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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed April 2022)

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The journal *Acta Ortopédica Brasileira*, official organ of the Department of Orthopedics and Traumatology, Faculdade de Medicina da Universidade de São Paulo (DOT/FMUSP), operates under a continuous publication model of bi-monthly issues (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct, and Nov/Dec) with an English version. The titles, abstracts and keywords are published in English and Portuguese.The publication follows entirely the international standard of the International Committee of Medical Journal Editors (ICMJE) - Vancouver Convention - and its uniform requirements [http://www.icmje.org/]. Submitted papers are sent for peer review evaluation to decide whether they should be published or not, suggesting improvements, asking the authors for clarification and making recommendations to the Editor-in-Chief. The editor(s) and/or reviewer(s) responsible for approval of the manuscript will be identified in the accepted articles. The concepts and statements contained in the papers are the sole responsibility of the authors.
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Type of Article	Abstract	Number of words	References	Figures	Tables	Maximum number of authors allowed
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INTRODUCTION: It must present the subject and the objective of the study, and provide citations without making any external review of the subject material.

ACKNOWLEDGEMENTS: Authors can acknowledge financial support to the work in the form of research grants, scholarships and other, as well as professionals who do not qualify as co-authors of the article, but somehow contributed to its development.

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RESULTS: Results should be present in logical sequence in the text, using tables and illustrations. Do not repeat in the text all the data in the tables and/or illustrations, but emphasize or summarize only the most relevant findings.

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CONCLUSION: The conclusion should be clear and concise, establishing a link between the conclusion and the study objectives. Avoiding conclusions not based on data from the study in question is recommended, as well as avoiding suggest that studies with larger samples are needed to confirm the results of the work in question.

ACKNOWLEDGEMENTS

When applicable, briefly acknowledge the people who have contributed intellectually or technically to the study, but whose contribution does not justify authorship. The author must ensure that people agree to have their names and institutions disclosed. Financial support for the research and fellowships should be acknowledged in this section (funding agency and project number).

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LEVELS OF EVIDENCE FOR PRIMARY RESEARCH QUESTION: Access the following link.

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Levels of Evidence for Primary Research Question[a]

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

Types of study

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

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

SUMMARY

VOLUME 32 – Nº 5 – 2024

Editorial

Original Article

ORTHOPEDIC ONCOLOGY

ORTHOPEDIC TRAUMA

PEDIATRIC ORTHOPEDIC

EDITORIAL

With more than 30 years of existence, Acta Ortopédica Brasileira is one of the main vehicles for the dissemination of Brazilian and international scientific research in Orthopedics and Traumatology, periodically disseminating quality scientific knowledge, and contributing to raising the level of Brazilian science in the international scenario as a whole.

This can be seen in its recognition by important indexes in the world, reflecting the high quality of the scientific production of Brazilian Orthopedics. Acta is currently part of the SciELO database, and is indexed in PubMed, Web of Science, PubMed Central, Scopus, Redalyc, LILACS and DOAJ.

We bring this result with satisfaction because it undoubtedly reflects the commitment of all members of the Editorial Board, as well as that of the researchers who, for 30 years, have entrusted the publication of their works to Acta.

We prioritize research works for master's theses and doctoral dissertations to strengthen Brazilian journals and recognize stricto sensu graduate studies. Therefore, there is nothing fairer than having PhD and associate professors as our Associate Editors and in the Editorial board. We have thus updated our editorial board to sync with our mission.

Recommended works, from medical schools and fruits of academic boards are accepted directly by the desk-review system (accepted by the Editor-in-Chief and/or Associate Editors) for having passed the scrutiny of "peer review" of professors not only during the research development as advisors, but also in their presentations and final approvals.

We will continue to seek excellence in editorial work, so that the journal can tread a path of constant evolution and for this we always hope to count on the immense support and valuable collaboration of the all!

Cordially,

Prof. Olavo Pires de Camargo
Editor-in-Chief

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LEVELS OF EVIDENCE IN ONCOLOGIC-ORTHOPEDIC STUDIES - ACTA ORTOP BRAS (1993-2022)

NÍVEIS DE EVIDÊNCIA EM ESTUDOS ONCOLÓGICO-ORTOPÉDICOS - ACTA ORTOP BRAS (1993-2022)

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ABSTRACT

Objectives: to identify oncological-orthopedic studies published in Acta Ortopédica Brasileira over three decades; to classify them according to the type and level of evidence (LE); to observe the inter-rater agreement in the classification of studies; to analyze the studies retrospectively, according to levels of evidence; and to outline the evolution of the evidence in the study period. Methods: Descriptive analyses were performed with absolute and relative frequencies of studies published between 1993 and 2022. Inter-rater agreement was analyzed by percentage of agreement and Kappa statistic (95%CI). The interpretation of the magnitude of the agreement was performed according to Landis & Koch. The association between classifications and publication period was analyzed using Fisher's exact test. The analyses were performed using the R program (significance of 5%). Results: 69/1349 papers were selected; there was a significant association between type of study, statistical methodology, and LE with publication period ($p < 0.05$); inter-rater agreement regarding LE was 92.8%. Conclusions: Oncological-orthopedic studies accounted for 5.1% of all published papers. Regarding the LE, 80% were NE IV and V studies, despite the evolution observed between the first and last decade (decrease in LE V studies and increase in LE II, III and IV). ***Level of Evidence III, Retrospective Comparative Study.***

Keywords: Evidence-Based Medicine. Epidemiologic Methods. Neoplasms. Orthopedics. Research Design. Periodicals as Topic.

