqueles da literatura. Há, também, concordância geral dos dados epidemiológicos deste estudo com os relatados por outros autores. **Nível de Evidência IV, Série de Casos.**

Descritores: Malformações Congênitas. Deformidades do Pé. Pé Torto Equinovaro.

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INTRODUCTION

Congenital clubfoot (CCF) is a complex three-dimensional deformity that results from the association of equinus, cavus, varus, and adductus foot.¹ The condition has an approximate incidence of one case per 1,000 live births among white people, but this number varies according to the population studied² and affects both sexes and ethnicities.³ Most CCF cases occur isolated, called "idiopathic" (iCCF) due to their unknown cause. However, around 20% of cases are associated with underlying diseases, classified as "teratological."⁴

The treatment has been challenging, with manipulations and bandages being recommended by Hippocrates. Therapy has become more aggressive, with wrench-like devices being developed, which forced the correction of the foot, actually crushing the bones.⁵ Then, conservative treatment was reestablished, culminating in Kite,⁶ which was slow and presented uncertain results. Kite's technique was associated with early but increasingly extensive surgical releases until reaching the "circumferential release of the foot",⁷ still unsatisfactory. This scenario changed with Laaveg and Ponseti,⁸ who created a new concept of the type of manipulation and plaster cast, associated or

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

The study was conducted at Universidade de São Paulo, Faculdade de Medicina de Ribeirão Preto, Hospital das Clínicas, Departamento de Ortopedia e Anestesiologia. Correspondence: Caio Luiz de Toledo Oliveira. R. Euclides da Cunha, 264, Santos, SP, Brazil, 11065100. caiooledo@gmail.com

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not with percutaneous Achilles tenotomy and a prolonged use of the Denis Browne splint. This resulted in well-corrected and flexible feet and lower rate of recurrences.

Due to its effect, this method is now widespread, well established, being used in over 50 countries.⁹ Many Brazilian authors have already published their results, which were mostly favorable.¹⁰⁻¹² Our institution has been using this method for several years; however, the results must be always reevaluated and compared to those of the literature. Thus, this study aimed to analyze the results of cases of idiopathic congenital clubfoot treated early by the Ponseti method.

METHODS

This is a retrospective observational study of data from patients with idiopathic congenital clubfoot, who underwent treatment with the Ponseti method from 2011 to 2016. This study was approved by the Research Ethics Committee of the Hospital das Clínicas of the Ribeirão Preto Medical School of the University of São Paulo (Opinion No. 13,034-2019, approved on 12/02/2019). Individuals who started treatment until three months of age were included, whereas those who started treatment in another institution or were treated by other methods were excluded. Patients with irregular follow-up, who interrupted the treatment, or whose medical records were unavailable were also excluded. The minimum follow-up time after treatment was established as 12 months.

In total, 142 children with congenital clubfoot were treated during this period, 53 of which being included in the study, totaling 74 feet. Data such as gender, laterality, classification according to Pirani, Staheli, and Naddumba,¹³ number of exchanges, need for tenotomy, recurrences, and follow-up time were obtained.

In the institution, treatment is initiated by foot manipulation, according to Ponseti's strict orientation,¹⁴ then, plaster immobilization is performed in the position in which the foot could be manipulated. Radiographic evaluation was performed in the first and last appointments. Kite's angles (talocalcaneal) were measured in the anteroposterior and profile incidences before and after treatment (Figures 1 and 2), as well as the relation between the forefoot and hindfoot bones using the relation between the long axes of the talus and calcaneus with the first and fourth metatarsals, respectively (Figure 3).

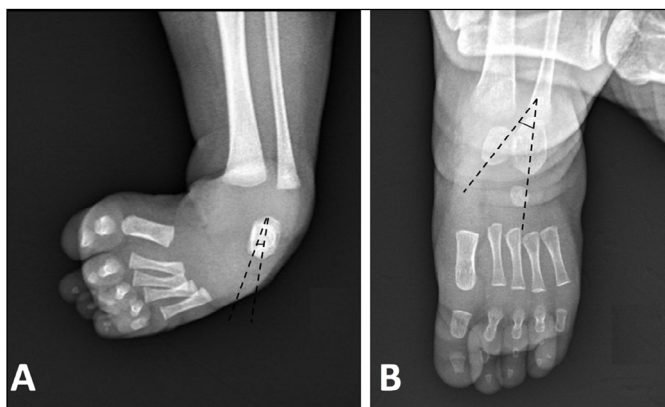


Figure 1. Illustration of the determined longitudinal axes of the talus and calcaneus on radiographs in the anteroposterior incidence of the foot (Kite's angle). (A) The idiopathic congenital clubfoot presents overlap of the two bones expressed by the smallest opening angle between them; (B) the corrected foot presents separation between the bones and the shafts are very divergent.

Source: Arquivo da Disciplina de Ortopedia Pediátrica e Afecções do Pé, Hospital das Clínicas of the Ribeirão Preto Medical School of the Universidade de São Paulo.



Figure 2. Illustration of the determined angle between the talus and calcaneus in the lateral incidence (Kite's angle). (A) Before treatment; (B) after treatment. When the foot is not corrected, the angle vertex is in the dorsal region. After correction, the angle should be on the midfoot, preferably on the cuboid ossification center.

Source: Arquivo da Disciplina de Ortopedia Pediátrica e Afecções do Pé, Hospital das Clínicas of the Ribeirão Preto Medical School of the Universidade de São Paulo.

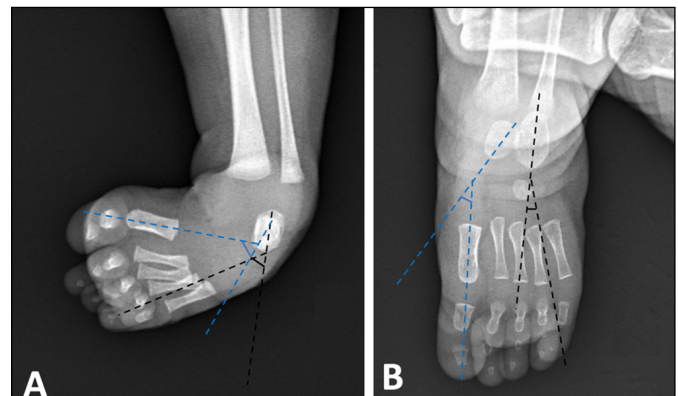


Figure 3. Illustration of the determined longitudinal axes of the talus and calcaneus on radiographs in the anteroposterior incidence of the foot. In the radiographs in the anteroposterior incidence, lines were drawn based on the longitudinal axes of the talus and calcaneus, along the first metatarsal, as well as in the space between the fourth and fifth metatarsals for evaluation of the forefoot deviation. (A) In the idiopathic congenital clubfoot, these lines are broken, and the corresponding angles increased; (B) in the normal foot, the longitudinal axis of the talus coincides or points medially to the bone of the first metatarsal, and the axis of the calcaneus coincides with the alignment between the fourth and fifth metatarsals.

Source: Arquivo da Disciplina de Ortopedia Pediátrica e Afecções do Pé, Hospital das Clínicas of the Ribeirão Preto Medical School of the Universidade de São Paulo.

The Assessing Clubfoot Treatment (ACT) satisfaction index¹⁵ was applied (Chart 1). Information were obtained from the families by phone calls. Out of the 53 cases, 33 families were contacted (44 feet). Simple and multiple logistic regressions were used to test the associations between treatment satisfaction and potential variables. Statistical analyses were performed with the RStudio software (version 1.1.456), and all tests considered $p < 0.05$ as statistically significant.

Chart 1. Questionnaire to evaluate clinical results, according to family members.

Score	Questions			
	What do you consider to be the shape of your child's foot?	Does your child complain of foot pain?	Can your child wear any type of footwear?	Are you satisfied with the treatment of your child's feet?
	Answer option			
0	Very altered	Yes, and with frequent limitations	Never	Very dissatisfied
1	Altered	Yes, but it rarely limits their activities	Rarely	Dissatisfied
2	Almost normal	Yes, but it does not limit their activities	Almost always	Satisfied
3	Normal	No	Always	Very satisfied

RESULTS

Out of the 53 patients selected for the study, 35 (66%) were boys and 18 (34%) girls; 34 had unilateral iCCF (64%), 18 in the left foot (52%), and 16 in the right foot (48%). Statistical relationship between sex and either good or bad results ($p = 0.93$), or between bilaterality and treatment results ($p = 0.33$), was not found. Mean follow-up time was 50 months, with a minimum of 12 months, and a maximum of 98 months. Mean number of plaster exchanges was 7.41 per patient, with a minimum of four and maximum of 16. Mean age at the beginning of treatment was 42 days, with a minimum of four days and maximum of 82 days. Likewise, no statistically relevant relationship was found between the number of exchanges and treatment results ($p = 0.11$).

Out of the 74 feet evaluated, 63 (85%) underwent percutaneous Achilles tenotomy. Mean initial Pirani score was 5.1, suggesting the occurrence of severe feet. We found no statistical relationship between the Pirani classification score and treatment results ($p = 0.13$).