RESUMO

Objetivos: identificar estudos oncológico-ortopédicos publicados na Acta Ortopédica Brasileira (Acta Ortop Bras) ao longo de três décadas; classificá-los quanto ao tipo e nível de evidência (NE); observar a concordância interavaliadores na classificação dos estudos; analisar os trabalhos retrospectivamente, de acordo com níveis de evidência; e traçar os perfis evolutivos das evidências no período avaliado. Métodos: Realizou-se análises descritivas com frequências absolutas e relativas dos estudos publicados entre 1993 e 2022. A concordância interavaliadores foi analisada pela porcentagem de concordância e estatística Kappa (IC95%). A interpretação da magnitude da concordância foi realizada de acordo com Landis & Koch. A associação entre classificações e período de publicação foi analisada pelo teste exato de Fisher. As análises foram realizadas no programa R (significância de 5%). Resultados: foram selecionados 69 de um total de 1349 artigos; houve associação significativa entre tipo de estudo, metodologia estatística e NE com período de publicação ($p < 0,05$); a concordância interavaliadores quanto ao NE foi de 92,8%. Conclusões: Os estudos oncológico-ortopédicos corresponderam a 5,1% de todos os artigos publicados. Quanto ao NE, 80% foram estudos NE IV e V, apesar da evolução observada entre a primeira e a última década (decréscimo de estudos NE V e aumento de NE II, III e IV). ***Nível de Evidência III, Estudo Retrospectivo Comparativo.***

Descritores: *Medicina Baseada em Evidências. Métodos Epidemiológicos. Neoplasias. Ortopedia. Projetos de Pesquisa. Publicações Periódicas como Assunto.*

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The study was conducted at Grupo de Oncologia Ortopédica, Hospital Santa Izabel, Santa Casa de Misericórdia da Bahia, Salvador, BA, Brazil.
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INTRODUCTION

Evidence-based medicine (EBM) is an approach that seeks to use the best available scientific evidence to guide medical decisions[1-9] that are appropriate to patients' values and preferences.[5] Scientific evidence can modify actions, allocate research resources, and influence healthcare decision-makers.[10]

The systematic approach to EBM involves, initially, a critical evaluation and stratification of studies into hierarchical levels of evidence.[11,12] The stratification of evidence is the central element in distinguishing between low- and high-quality studies, which is essential amid the increasing number of studies year after year.[13]

Much has been done to disseminate the concepts of EBM that apply to the particular characteristics of orthopedics, along with the critical evaluation of the methodological quality of published studies.[14] This is particularly important when considering orthopedic oncology, a subspecialty of orthopedics that deals with neoplasms that affect the musculoskeletal system, characterized by a wide spectrum of rare pathologies, with case records and follow-up that are often insufficient to provide evidence that promotes clinical practice. It has become indispensable to critically analyze the literature for orthopedic oncologists in need of updates, that may be seeking a basis for their conduct in the face of the most diverse pathologies.

The journal Acta Ortopédica Brasileira (*Acta Ortop Bras*), a publication specialized in Orthopedics and Traumatology with bimonthly periodicity and indexed in PubMed, PubMed Central, Web of Science, SciELO, SCOPUS, Redalyc and LILACS, has achieved great relevance in the Brazilian orthopedic oncology environment since its creation (1993), and is one of the most consulted sources of research in this field. This motivated us to trace an evolutionary line of publications on topics related to orthopedic oncology in this journal.

The objectives of this study were: to identify the orthopedic oncology studies published in the journal *Acta Ortop Bras* over three decades (1993-2002, 2003-2012 and 2013-2022); to classify the types of studies and the levels of evidence according to EBM criteria; to observe the inter-rater agreement in the classification of the included studies; to analyze the studies retrospectively, according to their levels of evidence; and to trace an evolutionary profile of the evidence between the three decades in the time series considered.

METHODS

Two researchers independently evaluated all studies published since the first edition of *Acta Ortop Bras*, from 1993 to the year 2022. The studies were compiled from two databases, a promotional CD-ROM[15] with the first 15 years of *Acta Ortop Bras* (containing all publications between 1993 and 2007), and the journal's own website[16] (containing all publications between 2000 and 2022). The studies related to orthopedic oncology were selected based on the titles and classified as eligible, potentially eligible, and not eligible. After this initial screening, eligible and potentially eligible studies were screened again, first by reading the abstracts and then in full. A third evaluator resolved any disagreements.

Descriptive analyses of the data were then performed with absolute and relative frequencies. The inter-rater agreement regarding the level of evidence of the articles was analyzed by the percentage of agreement and the Kappa statistic, with the respective confidence interval (95%CI).

The interpretation of the magnitude of the inter-rater agreement was performed according to Landis and Koch.[17]

The associations of the classifications with the period of publication of the article were analyzed using Fisher's exact test.

All analyses were performed using the R program,[18] with a significance level of 5%.

RESULTS

Among the 1349 studies published in *Acta Ortop Bras* between 1993 and 2022, we identified 72 eligible studies related to orthopedic oncology. After complete reading, we identified that one of the studies was conducted with rat samples, another with bone samples (femur) and a third evaluated specimens composed of cement cylinders. Thus, 95.8% (n = 69) represented studies involving human beings, constituting the focus of subsequent analyses (Figure 1, Table 1).

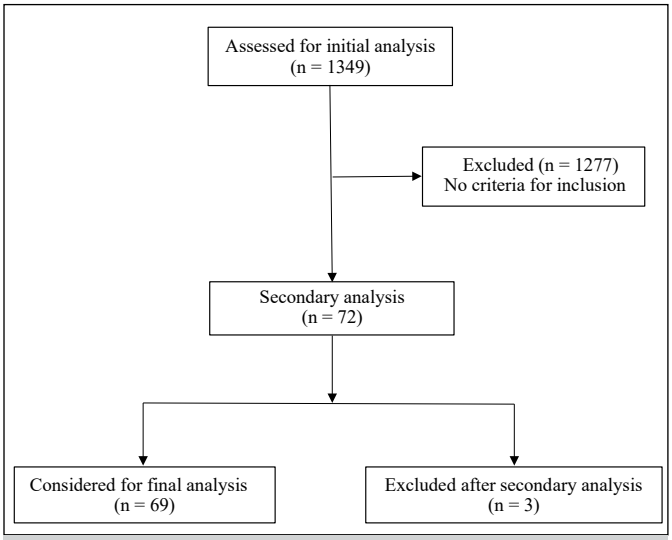

Figure 1. Flow chart.

Table 1. Distribution of papers according to characteristics (n = 72).

Features		Period		Total
	1993-2002	2003-2012	2013-2022	
Total Papers	15 (20.8%)	20 (27.8%)	37 (51.4%)	72 (100.0%)
Papers with specimens of animals, bones, or specimens	1 (6.7%)	0 (0.0%)	2 (5.4%)	3 (4.2%)
Papers involving human subjects, assessed for the level of evidence	14 (93.3%)	20 (100.0%)	35 (94.6%)	69 (95.8%)

The analyses that followed considered the division of the studies into publication periods, with the first period referring to papers published between 1993 and 2002, the second period between 2003 and 2012, and the third period between 2013 and 2022.

There was a significant association between the type of study and the period of publication ($p < 0.05$) (Table 2, Figures 2-5). We can observe that the percentage of papers published with only descriptive studies decreased from 35.7% in the period from 1993 to 2002 to 5.7% in the period from 2013 to 2022. There was also an increase in the percentage of papers with an analytical approach, from 7.1% to 77.1% of the papers published in these periods. There was also a decrease in the percentage of case reports, from 42.9% to 8.6% of the published papers (as of 2011 case reports were no longer accepted at *Acta Ortop Bras*), with an increase in the number of observational studies in medical records, from 21.4% of the studies in the first period evaluated to 48.6% in the last period.

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Table 2. Distribution of papers evaluating samples with human beings according to the type of design used in the study (n = 69).

Feature	Category	Period			Total
		1993-2002	2003-2012	2013-2022	
	Descriptive	5 (35.7%)	5 (25.0%)	2 (5.7%)	12 (17.4%)
	Analytic	1 (7.1%)	4 (20.0%)	27 (77.1%)	32 (46.4%)
	Other (Case report, Expert opinion, Literature review, Integrative review)	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		<0.0001			
Type of Study	Systematic review	0 (0.0%)	1 (5.0%)	1 (2.9%)	2 (2.9%)
	Clinical	3 (21.4%)	3 (15.0%)	3 (8.6%)	9 (13.0%)
	Observational in samples	0 (0.0%)	0 (0.0%)	6 (17.1%)	6 (8.7%)
	Observational in medical records	3 (21.4%)	5 (25.0%)	17 (48.6%)	25 (36.2%)
	Case series	0 (0.0%)	1 (5.0%)	3 (8.6%)	4 (5.8%)
	Case report	6 (42.9%)	9 (45.0%)	3 (8.6%)	18 (26.1%)
	Integrative review	2 (14.3%)	0 (0.0%)	1 (2.9%)	3 (4.4%)
	Narrative review	0 (0.0%)	1 (5.0%)	0 (0.0%)	1 (1.4%)
	Expert opinion	0 (0.0%)	0 (0.0%)	1 (2.9%)	1 (1.4%)
p-value		0.0074			
Observation strategy	Cross-sectional	0 (0.0%)	0 (0.0%)	4 (11.4%)	4 (5.8%)
	Cross-sectional in medical records	3 (21.4%)	5 (25.0%)	17 (48.6%)	25 (36.2%)
	Longitudinal	3 (21.4%)	4 (20.0%)	8 (22.9%)	15 (21.7%)
	Other (Case report, Expert Opinion, Review Literature Review, Integrative Review, Systematic review)	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		0.0282			
Temporality	Retrospective	0 (0.0%)	0 (0.0%)	3 (8.6%)	3 (4.3%)
	Prospective	3 (21.4%)	4 (20.0%)	5 (14.3%)	12 (17.4%)
	Cross-sectional	0 (0.0%)	0 (0.0%)	4 (11.4%)	4 (5.8%)
	Cross-sectional in medical records	3 (21.4%)	5 (25.0%)	17 (48.6%)	25 (36.2%)
	Other (Case report, Literature Review, Integrative Review, Systematic Review)	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		0.0255			

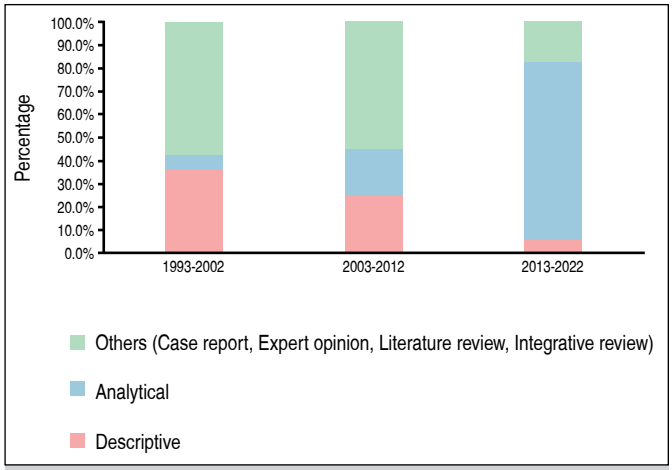

Figure 2. Distribution of papers according to the period and form of data analysis (n = 69).

Table 3 and Figures 6-8 present the results of the statistical methodology used in the studies. There was also a significant association with the period of publication of the paper ($p < 0.05$). There is an increase in the authors' concern with the sample size. Although only one paper from the period 2013-2022 presented sample calculation, four papers from the same period discussed the sample size as limitations of their studies. There was also a significant increase in the percentage of papers that used statistical methodology to analyze data, from 7.1% in the period from 1993 to 2002 to 77.1% in the period from 2013 to 2022. There was also a small increase in the percentage of papers with test power or confidence intervals, but none of the papers mentioned the size of the observed effect.

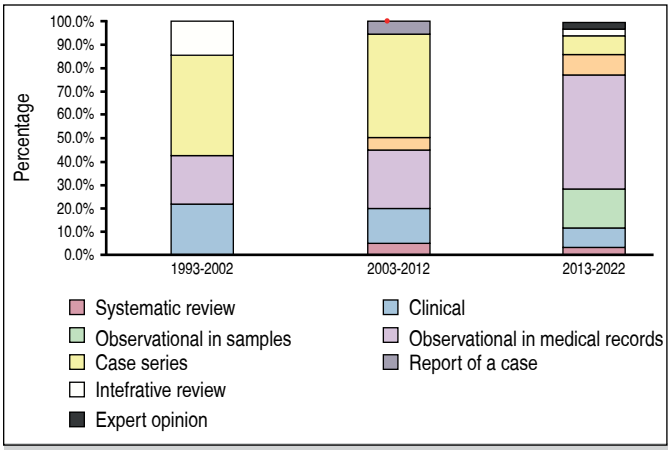

Figure 3. Distribution of papers according to period and type of study (n = 69).