We observed a mean increase of 18.73° in the talocalcaneal angle, in the anteroposterior incidence after treatment (178%). In total, 38 feet (51.3%) presented a talocalcaneal angle greater than or equal to 30° after treatment, a value considered satisfactory by Ponseti. In the relationship between the hindfoot bones, 21 out of the 71 feet (29.5%) presented correction of the axes after treatment. In the lateral incidence, 23 (44.1%) of the feet showed a reduction in the angle, whereas 28 (54.9%) showed an increase; 23 of them could not be compared.

Out of the 21 recurrences (40%), 18 patients required surgical interventions and, of these, 12 (57%) presented reports of incorrect orthosis use during follow-up in the medical records. Considering the number of feet, 33 out of 74 (39%) presented recurrence, and of these, 26 required surgery (35%). In total, 15 feet were subjected to anterior tibial translation associated or not with combined wedge osteotomy in the cuboid and navicular. Recurrences in four patients were treated exclusively with a plaster cast, and two were subjected to *à la carte* posteromedial release.

All 33 family members contacted (47 feet) answered the questionnaire. Regarding pain, 25 (75.7%) reported no complaints, six (18.1%) reported sporadic pain that did not limit activities. Two cases (6.2%) reported pain complaints with limitation of activities, even if not very often.

Regarding footwear wear, 23 families (69.6%) answered that their child wore any type of footwear, and two patients were could rarely wear any footwear (6%).

Regarding foot shape, 10 families (30.3%) answered that it was normal, 15 families (45.5%) reported that the feet were practically normal, seven families (21.2%) reported that the children had feet different than the usual, and one family (3%) reported that one foot presented a very different shape.

Regarding general satisfaction with the treatment, 22 families (66.6%) were very satisfied, 11 families (33.4%) were satisfied, and no family declared to be dissatisfied or very dissatisfied with the treatment. Table 1 shows data and clinical score.

Seven families scored ≤ 8 (21.2%), whereas 15 (45.5%) scored 11 and 12. Eleven families scored 9 or 10 (33.3%).

Simple and multiple logistic regressions were used to test the associations between treatment satisfaction and potential variables. None of the correlations studied were statistically significant.

DISCUSSION

The Ponseti method is considered a major advance in the treatment of CCF, with unprecedented results, as many feet achieved a normal or almost normal appearance and maintained flexibility. Recurrences are usually not severe, being corrected with new plasters or smaller surgeries. If surgery is required, anterior tibial translation is the most common.¹⁴ Overall, our results confirm these impressions. The epidemiological data of our population were similar to those reported in the literature regarding gender,² bilaterality,^{2,16} slightly differing regarding the similar involvement of the sides when compared with other reports,^{2,16,17} which probably represents only regional and typical variations of the sample. In Brazilian literature, Jaqueto et al.¹² found that 64.5% of males were affected and 80.6% of incidence in the right foot.

Our results of mean plaster exchange before indicating tenotomy are also in accordance with most of the reports.^{18,19} This information is important as it reflects the proper indication of the technique and the adherence of the families. When the number of plaster exchanges is very discrepant, they serve as a warning for the identification of possible problems, especially for public institutions working with resident physicians. Although Lourenço and Morcuende²⁰ reported that 90% of their patients required less than five plaster changes; this result may reflect local characteristics not observed in other regions or countries.

Regarding the need for Achilles tenotomy for equine correction, this occurred in 85% of our sample, similarly to that of other authors.^{14,18,20}

The percentage of recurrences is a very relevant data in the treatment of any deformity and in this case was around 40%. In his first series, Ponseti showed that up to 56% of his patients also needed a new approach after the end of treatment, whether surgery or plaster exchange.¹⁴ However, "recurrence" is comprehensive term that can be subjective. We evaluated the association between recurrences and the number of plaster changes ($p = 0.96$), initial Pirani score ($p = 1.00$), need for tenotomy, and age at the beginning of treatment ($p = 0.72$), and found no statistically significant association. The concepts of these parameters are also not clear

Table 1. Degree of satisfaction, score from 0-12 points.

Score	Number of families	Percentage	Results
6	1	3%	Bad
7	1	3%	
8	5	15%	
9	5	15%	Regular
10	6	18%	
11	6	18%	Good
12	9	28%	
Total	33	100%	

in the literature, which makes difficult a comparison against other results.

Originally, radiographic measurements had been proposed by Ponseti since his first publications on the method; however, good correlations between radiographic findings and clinical findings could never be established. Our analysis showed that 51.3% of the feet had a talocalcaneal angle above 30°. Considering only radiographic parameters, the correction rate in our patients would be 29.5-51%. In the lateral incidence, Kite's angle measurement presents great variation in normal patients, with normal considered 17-46°.14 Among the radiographs analyzed, only 28 (54%) of them presented an increase in the talocalcaneal angle that would be compatible with a decrease in the varus of the hindfoot. These results reinforce Ponseti's statement that the cases present clinicoradiographic dissociation. Other authors have also shown the limitation of radiographs to evaluate the Ponseti method, as they seem not that much useful to evaluate the efficacy of treatment if analyzed separately.21

Ponseti also proposed a system for evaluating CCF results that considers six parameters, in which the sum of their scores would have a maximum of 100 points.14 Recently, Smythe et al.15 presented a tool called ACT (Assessing Clubfoot Treatment) to establish a score that shows a good relationship with clinical evaluation. Given the many different forms of evaluations of CCF treatment, none of them seem to be validated and full accepted as standard. The results of our functional clinical evaluation showed that five patients (15.1% of those contacted) scored ≤ 8 , which would require a reevaluation;

however, no family reported dissatisfaction with the results of the treatment. This scenario may indicate the low expectation of family members regarding the result, especially when compared with the initial aspect of the foot.

This study has limitations for data analysis and association due to the observational retrospective design. Studies on CCF must carefully evaluate sample profile, treatment results and its complications. Further studies can be conducted implementing follow-up protocols that facilitate data collection and standardization, as well as objective and functional resources to access the results, such as baropodometry and gait analysis, which, however, could only be addressed in studies of a prospective design. Furthermore, evaluation of flexibility and muscle strength of the feet should have been included, which were disregarded since we found no objective methods in the literature that could be applied in children of different ages.

In short, the comparison of our results mostly agrees with those of the literature, presenting epidemiological data within parameters already known, weak association between radiological and clinical results, and 46% of good results with treatment.

CONCLUSION

The results of iCCF treatment by the Ponseti method in the population studied are good and generally similar to those in the literature. Our epidemiological data also generally agrees with those reported by other authors.





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FACTORS ASSOCIATED WITH THE OUTCOMES OF OLDER PATIENTS OPERATED DUE TO HIP FRACTURES

FATORES ASSOCIADOS AOS DESFECHOS DE PACIENTES IDOSOS OPERADOS POR FRATURAS DO QUADRIL

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ABSTRACT

Objective: Evaluating clinical factors associated with mortality in older patients who underwent surgical correction of hip fractures. **Methods:** This observational and retrospective study analyzed the medical records of 67 patients (aged older than 60 years), both men and women, who underwent surgical correction of hip fractures from 2019 to 2020 at Hospital São Paulo. The following variables were analyzed: age, sex, presence of comorbidities, affected hip region, and trauma mechanism. Statistical analyses were performed using the SPSS software. **Results:** The mean age of patients was 78.12 ± 9.80 years and 80.6% of the sample were women. The prevalence of hip fractures on the right side (52.2%), in the transtrochanteric region (53.7%), and due to fall on the same level (88.1%) was higher. Systemic arterial hypertension (77.6%), diabetes mellitus (37.3%), and dementia (16.4%) were frequent comorbidities. The prevalence of death after fracture was 17.9% and it was associated with longer hospital stay after surgery ($p = 0.028$). **Conclusion:** The prevalence of mortality of patients with hip fractures who underwent surgery was 17.9%. A longer hospital stay due to pre-existing comorbidities was the main factor related to this outcome. **Level of Evidence III, Retrospective Study.**

Keywords: Hip Fractures. Femoral Fractures. Mortality. Retrospective Studies. Risk Factors. Orthopedic Procedures.

RESUMO

Objetivo: Avaliar os fatores clínicos associados à mortalidade em pacientes idosos submetidos ao tratamento cirúrgico para correção de fraturas do quadril. **Métodos:** Estudo observacional e retrospectivo de análise de prontuários de 67 pacientes (idade superior a 60 anos). Foram incluídos indivíduos de ambos os sexos, submetidos ao tratamento cirúrgico para correção de fraturas do quadril, entre 2019 e 2020, no Hospital São Paulo. Foram analisadas as variáveis: idade, sexo, presença de comorbidades, região do quadril acometido e mecanismo de trauma. As análises estatísticas foram realizadas pelo software SPSS. **Resultados:** A idade média dos participantes foi de $78,12 \pm 9,80$ anos, e 80,6% da amostra era constituída por mulheres. Houve maior prevalência de fraturas do quadril no lado direito (52,2%), na região transtrocanterica (53,7%) e causada por queda sem desnível (88,1%). Hipertensão arterial sistêmica (77,6%), diabetes mellitus (37,3%) e demência (16,4%) foram frequentes. A prevalência de óbito após a fratura foi de 17,9%, sendo associada a maior tempo de internação hospitalar após a cirurgia ($p = 0,028$). **Conclusão:** A prevalência de mortalidade dos pacientes com fratura do quadril submetidos à cirurgia foi de 17,9%. O tempo prolongando de internação hospitalar por comorbidades pré-existentes foi o principal fator relacionado a este desfecho. **Nível de Evidência III, Estudo Retrospectivo.**

Palavras-chave: Fraturas do Quadril. Fraturas do Fêmur. Mortalidade. Estudos Retrospectivos. Fatores de Risco. Procedimentos Ortopédicos.