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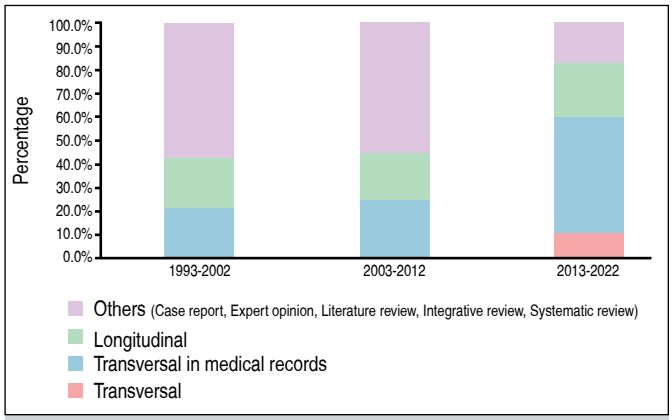

Figure 4. Distribution of papers according to period and observation strategy (n = 69).

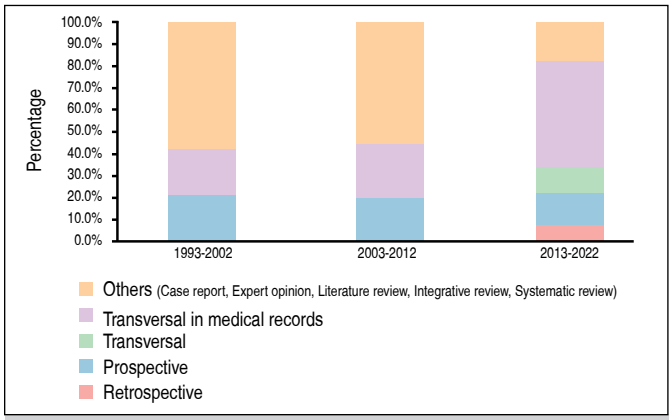

Figure 5. Distribution of papers according to period and temporality (n = 69).

Table 3. Distribution of papers evaluating samples with human beings as a function of statistical analysis (n=69).

Sample Feature	Category		Period		Total
		1993-2002	2003-2012	2013-2022	
Sample calculation presented	No	6 (42.9%)	9 (45.0%)	24 (68.6%)	39 (56.5%)
	No, but sample size is a limitation of the study	0 (0.0%)	1 (2.9%)	1 (1.4%)	4 (5.8%)
	Yes	0 (0.0%)	0 (0.0%)	1 (2.9%)	1 (1.4%)
	Not applicable	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		0.0147			
Applied methodology statistics for analyze the data		5 (35.7%)	5 (25.0%)	2 (5.7%)	12 (17.4%)
		1 (7.1%)	4 (20.0%)	27 (77.1%)	32 (46.4%)
	Not applicable	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		<0.0001			
It presented the power of the test, size of effect or confidence interval	No	6 (42.9%)	8 (40.0%)	22 (62.9%)	36 (52.2%)
	Confidence interval	0 (0.0%)	1 (5.0%)	6 (17.1%)	7 (10.1%)
	Effect Size	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.4%)
	Test Power	0 (0.0%)	0 (0.0%)	1 (2.9%)	25 (36.2%)
	Not applicable	8 (57.1%)	11 (55.0%)	6 (17.1%)	25 (36.2%)
p-value		0.0193			

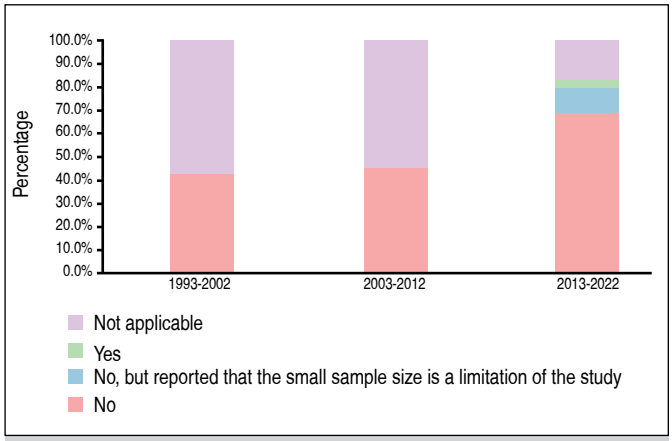

Figure 6. Distribution of papers according to period and sample calculation presentation (n=69).

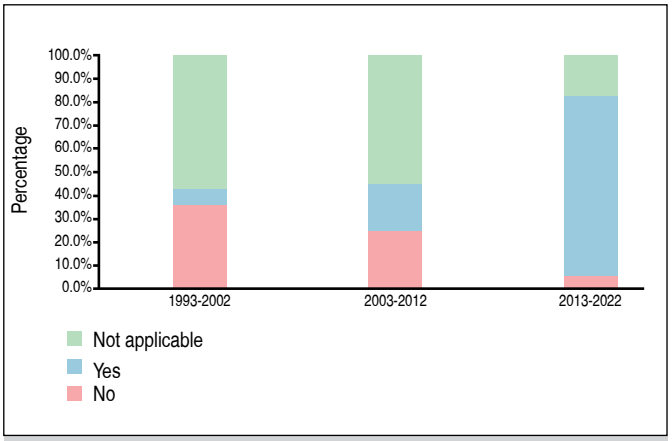

Figure 7. Distribution of papers according to period and application of statistical methodology to analyze data (n=69).

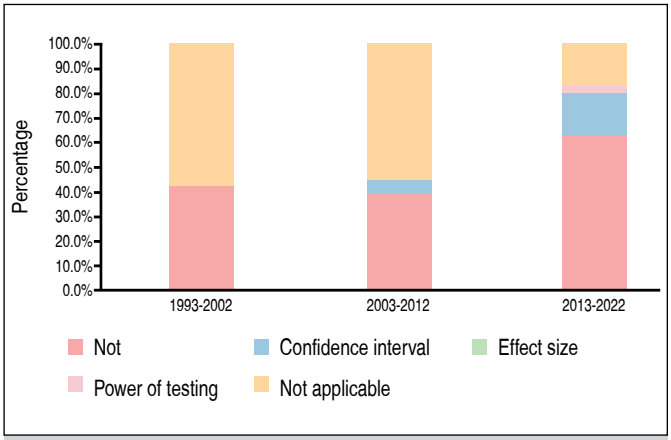

Figure 8. Distribution of papers according to the period and presentation of test power, effect size or confidence interval (n=69).

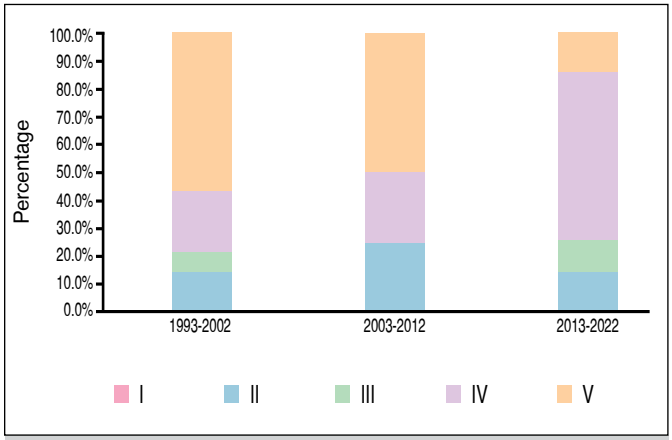

Figure 9. Distribution of papers according to level of evidence (n = 69).

The inter-rater agreement regarding the level of evidence of the published papers, according to the table provided by the journal, was 92.8%, classified as almost perfect agreement according to Landis and Koch[13] (Kappa = 0.89) (Table 4).

Table 4. Results of the inter-rater reproducibility analysis for the level of evidence of the papers (n = 69).

Statistics	Value
Agreement	92.8%
Weighted Kappa (CI95%)	0.89 (0.80-0.99)

CI: Confidence interval. Classification of reproducibility according to Landis and Koch[4]: Almost perfect agreement.

The inter-rater cases of disagreement were presented to a third evaluator and the final level of evidence is presented in Table 5 and Figure 9. A significant association was observed between the level of evidence of the study and the period of paper publication ($p < 0.05$). There was a decrease in the percentage of papers with evidence level V, from 57.1% in the period from 1993 to 2002 to 14.3% in the period from 2013 to 2022. On the other hand, the percentage of papers with evidence level IV increased from 21.4% to 60.0%. There was also a slight increase in the percentage of papers with level III evidence, from 7.1% to 11.4% of published papers.

Table 5. Distribution of papers evaluating samples with human beings according to the level of evidence (n = 69).

		Period		
Level of evidence				**Total**
	1993-2002	2003-2012	2013-2022	
I	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
II	2 (14.3%)	5 (25.0%)	5 (14.3%)	12 (17.4%)
III	1 (7.1%)	0 (0.0%)	4 (11.4%)	5 (7.2%)
IV	3 (21.4%)	5 (25.0%)	21 (60.0%)	29 (42.0%)
V	8 (57.1%)	10 (50.0%)	5 (14.3%)	23 (33.3%)
p-value	0.0056			

DISCUSSION

The number of orthopedic oncology publications in *Acta Ortop Bras* over the study period was restricted; of the total 1349 papers published in thirty years, only 5.1% referred to this orthopedic subspecialty, which indicates the need to stimulate further scientific research in the national reference centers of this subspecialty.

The most frequent study designs were case reports, case-control studies, retrospective-comparative studies, systematic reviews of level III studies, and expert opinions, representing approximately 80% of all papers evaluated. Orthopedic publications seem to follow this trend of low level of methodological evidence, as pointed out by Moraes et al.[10] in a study on the hierarchy of evidence in hand surgery in Brazilian orthopedic journals and by Kiter et al.,[1] in the analysis of publications in nine high-impact international orthopedic journals. Orthopedists have been criticized for publishing few studies with a high methodological level; however, since not all questions can be studied with these characteristics, the relative preponderance of lower-level studies may not accurately describe the frequency with which orthopedic researchers use inappropriate means and, in turn, may not accurately represent the quality of the literature on orthopedics.[19] The current state of Brazilian research in orthopedic oncology cannot be judged by the findings of our study, since relevant research of high methodological quality is usually published in journals with greater visibility and academic impact.

In parallel with the above, a significant association was identified between the type of study and the period of publication, since the percentage of papers published only with descriptive studies decreased (37.5% in 1993-2002 to 5.7% in 2013-2022), while the percentage of studies with an analytical approach increased significantly (7.1% to 77.1% in the same period). This was in addition to the perception of an increase in the use of statistical methodology to analyze and validate study data: only 7.1% of the studies used statistics in 1993-2002, while 77.1% used them in 2013-2022. This demonstrates the authors' concern with the improvement in the methodology of the studies over time.

We also observed an improvement in the quality of the predominant studies over the decades, since there was a significant drop in the percentage of papers with levels of evidence V (57.1% in 1992-2003 to 14.3% in 2013-2022) as well as a significant increase in the observance of papers with level of evidence IV (21.4% in 1992-2003 to 60%% in 2013-2022) and a discrete increase in the number of papers with level of evidence IV (21.4% in 1992-2003 to 60% in 2013-2022) . There was an evolution in relation to papers with levels of evidence II and III (21.4% in 1992-2003 to 24.6% in 2013-2022). This chronological change, directed to research designs of a higher methodological level, has been identified in similar studies based

on historical series of orthopedic journals.[12,20] Finally, we observed that the inter-rater agreement was classified as almost perfect, conferring good reproducibility to the method of classification of evidence used by the journal, which makes it a viable instrument for the evaluation of studies.

CONCLUSIONS

The orthopedic oncology studies published in *Acta Ortop Bras* during the study period showed a low prevalence (5%) considering the number of studies published on other subspecialties. The level of evidence (LE) of these studies still showed, after three decades, a predominance of studies classified as LE IV and V, despite a significant improvement observed between the first and last decade regarding the decrease in LE V studies and an increase in LE II, III and IV studies; which leads us to believe that high-quality evidence related to orthopedic oncology is still poorly available. This scenario puts researchers in the position to make an effort to produce more randomized clinical trials and meta-analyses for the subspecialty. The inter-rater agreement regarding the level of evidence of the published papers was 92.8%, classified as almost perfect.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to the development of this manuscript. AG: substantial contribution to the conception and design of the work, acquisition, analysis and interpretation of the data for the work and final approval of the version of the manuscript to be published; ARFCS: Writing of the paper and critical review of its intellectual content; MASS: Writing of the work or critical review of its intellectual content; AALG: Writing of the work or critical review of its intellectual content; RGB: final approval of the version of the manuscript to be published; OPC: final approval of the version of the manuscript to be published.