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INTRODUCTION

Population aging is a worldwide phenomenon in a progressive increase. By 2050, the number of older adults in the world is estimated to be about 2 billion.¹ The epidemiology of fractures also tends to increase, with 4.5 million cases estimated for 2050.² In Brazil, population aging poses new challenges for health services, since, as the older population increases, fragility fractures (hip, shoulder, wrist, and spine) affect an increasingly significant number of individuals.³⁻⁷

In general, treatment in geriatric trauma needs special attention, as it requires specialized services and longer hospital stay, increasing morbidity and mortality and the costs of health services.^{3,8} In this scenario, hip fractures stand out, since they are associated with severe complications, such as increased rates of admission in intensive care units, risk of infection, and mortality.⁹⁻¹¹ High-energy mechanisms such as traffic accidents, falls from great heights, and firearm injuries are the most frequent cause of fractures among young adults, whereas low-energy traumas

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The study was conducted at Universidade Federal de Sao Paulo, Escola Paulista de Medicina, Departamento de Ortopedia e Traumatologia. Correspondence: Fernando Gonzalez Corrêa. Rua Napoleão de Barros, 715, 1st floor, Sao Paulo, SP, Brazil, 04024002. fer_correa89@hotmail.com

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such as simple falls are more frequent among older adults with less unstable fracture traits.^{9,12} Moreover, fracture characteristics, anatomical site, and severity can also be influenced by factors related to bone density quality.^{12,13}

We found other peculiarities in the process of fracture healing in older adults. A decrease in the healing potential results in lower rates of healing or bone nonunion and, consequently, higher mortality risk.^{3,12} Among factors associated with mortality after hip fracture, advanced age, female sex, the presence of comorbidities, surgical delay, the type of anesthesia, and altered laboratory tests play an important role.^{8,9} Thus, handling with manageable risks in the treatment schedule of older patients with proximal femoral fractures is mandatory.¹³ Moreover, studies on the outcomes of these patients are essential for the development of national policies focused on assisting health care professionals in creating more effective preventive strategies. Thus, this study aims to evaluate the clinical factors related to mortality in older patients who underwent surgical correction of hip fractures at Hospital São Paulo.

METHODS

Type of study

This observational and retrospective study collected data from the medical records of patients treated at Hospital São Paulo by the Department of Orthopedics and Traumatology of the Paulista School of Medicine (UNIFESP). The study respects the ethical and legal aspects of studies with human beings and was approved by the Research Ethics Committee of the Universidade Federal São Paulo (no. 5.143.826).

Casuistry

This study was based on the analysis of medical records of patients older than 60 years, both men and women, who underwent surgical correction of hip fractures at Hospital São Paulo from January 1, 2019, to January 1, 2020, with outpatient follow-up for one year. Patients with incomplete or outdated medical records or who did not agree with the terms of consent to participate in the study were excluded. Deaths during hospitalization or outpatient follow-up were considered.

Data collection

Researchers analyzed cases exclusively by electronic medical records. The following data were collected: age, sex, presence of comorbidities (systemic arterial hypertension and diabetes mellitus), trauma mechanism, type of fracture (intracapsular or extracapsular), preoperative time (from admission to surgery), postoperative time (from surgery to hospital discharge), total length of hospital stay, type of surgery (osteosynthesis or arthroplasty), clinical outcome (survival or mortality), laterality, and autonomy to walk before fracture. Researchers neither collected data in person nor had access to the name or hospital record of patients, ensuring their anonymity.

Statistical analysis

Data were placed in an Excel spreadsheet for further analysis regarding age, sex, and pre-existing diseases related to clinical outcomes after surgical treatment of fractures. Descriptive analyses were presented in absolute numbers (n) and relative frequencies (%), along with mean and standard deviation. Statistical analyses were performed using the SPSS software (version 21). For statistical significance, the established cutoff value was $p < 0.05$.

RESULTS

This study included 67 older patients, with a mean age of 78.12 ± 9.80 years. Most patients were women (80.6%; $n = 54$).

Among comorbidities at admission, systemic arterial hypertension (77.6%; $n = 52$) stood out, followed by diabetes mellitus (37.3%; $n = 25$). Older patients with some degree of dementia confirmed by geriatric clinical examinations represented 16.4% ($n = 11$) of the sample. Most cases were femoral fractures on the right side (52.2%; $n = 35$) and transtrochanteric fractures (53.7%; $n = 36$). Among patients, 64.2% ($n = 43$) walked almost exclusively at home and 34.3% ($n = 23$) were able to walk both inside and outside the home before fracture. The main cause of femoral fracture was fall from the same level (88.1%; $n = 59$). The prevalence of death due to femoral fracture was 17.9% ($n = 12$) even after surgery. Regarding hospital parameters, length of hospital stay was 8.45 ± 5.63 days, preoperative time was 3.32 ± 3.91 days, and postoperative time was 4.52 ± 3.894 days (Table 1).

Table 1. Characteristics of older patients who underwent surgical correction of hip fractures at Hospital São Paulo from 2016 to 2021.

Variables	Frequency	%
Gender		
Men	13	19.4
Women	54	80.6
Total	67	100
Systemic arterial hypertension		
No	15	22.4
Yes	52	77.6
Total	67	100
Diabetes mellitus		
No	42	62.7
Yes	25	37.3
Total	67	100
Dementia		
No	56	83.6
Yes	11	16.4
Total	67	100
Laterality		
Right	35	52.2
Left	32	47.8
Total	67	100
Functional status		
Walked at home	43	64.2
Walked inside and outside home	23	34.3
Other [#]	1	1.5
Total	67	100
Diagnosis		
Femoral neck fracture	23	34.3
Transtrochanteric fracture	36	53.7
Other [%]	8	11.9
Cause		
Fall from the same level	59	88.1
Traffic accident	1	1.5
Other [*]	7	10.4
Total	67	100
Final outcome		
Non-mortality	55	82.1
Mortality	12	17.9
Total	67	100

[#]Bedridden, and paraplegic patients and wheelchair users; [%]Multiple femoral fractures and diaphyseal femoral fractures; ^{*}Unwitnessed fall, prophylactic fixation (myeloma), physical aggression, and pathologic fracture; n: sample number.

To analyze epidemiological and clinical factors that influenced outcomes, patients were divided into two groups: non-mortality (82.10%; n = 55) and mortality (17.90%; n = 12). However, groups had no significant difference between them (Table 2)

Regarding numerical variables, patients with mortality outcome had longer hospital stay (11.67 ± 7.19 days) compared to patients with non-mortality outcome (7.75 ± 5.045 days) ($p = 0.028$; Table 3). Patients who died also had higher mean age, more comorbidities, and longer preoperative and postoperative time. However, we found no significant differences ($p \geq 0.050$).

To assess if length of hospital stay increased mortality risk, a binary regression model was made, including the variables length of hospital stay and preoperative and postoperative time. Hospitalization time increases the risk of death with borderline p-values (OR = 1.127; $p = 0.057$) (Table 4).

Table 2. Association of epidemiological and clinical aspects with the outcome in patients who underwent surgical correction of hip fractures.

Variables	Non-mortality (n = 55)		Mortality (n = 12)		p
	n	%	n	%	
Gender					0.227 [#]
Men	9	16.40%	4	33.30%	
Women	46	83.60%	8	66.70%	
SAH					0.443 [#]
No	11	20.00%	4	33.30%	
Yes	44	80.00%	8	66.70%	
DM					0.751 [†]
No	35	63.60%	7	58.30%	
Yes	20	36.40%	5	41.70%	
Dementia					0.400 [#]
No	47	85.50%	9	75.00%	
Yes	8	14.50%	3	25.00%	
Laterality					1.000 [†]
Right	29	52.70%	6	50.00%	
Left	26	47.30%	6	50.00%	
Diagnosis					0.449 [#]
Femoral neck fracture	17	30.90%	6	50.00%	
Transtrochanteric fracture	31	56.40%	5	41.70%	
Other [§]	7	12.70%	1	8.30%	
Functional status					0.743 [†]
Walked at home	36	65.50%	7	58.30%	
Other [‡]	19	34.50%	5	41.70%	
Cause					1.000 [#]
Fall from the same level	48	87.30%	11	91.70%	
Other [¶]	7	12.70%	1	8.30%	

[#]Fisher's exact test; [†]Chi-square test; [‡]Multiple femoral fractures and diaphyseal femoral fractures; [§]Bedridden and paraplegic patients and wheelchair users; [¶]Unwitnessed fall, prophylactic fixation (myeloma), physical aggression, and pathologic fracture; $p < 0.05$: statistical significance; n: sample number; SAH: systemic arterial hypertension; DM: diabetes mellitus.

Table 3. Association of age, number of comorbidities, length of hospital stay, preoperative and postoperative time with clinical outcomes of patients who underwent surgical correction of hip fractures.

Variables	Non-mortality (n = 55)		Mortality (n = 12)		p
	Mean	SD	Mean	SD	
Age	77.870	10.123	79.250	8.487	0.663
Number of comorbidities	2.150	1.183	2.330	0.985	0.620
Length of hospital stay (days)	7.750	5.045	11.670	7.190	0.028
Preoperative time (days)	4.360	3.602	5.250	5.154	0.581
Postoperative time (days)	3.190	2.727	3.920	7.366	0.592

[#]Student's t-test; n: sample number; SD: standard deviation; $p < 0.05$: statistical significance.

Table 4. Binary logistic regression of the influence of length of hospital stay on the clinical outcome of patients who underwent surgical correction of hip fractures.

Variables	OR	95%CI		p
		Lower	Upper	
Length of hospital stay	1.127	0.997	1.275	0.057
Preoperative time	1.017	0.855	1.210	0.850
Postoperative time	0.959	0.804	1.142	0.636

OR: odds ratio; CI: confidence interval; $p < 0.05$: statistical significance.

DISCUSSION

This study aimed to retrospectively evaluate factors associated with mortality after surgical correction of hip fractures in older adults. The prevalence of mortality after surgery was 17.9%, which was associated with longer hospital stay due to pre-existing comorbidities. Hip fractures represent a growing public health problem worldwide and are associated with higher mortality in older patients.³ Among hip fractures, proximal femoral fractures stood out, especially transtrochanteric fractures due to their high frequency among older adults and significant social and economic impact.¹⁴ Our study is in line with other studies that show the prevalence of intertrochanteric fractures in relation to the femoral neck.^{8,10} Moreover, our sample has a profile similar to the literature, considering the occurrence in older and women, with comorbidities such as diabetes mellitus and arterial hypertension.^{3,8-10,13} A study with 38,126 women with hip fractures and a six-year follow-up time showed that the presence of comorbidities before fracture was associated with high short-term mortality and reduced survival in 39% of cases. Thus, due to the increasing number of patients with comorbidities associated with aging and high mortality in patients with hip fractures, improving preoperative and postoperative care for patients with chronic heart, kidney, or lung diseases can potentially reduce mortality.¹⁵ Brazil has a high prevalence of hip fractures and high mortality and morbidity rates associated with this condition.^{3,8,10} In this study, hip fracture mortality rates were similar to previous studies.¹⁶⁻¹⁸ In a study conducted in Brazil, the mortality rate was 14.4% among patients with femoral fractures and this mortality was associated with increasing age, leukocytosis, need for intensive care, and no surgical treatment. Correa et al.¹⁰ showed that the mortality rate among older adults with proximal femoral fractures at the national level was 8% and male sex, reduced Parker score, delirium diagnosed at hospital admission or developed during hospitalization, and surgical delay were the main associated risk factors.

In the United States, a study presented a femoral fracture mortality rate of 1.6%.¹¹ The authors concluded that patients have a high risk of mortality and postoperative complications if they undergo surgical fixation 48 hours after admission, with longer ICU and hospital stay and increased need for mechanical ventilation.¹¹

As one of the main causes of hospitalization of older patients, hip fractures require careful perioperative management to avoid complications and decrease mortality rates. Most of the available guidelines recommend surgical correction of fractures in the first 24 hours, up to 48 hours, as an increased waiting time is correlated with higher medium-term complication and mortality rates. Moreover, diagnostic-therapeutic care proved to significantly reduce the length of hospital stay.¹⁹

Similarly to our findings, studies show that a longer hospital stay negatively affects older patients with femoral fractures, as it contributes to the development of other hospital complications such as infection, pressure ulcers, and sepsis, besides increasing mortality rate.^{8,9,18} According to a recent demographic study, the southeastern region of Brazil showed the highest femoral fracture mortality rates

and the longest total hospital stay.³ Thus, a longer hospital stay may contribute to higher mortality rates in this region, which is in line with our findings.

With population aging, optimizing length of hospital stay and reducing overload in health and social services is essential.³ Mortality risk may be high, especially due to the low bone quality of older patients.^{3,12,13} Thus, preventive measures to reduce fractures among this population are extremely important.

Despite the limitations of this study due to its retrospective nature, development in a single center, and small sample size, we could identify the association between hip fracture mortality in older adults and length of hospital stay. Our data can be used in the planning of services and care protocols focused on older patients with femoral fractures in order to reduce mortality risk. This should occur within a multidisciplinary approach, including hospital care

and improvements in the availability of rehabilitation services. However, further epidemiological studies with a larger sample size are necessary to analyze the association of hip fracture mortality in older adults, since studies on this topic are scarce.

CONCLUSION

In this study, the prevalence of mortality of patients with hip fractures who underwent surgery was 17.9%, and a longer hospital stay due to comorbidities was the main factor related to this outcome.

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MINIMALLY INVASIVE OSTEOSYNTHESIS FOR CLAVICULAR FRACTURE WITH LOCKED PLATE

OSTEOSSÍNTESE MINIMAMENTE INVASIVA PARA FRATURA DA CLAVÍCULA COM PLACA BLOQUEADA

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ABSTRACT

Objective: To evaluate the clinical and radiographic results of the surgical treatment of fractures of the middle third of the clavicle, using the technique of minimally invasive plate osteosynthesis (MIPO) with locking. **Methods:** Prospective case series, evaluating displaced fractures of the middle third of the clavicle submitted to MIPO with locking, with procedures performed by a single surgeon. Patients were evaluated at 12 months using the University of Los Angeles (UCLA) scale and anteroposterior radiographs of the clavicles with 45° cranial and caudal inclination, as well as reporting complications. **Results:** In total, 15 patients were evaluated. The median of surgical time was 50 minutes (IQR 35). The UCLA scale had a median of 35 (IQR 2) at 12 months. All patients presented fracture healing. Minor complications occurred in three cases (20%), with two (13.3%) evolving with plate prominence and one (6.7%) with local paresthesia, while major complications occurred in only one case (6.7%), with suture dehiscence requiring surgical re-approach. **Conclusion:** MIPO with locking is a viable option for the treatment of displaced fractures of the middle third of the clavicle, with excellent results according to the UCLA scale, fracture healing in all cases, and a low rate of complications. **Level of Evidence IV, Case Series.**

Keywords: Clavicle. Fractures, Bone. Osteosynthesis.

RESUMO

Objetivo: Avaliar os resultados clínicos e radiográficos do tratamento cirúrgico de fraturas do terço médio da clavícula pela técnica de osteossíntese minimamente invasiva com placa (OMIP) bloqueada. **Métodos:** Série de casos prospectiva que avaliou fraturas desviadas do terço médio da clavícula submetidas à OMIP bloqueada, com procedimentos realizados por um único cirurgião. Os pacientes foram avaliados aos 12 meses por meio da escala da Universidade da Califórnia em Los Angeles (UCLA) e por radiografias das clavículas em anteroposterior (AP) com inclinação cranial e caudal de 45°, além de relatos de complicações. **Resultados:** Foram avaliados 15 pacientes. A mediana do tempo cirúrgico foi de 50 minutos (IIQ 35). A escala da UCLA aos 12 meses teve mediana de 35 (IIQ 2). Todos os pacientes apresentaram consolidação da fratura. Complicações menores ocorreram em três casos (20%): dois (13,3%) com proeminência da placa e um (6,7%) com parestesia local. Maiores complicações ocorreram em apenas um caso (6,7%), com deiscência de sutura, necessitando de reabordagem cirúrgica. **Conclusão:** A OMIP bloqueada se mostrou uma opção viável ao tratamento das fraturas desviadas do terço médio da clavícula, com resultados excelentes de acordo com a escala UCLA, consolidação em todos os casos e baixo índice de complicações. **Nível de Evidência IV, Série de Casos.**

Descritores: Clavícula. Fraturas Ósseas. Osteossíntese.

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INTRODUÇÃO

Clavicle fracture represents 44% of fractures of the scapular waist and 2.6% of fractures of the human body. They are more frequent in young and active individuals. The main mechanism of trauma of clavicle fracture results from a fall on the shoulder, in a smaller frequency by indirect trauma on the outstretched arm or direct trauma to the clavicle.¹⁻³

Fractures of the middle third of the clavicle are the most common, representing 80% of clavicle fractures.^{1,3} Although the most show good results with the conservative management, pseudarthrosis rates are higher than those treated surgically.^{4,5} Displaced fractures and fractures without contact between fragments present faster fracture healing, better functional results, and lower rates of complications when treated surgically.^{3,6}

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The study was conducted at Hospital Geral de Pedreira and at Universidade de Sao Paulo, Hospital Universitário.

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Osteosynthesis with open plate is considered the gold standard in the surgical treatment of fractures of the middle third of the clavicle.^{4,5} Some authors advocate the minimally invasive plate osteosynthesis (MIPO) with locking as a way to reduce complications and surgical aggression to the fracture focus, as well as to improve the aesthetic aspect.⁷ However, few studies have been published on this subject.^{7,8}

Objectives

This study aimed to describe the functional and radiographic results, as well as the complications of the MIPO with locking technique for fractures of the middle third of the clavicle.