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EPIDEMIOLOGICAL PROFILE OF PATIENTS WITH TIBIA DIAPHYSIS FRACTURE TREATED AT A TERTIARY LEVEL HOSPITAL

PERFIL EPIDEMIOLÓGICO DE PACIENTES COM FRATURA DA DIÁFISE DA TÍBIA TRATADOS EM UM HOSPITAL DE NÍVEL TERCIÁRIO

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ABSTRACT

Objective: To outline the epidemiological profile of tibial fractures treated in a tertiary hospital and explore associations between the characteristics of the fractures and the clinical outcome of post-operative complications. Methods: Retrospective cross-sectional study involving adult patients diagnosed with tibial fractures who underwent surgical and/or conservative treatment in a tertiary hospital between January 2019 and December 2021. The variables sex, age, mechanism of injury, type and classification of fracture, associated injuries, personal history, length of hospital stay, surgical treatment, post-surgical complications (infections, loss of synthesis material, surgical wound dehiscence) and death. Results: The sample consisted of 100 individuals, with an average age of 35.8 years, 86% of whom were male, with a higher prevalence of motorcycle accidents. The most common treatment was intramedullary stem, and type C fractures, which are more complex, were more associated with complications. Conclusion: Given the predominance of motorcycle accidents involving young people, there is a need for intervention in accident prevention policies, aiming to reduce the incidence, as well as the morbidity and mortality, of these individuals and, consequently, to reduce costs to the health system. ***Level of evidence III, Retrospective Study.***

Keywords: Fracture. Tibia. Orthopedics.

RESUMO

Objetivo: Traçar o perfil epidemiológico das fraturas de tíbia tratadas em um Hospital de nível terciário e explorar associações entre a caraterística da fratura e o desfecho clínico de complicações pós-operatórias. Métodos: Estudo transversal retrospectivo, envolvendo pacientes adultos, com diagnóstico de fratura de tíbia que realizaram tratamento cirúrgico e/ou conservador em um hospital de nível terciário entre janeiro de 2019 e dezembro de 2021. Foram analisadas as variáveis sexo, idade, mecanismo de lesão, tipo e classificação de fratura, lesões associadas, antecedentes pessoais, tempo de internação hospitalar, tratamento cirúrgico, complicações pós cirúrgicas (infecções, perda do material de síntese, deiscência de ferida operatória) e óbito. Resultados: A amostra foi composta por 100 indivíduos, com média de idade de 35,8 anos, sendo 86% do gênero masculino, com maior prevalência de acidente motociclístico. O tratamento mais realizado foi a Haste intra-medular e as fraturas do tipo C, mais complexas, foram mais associadas às complicações. Conclusão: Diante da predominância de acidentes motociclísticos envolvendo o público jovem há necessidade de intervenção de políticas de prevenção de acidentes, visando diminuir a incidência, bem como a morbidade e mortalidade desses indivíduos e consequentemente a diminuição de custos ao sistema de saúde. ***Nível de evidência III, Estudo Retrospectivo.***

Descritores: *Fratura. Tíbia. Ortopedia.*

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

The study was conducted at Universidade Federal de São Paulo, Escola Paulista de Medicina, Department of Orthopedics and Traumatology
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INTRODUCTION

Traumatology of the musculoskeletal system is an important problem in public health as it accounts for a large part of hospital care and is responsible for high morbidity and mortality rates.[1,2]

Diaphyseal tibial fractures are the most common among fractures of the long bones. In North America, around 300,000 fractures occur per year, and in Brazil around 50,000 per year.[1] Tibial fractures usually occur in two forms: spiral fractures, which are more frequent in people aged over 50 years and result from low-energy trauma, and transverse and/or comminuted fractures, which are more related to high-energy trauma in people aged over 30 years. Low-energy trauma is more related to falls from one's height and sports injuries, while high-energy trauma is more associated with automobile accidents.[2]

The most used classification is the Orthopaedic Trauma Association/Arbeitsgemeinschaft für Osteosynthesefragen (OTA/AO), which considers the mechanism, location and energy of the trauma. Type "A" stands for simple fractures, type "B" for fragmented fractures with wedges and type "C" for complex multifragmented fractures.[3,4] Due to force transmission mechanisms and local anatomical characteristics, diaphyseal tibial fractures can have some complications and association with other injuries, such as compartment syndrome, ankle injuries, extension of injury to the tibial plateau, knee ligament injury, among others, which can trigger greater functional impairments and risks.[1,2]

The most used diagnostic method is radiography. In cases in which there is a suspicion of associated joint and/or ligament injuries, computed tomography or even, in some cases, magnetic resonance imaging is recommended.[5,6]

Treatment for diaphyseal tibial fractures can be conservative or surgical, with the latter being increasingly used in orthopedic practice. There are different options of surgical treatment,[1,3,4] which can take into account factors such as fracture type, age, among others, aiming at fracture stability, rehabilitation and an early return to activities, in addition to avoiding postoperative complications.[4-6]

Since traumatology of the musculoskeletal system comprehends an important part of hospital care and accounts for high rates of morbidity and mortality, especially related to postoperative complications,[4,6] it is very important to properly understand the current epidemiological situation of this condition in our environment. In Brazil, few epidemiological studies on this topic have been published in recent years, and there is currently no basis for a better understanding of the impact of tibial fractures on the health system and, consequently, for the development of preventive strategies to reduce the risk of comorbidities and complications. Thus, the objectives of this study were to outline the epidemiological profile of ankle fractures treated in a tertiary hospital and to explore associations between fracture characteristics and clinical outcomes of postoperative complications.

MATERIAL AND METHODS

This is a retrospective study conducted by searching the electronic Patient Records System (PRS) for hospital admission records of patients with diaphyseal tibial fractures who were hospitalized and treated between January 2019 and December 2021. Records with incomplete data, patients under 18 years of age or transferred to other hospital services were excluded.

All the information used in this project was collected after the participants signed the Informed Consent Form (ICF) issued by the research team. This study was registered and approved by the Research Ethics Committee, with registration in Plataforma Brasil under CAEE number: 68883423.9.0000.5505, opinion 6.297.715.

The variables sex, age, mechanism of injury, fracture type, fracture classification, associated injuries and personal history were recorded. The analyzed outcomes were divided into primary, postoperative complications (infections, loss of synthesis material, wound dehiscence) and death; and secondary, length of hospital stay and surgical treatment variables.