METHODS

A series of prospective cases of patients with fracture of the middle third of the clavicle were performed and subjected to MIPO with locking. All procedures were performed in the same institution by a single surgeon, member of the Brazilian Society of Shoulder and Elbow Surgery (SBCOC) and the Brazilian Society of Orthopedics and Traumatology (SBTO), and with seven years of experience, between January 2017 and December 2018. The study was approved by The Ethics Committee (229891 19.3.0000.8054), and the patients signed an informed consent form. Inclusion criteria were: skeletally mature patients, between 18 and 70 years old, and with displaced fractures of the middle third of the clavicle. As a deviation, the presence of fracture without bone contact, with ≥ 2 cm, intermediate displaced fragment (Z-fragment), or tent skin were considered (Figure 1). Exclusion criteria were: fractures older than two weeks between trauma and the surgical procedure, fractures that included the proximal and/or distal third of the clavicle, exposed or pathological fractures, any previous morbidity of the affected upper extremity that could compromise limb function, bilateral clavicle fractures, or previous history of ipsilateral fracture, and presence of neurovascular involvement in the initial trauma.

The time of surgery was evaluated, and the moment of incision was standardized until the last stitch on the skin was closed.

Clinical evaluation was performed by the scale of the University of California (UCLA), Los Angeles, and applied by the surgeon at 12 months of follow-up.^{9,10}

All patients initiated pendulum movements, encouraging active and passive movement in the immediate postoperative period. Patients started physical therapy after six weeks, twice a week. In total, 20 sessions were performed, the last ten with resistance active exercises. Radiographic evaluation was performed with anteroposterior (AP) radiographs, cephalic inclination of 45°, and caudal of 45° of the clavicle at two and six weeks, and at three, six, and 12 months after the surgery. Fractures with at least three integrated corticals were considered consolidated. Absence of fracture healing after three months was considered a delay in fracture healing, and at six months, pseudarthrosis.



Figure 1. Complete transverse and displaced fracture of the middle third of the clavicle.

Complications were divided into greater or minor, according to the impact on patient function or increased treatment time. Thus, the following events were evaluated:

- Minor complications: hypertrophic scar, peri-incisional paraesthesia, skin irritation, or prominence of osteosynthesis material.
- Major complications: osteosynthesis failure, refracture, superficial infection or suture dehiscence requiring reoperation, deep infection, and consolidation failure.

Surgical technique

The patients were subjected to general anesthesia associated with interscalene block of the brachial plexus and positioned in dorsal decubitus in the beach chair position. Initially, the plate size is chosen, leaving a minimum work area of four holes, with the help of radioscopy. After demarcation of the length of the plate on the skin, two 1.5-cm accesses are made on the distal and proximal parts of the plate equidistant to the fracture trait (Figure 2).

Then, subcutaneous tissue detachment was performed in the upper aspect of the clavicle, incision of the fascia, with maximum periosteal preservation possible until the communication of the two accesses, medial and lateral. The plate was placed by the medial access toward the lateral access.

For fracture reduction, two 2.0-mm Kirschner wires are inserted into the anterior surface of the clavicle by each of the access, medial and lateral, and the deviation was reduced by using the joystick technique (Figure 3). A 2.0-mm Kirschner wire is inserted into the most dislocated holes of the plate at the fracture focus, medial and lateral, for temporary fixation of the plate.

A cortical screw is inserted centrally into each bone fragment, close to the fracture focus. A 3.5-mm blocking screw is inserted into each bone fragment in the previous location of the Kirschner wire (Figure 4). The closure of the muscular fascia is performed with Vycril 1 wire, with continuous anchored point, the subcutaneous tissue is closed with Vycril 2.0 wire, with simple stitches, and finally the skin is closed with nylon thread 3.0, with Donatti-type stitches. A simple dressing on the surgical wound is changed 24 hours before discharge. Antibiotic therapy is performed with intravenous 1 g cefazolin (EV) within 24 hours of the procedure. To use at home, dipyrrone is prescribed 1 g orally (VO) every six hours for five days, and tramadol 50 mg VO in a rescue manner every eight hours.

RESULTS

In the period studied, 17 patients were operated with the MIPO with locking technique. We excluded two patients due to loss of follow-up, thus remaining 15 patients as the object of analysis. No case required conversion of the closed to open technique. Most patients were male (93%) and had fractures on the left side (80%). The mean age was 31.8 ± 12.7 years. According to the



Figure 2. Measurement of plate size and percutaneous pathway access.



Figure 3. Intraoperative image of the joystick technique to indirectly reduce the fracture.

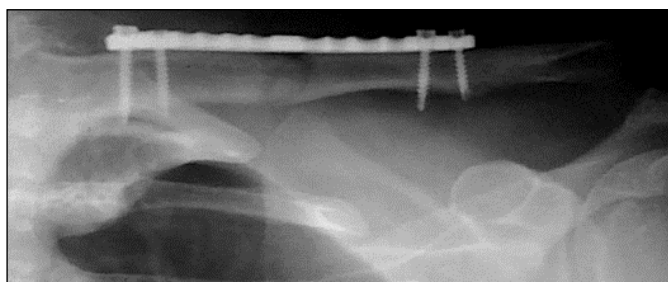


Figure 4. Radiography in postoperative anteroposterior incidence showing fracture reduction and fixation by plate and screws.

AO/OTA classification, six (40%) were type A, four (26.7%) type B, and five (33.3%) type C. Table 1 shows the general characteristics of the sample.

Functional evaluation by the UCLA scale at 12 months showed a median of 35 (interquartile interval – IQR 2). The median of time of surgery was 54.8 minutes. Table 2 shows the data.

All cases presented bone consolidation, which was found at three months in all 15 patients (100%).

In the evaluation of complications, three patients (20%) presented minor complications, one (6.7%) had anterior paraesthesia of the clavicle, and two (13.3%) evolved with prominence of the plate, but it was not necessary to remove the synthesis material. No patient presented hypertrophic scarring or skin irritation. Only one patient presented a major complication (6.7%) with surgical scar dehiscence, thus cleaning, debridement, and suture were performed in the operating room (Table 3). No other major complications were observed.

DISCUSSION

In this study, the minimally invasive treatment of displaced fractures from the clavicle had excellent clinical and radiographic results, with complete fracture healing in all cases. At the same time, the rate of complications was low compared to studies that used open plate fixation.³ The mean values found in the functional evaluation by the UCLA scale (34 points) are comparable to those described by Sohn, Kim, and Shon,⁸ who observed a mean of 33 in a retrospective study with 19 patients subjected to MIPO with locking. Treatment with open osteosynthesis also has excellent results. The Canadian Orthopedic Trauma Society reports 96 points according to the Constant-Murley scale and 5.2 by the DASH scale.³ Jiang and Qu,⁷ observed excellent results with both approaches, without statistically significant differences in the only randomized study comparing the conventional technique with the minimally invasive technique.

All patients in our series presented fracture healing at three months. The Canadian Orthopedic Trauma Society also describes 100%

Table 1. General characteristics of the sample.

Characteristics	
Age – years old (sd)	31.8 (12.7)
Sex – n (%)	
Male	14 (93.3)
Female	1 (6.7)
Affected side – n (%)	
Right	3 (20.0)
Left	12 (80.0)
AO classification – n (%)	
A1	2 (13.3)
A2	4 (26.7)
B1	1 (6.7)
B2	2 (13.3)
B3	1 (6.7)
C1	3 (20.0)
C2	1 (6.7)
C3	1 (6.7)
Fracture time - days (sd)	8 (1.8)

sd: standard deviation.

Table 2. Functional evaluation by the scale of the University of California in Los Angeles at 12 months and time of surgery.

	Mean	sd	Median	IQR
UCLA scale	34.1	1.2	35	2
Time of surgery (minutes)	54.8	21.6	50	35

UCLA: University of California in Los Angeles; sd: standard deviation; IQR: interquartile range.

Table 3. Complications.

	n	%
Suture dehiscence*	1	6.7
Paresthesia**	1	6.7
Plate prominence**	2	13.3

*major complication; **minor complication.

fracture healing in the group of 62 patients undergoing open osteosynthesis.³ Sohn, Kim, and Shon⁸ describe one case (3%) of pseudarthrosis in the 32 patients subjected to MIPO with locking, and no case in the group subjected to osteosynthesis openly, but without statistically significant difference.

In this study, the average surgery time was 54.8 minutes, shorter than that reported by Sohn, Kim, and Shon,⁸ with 77.2 minutes of average in the MIPO and 87.5 in open reduction and internal fixation (ORIF), but similar to that of Jiang and Qu,⁷ which report an average of 60 minutes in both techniques. Due to a learning curve at the beginning, to reproduce any minimally invasive technique is a greater difficulty; however, by acquiring a certain experience with a certain number of cases, surgery tends to occur faster than the conventional ORIF technique.

As minor complications, we had only one case (6.7%) that evolved with local paresthesia. Low rates of this complication are reported by other authors who evaluate MIPO.^{7,8} Jiang and Qu,⁷ report two cases (6%) of paresthesia in the MIPO group, against 10 (31%) in the group subjected to MIPO with locking. On the other hand, Sohn, Kim, and Shon,⁸ report that none of the 19 patients subjected to MIPO with locking developed this complication. However, You, Wu, and Wang¹¹ describe 11 cases (28.9%) in patients undergoing MIPO with locking. A possible explanation for the index of this complication is that we performed a small access (1.5 cm), focused on the distal orifices of the plate, thus preserving the branches of

the supraclavicular nerve as much as possible. Comparative studies observe significantly lower values of this complication in patients operated by the MIPO technique, compared to patients operated by a crude technique.^{7,8} You, Wu, and Wang¹¹ report incidence of 29% vs 69%, whereas Jiang and Qu.⁷ 6% vs. 28%, demonstrating the greater safety of the minimally invasive technique related to this outcome. Two patients in our series (13.3%) presented prominence of the synthesis material, who did not need to be subjected to a new approach to implant removal, since the patients were satisfied with the result. The values obtained in this study agree with those reported by other authors.⁹ Sohn, Kim and Shon⁸ reported two cases (10%) among those subjected to the MIPO technique with this complication, a value lower than that observed in the group subjected to the conventional technique, that is, three cases (21%). As major complications, we had one patient (6.7%) who evolved with suture dehiscence, and, thus, we needed a new approach in the operating room, where local cleaning was performed with a new closure of the subcutaneous tissue and skin, and osteosynthesis was not addressed. The Canadian Orthopedic Trauma Society describes this complication in three cases (5%) of patients subjected to ORIF with plate.³ Among the studies evaluating MIPO, we did not find reports of suture dehiscence.

We observed no type of synthesis failure, such as loosening or implant breakage. Thus we associated this failure with the fact that we use only blocked and unconventional plates (3.5 mm CPD and 3.5 mm reconstruction). Some biomechanical studies show the superiority of locking plates compared to conventional plates, although *in vivo* studies that present such differences are scarce.¹² Mendes et al.¹³ conducted a longitudinal

observational study in comminuted fractures of the clavicle subjected to conventional MIPO, reporting two synthesis failures in 32 approaches, but no implant breaks or fatigues, such as Silva et al.⁶ in their comparative study on the surgical treatment of fractures displaced from the clavicle using conventional plates or intramedullary nail, without the break of the plate when this was the treatment option used.

Studies show that fractures with deviation and without contact between fragments present better results when treated surgically.^{3,14} ORIF with plate is considered the gold standard of osteosynthesis today.¹⁴ Nevertheless, the results of studies evaluating MIPO allow us to say that this is a safe treatment option, with good clinical results and high consolidation rate.^{7,8,11}

This study has some limitations. First, we cannot claim the superiority of this method over the gold standard due to the absence of a control group. Moreover, this study has a small casuistry and does not compare other techniques, open or minimally invasive. Finally, we used the UCLA scale as a clinical outcome, without specifically evaluating outcomes such as pain, range of motion, and quality of life.

This is one of the few studies on MIPO with locking in the treatment of fractures of the middle third of the clavicle, evaluating functional and radiographic results in a standardized manner. We consider this technique reproducible, safe, and viable, as an alternative to open osteosynthesis.

CONCLUSION

MIPO with locking had excellent results according to the UCLA scale, fracture healing in all cases, and low rate of complications.








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PATELLAR FRACTURE IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: IN VITRO ANALYSIS

FRATURA PATELAR NA RECONSTRUÇÃO DO LIGAMENTO CRUZADO ANTERIOR: ANÁLISE IN VITRO

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ABSTRACT

Objective: To determine, by biomechanical analysis, safe patellar cut limits in anterior cruciate ligament (ACL) reconstruction that minimize fracture risks. **Methods:** From three-dimensional reconstruction, triangular cuts were made in the patella, with a depth of 6.5 mm and variable width and length (10 to 20 mm and 8 to 12 mm, respectively, both with an interval of 1 mm). The combinations of cuts constituted 55 models for tests, with five variations in width and 11 variations in length, tested with the finite element method (FEM). **Results:** The mean of the localized principal maximum (traction force) values was 4.36 Pa (SD 0.87 ± 0.76) and the localized principal minimum (compression force) was -4.33 Pa (SD 1.05 ± 1.11). Comparing width and length to the tension force of the values of the main maximum, we found statistical significance from 11 mm for width and 13 mm for length. **Conclusion:** In ACL reconstruction, the removal of the patellar bone fragment is safe for fragments smaller than 11 mm in width and 13 mm in length, which corresponds to 24% of the width and 28% of the length of the patella used. **Level of Evidence II, Comparative Prospective Study.**

Keywords: Biomechanical Phenomena. Finite Element Analysis. Bone-Patellar Tendon-Bone Grafting. Anterior Cruciate Ligament Injuries.

RESUMO

Objetivo: Determinar, por meio de análise biomecânica, os limites de corte patelar seguros para a reconstrução do ligamento cruzado anterior (LCA) e que minimizem riscos de fratura. **Métodos:** A partir de reconstrução tridimensional, foram feitos cortes triangulares na patela, com profundidade de 6,5 mm e largura e comprimento variáveis (8 a 12 mm e 10 a 20 mm), respectivamente, com intervalo de 1 mm). As combinações dos cortes constituíram 55 modelos para ensaios, com 5 variações de largura e 11 variações de comprimento, ensaiados por meio do método dos elementos finitos (MEF). **Resultados:** A média dos valores da máxima principal localizada (força de tração) foi de 4,36 Pa (DP 0,87 ± 0,76), e a mínima principal localizada (força de compressão) foi de -4,33 Pa (DP 1,05 ± 1,11). Comparando largura e comprimento à força de tensões dos valores da máxima principal, houve significância estatística a partir de 11 mm para largura e 13 mm para comprimento. **Conclusão:** Na reconstrução do LCA, a retirada do fragmento ósseo patelar mostrou-se segura para fragmentos menores que 11 mm de largura e 13 mm de comprimento, o que corresponde a 24% da largura e 28% do comprimento da patela utilizada. **Nível de Evidência II, Estudo Prospectivo Comparativo.**

Descritores: Fenômenos Biomecânicos. Análise de Elementos Finitos. Enxerto Osso-Tendão Patelar-Osso. Lesões do Ligamento Cruzado Anterior.

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INTRODUCTION

Among many techniques for the reconstruction of the anterior cruciate ligament (ACL), bone-patellar tendon-bone autograft remains commonly used,¹ only behind hamstrings autografts.^{2,3} The main advantages of autograft techniques are the easy reproducibility, graft resistance, and the fixation and consolidation between host bone

and bone block of the graft.⁴ Some negatives of the technique are postoperative pain in the anterior knee, difficulty of kneeling, and possible fracture of the patella and rupture of the patellar tendon.^{1,5} ACL reconstruction results are very positive since normal function is restored in 90% of patients, enabling the return to sports activities in up to 80% of cases. However, many complications may arise with

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The study was conducted at Instituto de Pesquisa e Ensino, Hospital HOME.

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the procedure, regardless of the technique used, such as anterior knee pain, joint stiffness, secondary meniscal injury, pain around the graft fixation point, graft rupture, and patella fracture, which is rare but the most frequent when using bone/patellar/bone graft.^{6,7} Some proximal bone block shapes reduce the risk of fracture, such as triangular, trapezoid, cylindrical and rectangular.⁸ Studies show that the shape of the block is unrelated to patellar fracture as long as the graft removal techniques are respected, that is, not exceeding 25 to 30 mm in length, 9 to 12 mm in width or one third of the tendon width, and 6 mm depth or one third of the patella depth.^{9,10} Moreover, even after using the appropriate technique, patella resistance reduction ranges from 30 to 40%,^{9,11} because the patellar dimensions are very variable depending on the patient's gender, height and ethnicity. Establishing a fixed graft size pattern can be a variable to make the patella susceptible to fracture.

This study aimed to determine the safe patellar cut-off limits in ACL reconstruction that minimize fracture risks by biomechanical analysis using the whole finite element method (FEM) with several dimensions, demonstrating the results obtained in absolute value and percentile.

METHODS

Tomographic images of a left patella, 45 mm wide, 43 mm long, and 20 mm thick, in its greatest measurements, were used in this study. The images were extracted from the synthetic model 1145-70 of large size, from the Sawbone brand, composed of cortical and spongy bones manufactured in polyurethane, which were filed in the communication protocol that encompasses Digital Imaging and Communications in Medicine (DICOM) and used an Emotion tomography (16 channels, Siemens™, Munich, Germany) with 512 × 512 resolution and 1.0 mm between cuts. The file was imported into the InVesalius™ program for three-dimensional (3D) reconstruction of the anatomical structure. The program generated 3D files in STereoLithography (STL) format, sometimes also referred to as Standard Triangle Language (STL).

The 3D virtual models of each system (bone and ligament) were started using the Rhinoceros™ 6 program (Robert McNeel & Associates, United States) and the MEF was performed in the SimLab™ program (HyperWorks, United States) using the Optistruct solver.

Triangular-shape cuts were made in the patella to simplify the technique applied—clinically, rectangular and trapezoidal shapes are more commonly used—, always with the same 6.5 mm depth. This shape is the one that most resembles the graft in a narrow-base trapezoidal form, which is usually obtained during the extraction of the graft during surgery. The width and length were the variables for this study, generating a gap that simulated graft removal, usually used in ACL reconstruction, with the ligament (Figure 1). The variation in length of the cuts was from 10 to 20 mm and in width from 8 to 12 mm, both with a 1 mm interval. Cut combinations constituted 55 models for testing, 5 variations of width and 11 of length.

For the simulations, after the removal of the gap that simulates the patellar graft, all models were imported into the Simlab™ program to run the test by the FEM. First, the individual identification of each part of the digital models (cortical bone, spongy bone, and ligament) was performed. The meshes were then controlled by each part, always maintaining the size of the element, to avoid contact problems between the different parts in the simulations. The element adopted for the formation of the meshes was the tetrahedral and the number of nodes and elements was also defined.