Statistical analysis

Categorical data were expressed as relative frequency (%), continuous data were expressed as mean and standard deviation, and discrete data were expressed as median and quartiles 25-75%. Firstly, a descriptive analysis was conducted to verify the prevalence and distribution of clinical, anthropometric and surgical characteristics of patients.

To explore the association between fracture types "A", "B" or "C" and the clinical outcomes, a generalized linear model was performed with the distributions linear, *gamma* and logistics, according to the nature of the dependent variables. The postoperative complication outcome was determined by the existence of at least one clinical event considered not expected in the postoperative period, such as loosening of surgical material, need for reoperation, surgical site infection, pneumonia, associated fracture and cardiorespiratory arrest. The adopted level of statistical significance was $p < 0.05$. The software used was JAMOVI (*Version* 1.6.23.0).

RESULTS

The data related to sociodemographic characteristics are shown in Table 1. The study involved 100 patients: 86% of the participants were male and 14% female, with a mean age of 35.8 ± 14.6 years.

Table 1. Sample distribution by gender and age.

Gender	n	%	Mean	M	Ma
Female	14	14.00	45.00	18	72
Male	86	86.00	33.93	18	71
Total	100	100.00	35.82	18	72

Legend: n - number of patients; % - percentage; M - minimum; Ma - maximum

Table 2 presents the data regarding the AO classification of fractures, with the most frequent fractures being the simple type (A), followed by wedge (B) and multifragmented fractures (C). A higher prevalence of simple type (A) fractures was found, with 58% of all fractures.

Table 2. Distribution of diaphyseal tibial fractures as classified by the *Orthopaedic Trauma Association / Arbeitsgemeinschaft für Osteosynthesefragen*.

Fracture type	N	Percentage (%)
A1	22	22.00
A2	16	16.00
A3	20	20.00
B1	2	2.00
B2	16	16.00
B3	4	4.00
C1	1	1.00
C2	10	10.00
C3	9	9.00

Legend: N - number of patients, A1 (spiral), A2 (oblique), A3 (transverse), B1 (spiral wedge), B2 (flexion wedge), B3 (fragmented wedge), C1 (comminuted spiral), C2 (Segmental) and C3 (crushing)

Among the mechanisms of injury, automobile traumas stood out, followed by falls (from one's height or flat floor), pedestrian collisions and sports practice, respectively (Table 3). Of the total, 6.00% could not report their mechanism of trauma.

Table 3. Mechanism of injury.

Causes	N	Percentage (%)
Automobile accident	62	62.00
Pedestrian collision	14	14.00
Fall	15	15.00
Sports practice	3	3.00
Could not report	6	6.00

Legend: N - number of patients

The most used treatment was the intramedullary stem (IM), followed by locking plates, conservative treatment and treatment with Ilizarov-type linear or ring external fixators (Table 4).

Table 4. Treatment

Treatment	N	Percentage
External fixator	4	4.00
Intramedullary stem	83	83.00
Plates and screws	8	8.00
Conservative treatment	5	5.00

Legend: N - number of patients

Considering the classification of fractures into types A, B and C, it was found that fracture severity was a determining factor in the outcome of postoperative complications. Patients with a type C fracture were 4.9 times more likely to develop postoperative complications compared to those with a type A fracture (OR = 4.88 [95% CI = 1.61 – 15.46], p = 0.006, Table 5). No difference was found when comparing patients who evolved with a type B fracture compared to types A and C.

Table 5. Odds ratio of clinical outcomes by group.

Postoperative complications						
Comparison of groups			OR(B)	CI 95%	Z	P value
C	-	A	4.88	1.61 – 15.46	2.77	0.006*
B	-	A	0.73	0.15 – 2.70	-0.45	0,655

Notes: OR - Odds ratio, CI - Confidence interval

The mean length of hospital stay was 6 (3 - 8.75) days for patients with a type A fracture, 5 (3-7) days for patients with a type B fracture, and 6 (4 - 10.3) days for patients with a type C fracture. There was no association between fracture type and length of hospital stay (Kruskal Wallis = 1.42, df = 2, p = 0.491). Individuals who developed complications in the postoperative period had a longer hospital stay compared to those who did not have complications (Mann-Whitney U = 288, p < 0.001, Figure 1)
No deaths occurred during this study.