Knowing and defining the modulus of elasticity and Poisson's coefficient of the materials of each part of the digital models was required for the simulations, as follows: cortical bone 17,000 MPa and 0.26 v; trabecular bone 1,700 MPa and 0.26 v; and ligament 1,200 MPa and 0.45 v, respectively.

The tests were performed by traction force in the quadriceps tendon, in the cranial direction, with distal fixation, and 30° inclination of the patellar tendon, which exerted a force on the patella—simulating a flexed knee and tensioning the anterior face of the patella and compressing the posterior face. From these conditions, the values of the total main maximum (traction force) and main minimum (compression force) were obtained and located on the graft gap for each combination (Figures 2 and 3).

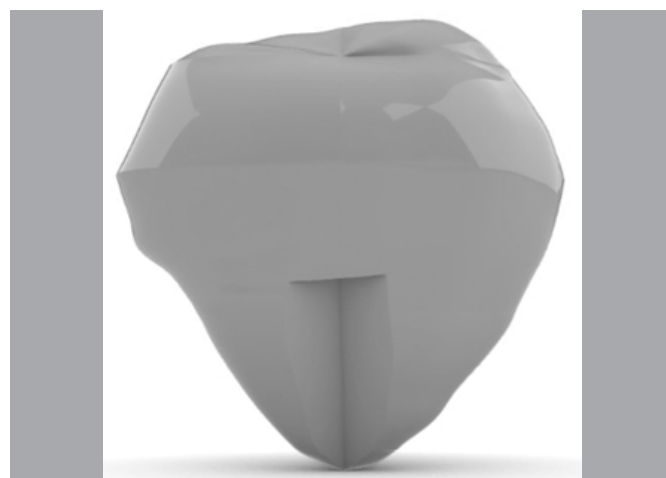


Figure 1. Frontal view of the patella, which shows the graft triangle in detail.

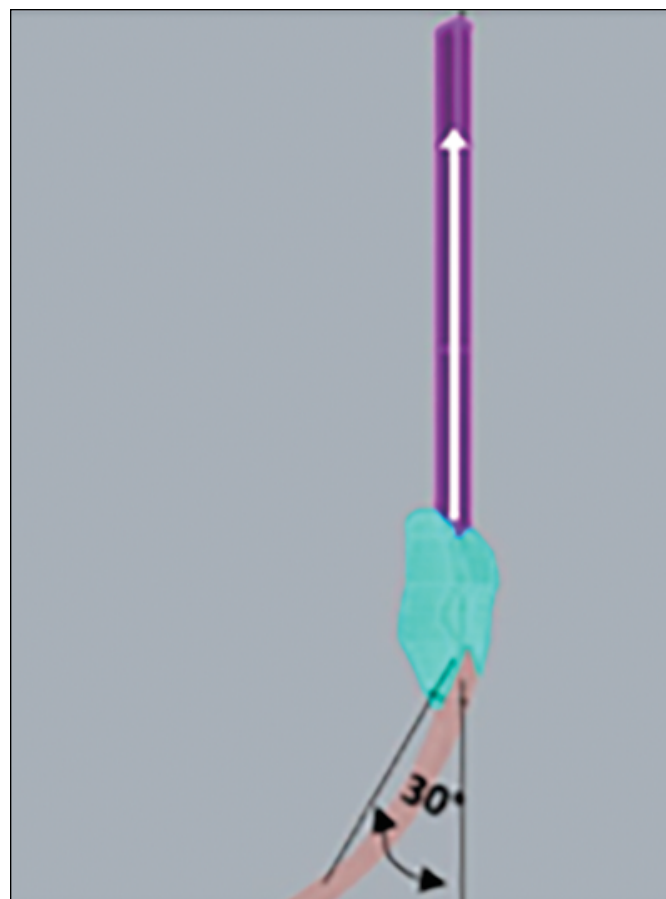


Figure 2. Vector-illustration of the traction force applied to the quadriceps tendon, cranial direction, with distal fixation, and inclination of the patellar tendon of 30°.

To define the contour conditions, 3,000 N traction loads were applied on the Y axis of the application regions. No loads were applied to the X and Z axes, only in the Y axis. Subsequently, the (fixed) motion constraint regions were delimited, marked in all directions of the X, Y, and Z axes (universal coordinates) of displacement and rotation. These restrictions ensure that the alignment of the system is perfect, without displacement and/or rotation (Figure 4). The tension results were analyzed in an exploratory way, by central position and dispersion measures. The statistical analysis was performed by analysis of variance (ANOVA) to verify the effect of length and width regarding stresses. Tukey's post-test was applied to compare the width and length compared to the tensile and tensile force. The analyses were implemented in the SAS program version 9.4. Significance was achieved when $p < 0.05$. The 55 models were tested respecting the same conditions and contours and the application loading.

RESULTS

The mean obtained from nodes and elements in the models was 296,606 and 183,719, respectively. The mean values of the localized maximum (traction force) were 4.36 Pa (SD 0.87 ± 0.76) and the minimum localized primary (compression force) was -4.33 Pa (SD 1.05 ± 1.11). Table 1 shows values of maximum and minimum for width and Table 2 shows these values for length. In Tukey's post-test analysis comparing width and length regarding the tensile force of the main maximum values, statistical significance was found for graft widths starting from 11 mm, corresponding to 24% of the total width of the patella, regarding length, from 13 mm, 28% of the total patella length (Figure 5). Regarding the main minimum, no statistical difference was found for the values obtained, using One-way ANOVA (5%).

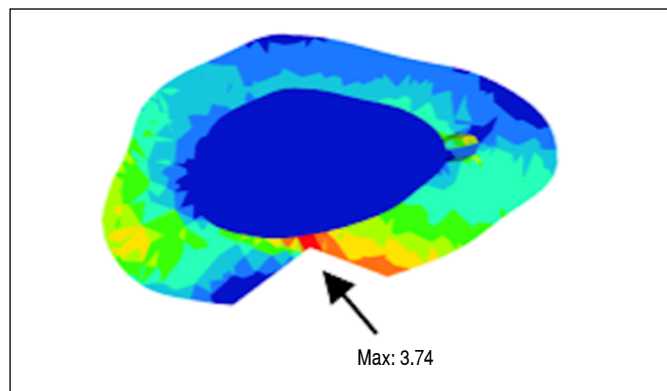


Figure 3. Tension region at the removal point of the graft.

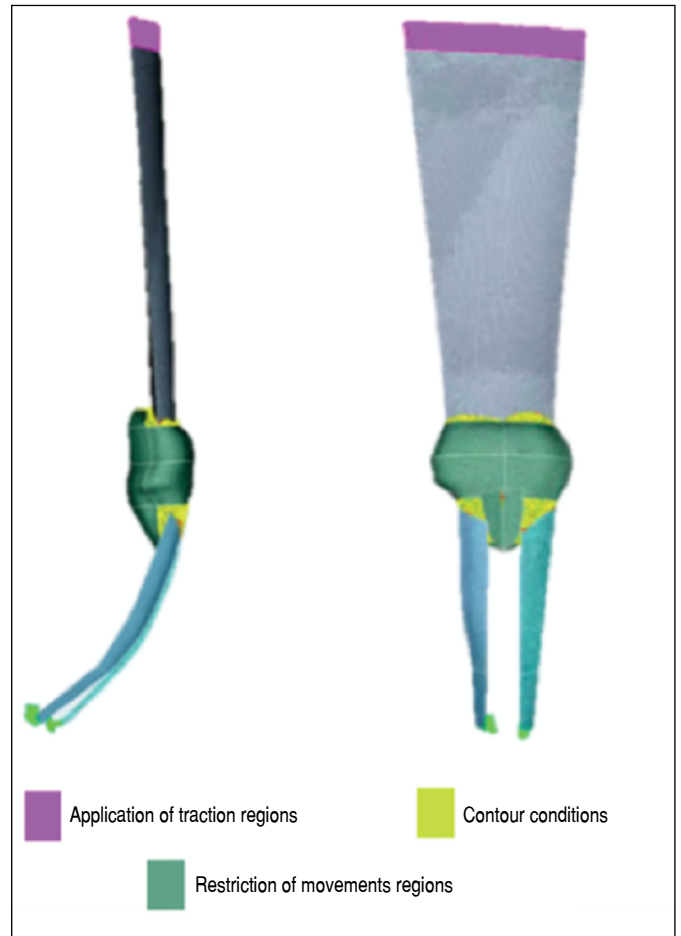


Figure 4. Contour conditions and load application regions.

DISCUSSION

The dissipation of internal stresses to the patellar body and the tension located in the focus of the gap of the graft removal followed an inverse pattern compared to the total stresses observed in the test body. The larger the graft, the more the total stresses decreased, due to the reduction of the total mass of the studied structure. However, the same did not occur when the localized stresses were observed.

The 6.5 mm depth for the graft was defined because it represented the mean between 6 and 7 mm presented as safety values in the literature. Values below 6 mm were excluded since they could not be applied from the clinical point of view, or above 7 mm because

Table 1. Measurements of central position and dispersion of the maximum and minimum variables regarding width.

Variable	Width	N. Obs.	Mean	Stand. Dev.	Median	Q1	Q3	Minimum	Maximum	P-value
Max	8	11	3.95	0.63	4.01	3.22	4.51	3.15	4.91	0.0089
	9	11	4.05	0.6	3.94	3.54	4.68	3.24	5.01	
	10	11	4.33	0.74	4.35	3.77	4.87	3.31	5.66	
	11	11	4.37	0.86	4.41	3.5	4.98	3.35	5.99	
	12	11	5.14	1.06	5.2	3.94	6.09	3.53	6.42	
Min	8	11	-3.89	1.09	-4.15	-4.8	-3.02	-5.2	-1.95	0.3852
	9	11	-4.47	0.83	-4.54	-5.12	-4.01	-5.7	-2.98	
	10	11	-4.52	0.87	-4.65	-5.3	-3.87	-5.69	-2.99	
	11	11	-4.59	0.97	-4.48	-5.48	-4.07	-6.12	-2.98	
	12	11	-4.58	0.97	-4.54	-5.48	-4.01	-6.15	-2.99	

N. Obs.: number of samples observed; Stand. Pad.: standard deviation; Q1: first quartile; Q3: third quartile. P-value for ANOVA.

Table 2. Measurements of central position and dispersion of the maximum and minimum variables regarding width.

Variable	Length	N. Obs.	Mean	Stand. Dev.	Median	Q1	Q3	Minimum	Maximum	P-value
Max	10	5	3.33	0.15	3.31	3.24	3.44	3.15	3.53	< 0.001
	11	5	3.44	0.22	3.4	3.33	3.5	3.18	3.78	
	12	5	3.59	0.3	3.65	3.35	3.77	3.22	3.94	
	13	5	3.86	0.45	3.74	3.59	3.79	3.54	4.65	
	14	5	4.08	0.49	3.99	3.77	4.02	3.71	4.92	
	15	5	4.38	0.5	4.35	4.01	4.41	3.94	5.2	
	16	5	4.64	0.67	4.49	4.21	4.57	4.13	5.78	
	17	5	4.84	0.63	4.69	4.45	4.78	4.37	5.92	
	18	5	5.03	0.62	4.87	4.68	4.98	4.51	6.09	
	19	5	5.25	0.67	5.15	4.7	5.4	4.69	6.33	
Min	10	5	-5.77	0.39	-5.7	-6.12	-5.69	-6.15	-5.2	< 0.001
	11	5	-5.42	0.17	-5.48	-5.51	-5.45	-5.56	-5.12	
	12	5	-5.26	0.32	-5.3	-5.48	-5.12	-5.61	-4.8	
	13	5	-4.88	0.31	-5.01	-5.06	-4.87	-5.09	-4.35	
	14	5	-4.71	0.32	-4.85	-4.87	-4.77	-4.9	-4.15	
	15	5	-4.57	0.08	-4.54	-4.65	-4.54	-4.65	-4.48	
	16	5	-4.21	0.2	-4.23	-4.34	-4.21	-4.4	-3.88	
	17	5	-3.93	0.45	-4.06	-4.12	-4.06	-4.25	-3.14	
	18	5	-3.8	0.44	-4.01	-4.01	-3.87	-4.07	-3.02	
	19	5	-3.17	0.4	-3.25	-3.41	-3.2	-3.51	-2.5	
20	5	-2.78	0.46	-2.98	-2.99	-2.98	-2.99	-1.95		

N. Obs.: number of samples observed; Stand. Pad.: standard deviation; Q1: first quartile; Q3: third quartile. P-value for ANOVA.

it is beyond 30% of the patellar thickness dimension applied in this study.^{7,9} The variation of the cuts in length (10 to 20 mm) differ from that described in the literature as a safe dimension for graft removal, which is from 25 to 30 mm in length.⁹ This fact reflects the need of further studies, since we found a statistical significance from 13 mm, or 28%, in the results obtained, and may observe patellae of

larger dimensions in studies that described dimensions from 25 to 30 mm as safe, confirming that demonstrating values in percentiles is essential. The variation in width (8 to 12 mm) adopted by the authors is similar to that described in the literature (9 to 12 mm).^{7,9} Other factors that denote the importance of the observations of the safety percentiles described in this study is the optimization of the surgical objectives with the size of the grafts removed,

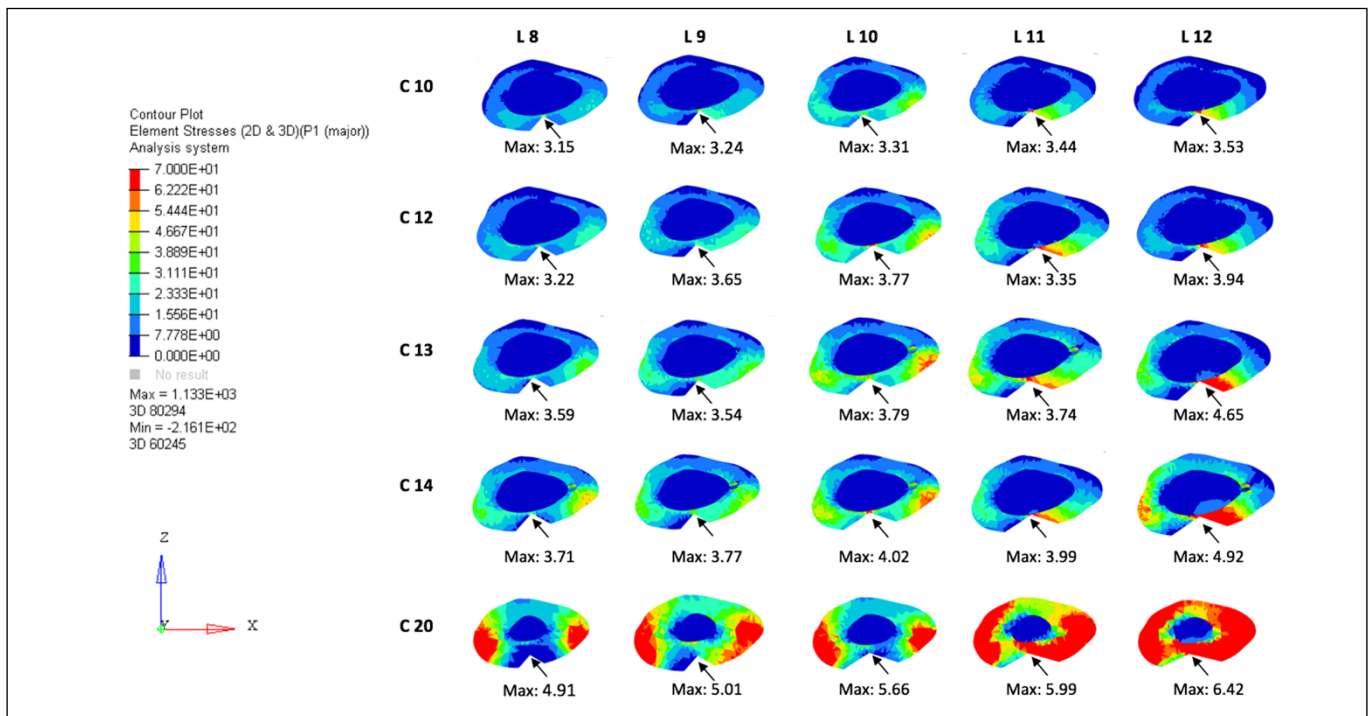


Figure 5. Association of patellar axial sections and their maxims located at the graft removal point.

the optimization of the contact of the graft with the tunnel to be performed and the safety of that of noble structures surrounding the donor site.¹²

At 15% of the gait cycle, a peak of quadriceps strength and knee angulation in flexion from 20 to 30° occurred, which in previous descriptions in the literature corresponds to 1.5 to 2 times body weight.^{13,14} The 30° flexion positioning adopted by the authors, between the center of the patella and the fixation of the patellar tendon, corroborates the possibility of a higher incidence of burden on the patella. The 3,000 N traction load in the quadriceps tendon corresponds to three times the body weight of a 100 kg patient, being a local supraphysiological load application. Although the patellar fracture in the reconstruction of the ACL most commonly occurs during its removal, the authors aimed to present a safety limit of the graft size and its possible post operative weaknesses.¹¹ Thus, such an assessment of positioning and loads was adopted.

The limitations of this study consist of excluding the presence of cartilage on the surfaces, in the anatomical differences of contacts of the different types of trochlear surface, in the absence of mechanical properties of the synovial fluid, and in the absence of ligament actions and meniscal structure, which could be mitigating factors to the stress forces studied. Moreover, the possibility of the presence of notches in the angles of the cuts was not considered, a common occurrence in the use of vibratory saws in the removal of the patellar graft.⁸

The results are not intended as conduct determinants products. However, values of graft removal length with statistical significance (13 mm in length mentioned above) and significantly lower than those presented by the current literature and safety (25–30 mm)¹⁰ highlight the need to evaluate, both by prospective clinical studies and by review evaluations of patients who suffered patellar fracture after ACL reconstruction with patellar graft, the real safety predictive factors related to the dimensions of patellar grafts in ACL reconstruction.

CONCLUSION

In this in vitro analysis, the removal of the patellar bone fragment from the ACL reconstruction proved to be safe in fragments smaller than 11 mm in width and 13 mm in length (maintaining a constant 6.5 mm depth), which corresponds to 24% of the width and 28% of the length of the patella used.

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