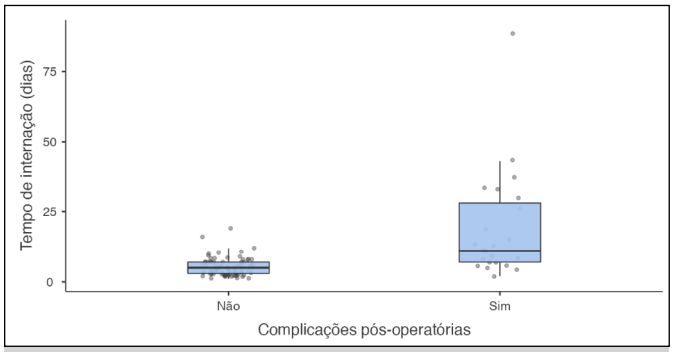

Figure 1 - Relationship between length of stay and complications

DISCUSSION

One hundred patients with diaphyseal tibial fractures were studied, predominantly young adult males. This predominance of males has also been reported in other studies, such as Grecco's[7], in which 73.7% of the sample was composed of men. The mean age of the patients in this study was 35.82 years (18-72 years), which corroborates other studies found in the literature,[8,9] such as those by Ali[8] and Grecco[7], who found mean ages of 38 and 32 years respectively.
Regarding fracture classification, simple (type A) fractures were the most found type, like the data from other studies that report a higher prevalence of simple fractures, also in hospitalized individuals.[8,9] The higher incidence in working-age men is directly linked to those previously mentioned factors, especially as regards the mechanism of injury, usually of high energy.[10]
The literature notes that there are several methods of treatment for diaphyseal tibial fractures, as well as discussions favoring one method or another. A study conducted by Canadian surgeons showed that 80% of them treated diaphyseal tibial fractures surgically.[6] Nevertheless, in a conference of the Orthopaedic Trauma Association, 70% of orthopedic surgeons opted for surgical treatment of this injury. Over the years, conservative treatment has become less common due to the risks of non-consolidation and possible displacement of the fracture during treatment.[5,6]
The intramedullary stem is considered by many surgeons to be the most effective treatment for these fractures.[6,10] At this point, depending on when the study was conducted, the literature was conflicting. In the study by Grecco et al.,[7] of the 179 diaphyseal tibial fractures, 86 underwent treatment with cast immobilization, 71 with external fixators and cast immobilization, 17 with plates and screws, and 5 with external fixators only. On the other hand, the study by Vieira Jr. et al.[10] showed a divergent situation, in which of the 123 fractures studied, 37.5% were definitively treated with dynamic compression plates (DCP), 20.3% with bridge plating and intramedullary stems, 15.6% with linear external fixators and 6.3% with Ilizarov-type ring external fixators.[10]
The mean length of hospital stay in this study was 8.2 days, a considerably lower number compared to data from other reported authors, who obtained a mean length of hospital stay of 26.61 days.[11.] The literature indicates that length of hospital stay is directly related to the number of procedures to which a patient is submitted. [12]
As in other studies, simple fractures (42A) were the most found type, while the wedge fractures (42B) and the complex, multifragmented fractures (42C) shown were not similar, but had no statistical significance.[12]
Vieira Junior et al., in a retrospective, descriptive and analytical study of a tertiary hospital, showed that the mean hospital stay for patients with a type A fracture was 25.5 days, with 16.8 days for type B and 48.3 days for type C. However, there was no statistical significance.[10]

Because it has a small range of muscle protection in its anterior part, the tibia is commonly fractured in an exposed way; and when evaluated between the mechanisms (high and low energy), this percentage varies between 12 and 47%, but when evaluated only in high energy traumas, the percentage increases to approximately 63%.[2,5,13] Similarly, when evaluating the number of hospital days in the literature, considering patients who had or did not have associated complications in the fracture, the length of hospital stay changes, resulting in a mean of 45.57 days for patients with associated injuries and 16.68 days for patients without associated injuries.[10,11]

No topics were found in the literature regarding the death of patients after complications related to diaphyseal tibial fractures, nor to physiotherapy services being offered to, and engaged by, patients with diaphyseal tibial fractures after hospital discharge.

The Ministry of Health warns that automobile accidents are the second largest cause of external deaths in Brazil. In 2017, 35.3 thousand people lost their lives due to a kind of automobile accident. It also reports that approximately BRL 260 million are spent annually on hospitalization of injured persons alone. In addition, those accident victims also cease to contribute to the state, meaning that they will not pay back what was spent on them, which strongly contributes to overburdening public services.[14]

This study reinforces relevant data on diaphyseal tibial fractures with a robust number of participants. It corroborates important aspects regarding the proper care of these injuries, which will allow us to continuously improve treatment and obtain increasingly favorable outcomes.

CONCLUSION

Diaphyseal tibial fractures had a higher incidence in males aged between 20 and 39 years. The most frequent cause was automobile accidents, mostly causing a simple (type A – AO) fracture, while patients with a type C fracture were more likely (4.9 x) to develop complications. Surgical treatment using an intramedullary stem was the most common method, accounting for 83% of cases, with a mean length of hospital stay of 8.42 days.

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PREGABALIN AS A PREOPERATIVE ADJUVANT IN PATIENTS WITH CARPAL TUNNEL SYNDROME

AÇÃO DA PREGABALINA COMO ADJUVANTE NO PRÉ OPERATÓRIO EM PACIENTES COM SÍNDROME DO TÚNEL DO CARPO

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ABSTRACT

Objective: To evaluate the pregabalins adjuvant effect in patients with carpal tunnel syndrome (CTS) surgically treated, analyzing postoperative pain and the incidence of complex regional pain syndrome (CRPS). Methods: Outpatient surgical candidates with CTS were selected and followed for 12 months, divided into three groups. The Control Group received a placebo, the Pregabalin 75 mg Group received a daily dose, and the Pregabalin 150 mg Group received a daily dose of the medication. Patient progress was evaluated using the visual analog scale (VAS) for pain and the DN4 neuropathic pain score before surgery, one month and three months after. Results: The administration of pregabalin to surgical patients with CTS did not demonstrate significant differences in immediate postoperative pain relief. Additionally, there were no statistically significant variations in the incidence of complications, such as CRPS, among the groups. Conclusion: This study did not show a significant impact of pregabalin on postoperative pain relief or the reduction of CRPS incidence in patients undergoing surgery for CTS. These results suggest that pregabalin might not be an effective adjuvant in these surgical situations. ***Level of Evidence II, Comparative prospective study***

Keywords: Carpal Tunnel Syndrome. Surgical Procedures. Operative. Pregabalin. Pain.

RESUMO

Objetivo: Avaliar o efeito adjuvante da pregabalina em pacientes com síndrome do túnel do carpo (STC) tratados cirurgicamente, analisando a dor pós-operatória e a incidência da síndrome da dor complexa regional (SDCR). Métodos: Foram selecionados pacientes com acompanhamento ambulatorial, indicação de tratamento cirúrgico para STC e acompanhados ao longo de 12 meses. Depois, foram divididos em três grupos. O Grupo Controle recebeu placebo, o Grupo Pregabalina 75 mg tomou uma dose diária e o Grupo Pregabalina 150 mg também recebeu dose diária da medicação. A evolução dos pacientes foi avaliada mediante aplicação da escala visual analógica de dor (EVA) e o escore de dor neuropática DN4, antes da cirurgia, um mês e três meses após. Resultados: A administração de pregabalina em pacientes cirúrgicos com STC não demonstrou diferenças significativas no alívio da dor pós-operatória imediata. Além disso, não houve variações estatisticamente significativas na incidência de complicações, como a SDCR, entre os grupos. Conclusão: Este estudo não evidenciou um impacto significativo da pregabalina no alívio da dor pós-operatória ou na redução da incidência da SDCR em pacientes submetidos a cirurgia para STC. Esses resultados sugerem que a pregabalina pode não ser um adjuvante eficaz nessas situações cirúrgicas. ***Nível de Evidência II, Estudo prospectivo comparativo****.*

Descritores: *Síndrome do Túnel do Carpo. Procedimento Cirúrgico. Pregabalina. Dor.*

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The study was conducted at Irmandade Santa Casa de Misericórdia de São Paulo, Departamento de Ortopedia e Traumatologia "Pavilhão Fernandinho Simonsen", Grupo da Mão e Microcirurgia.
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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common compression neuropathy of the upper limbs and affects approximately 4% of the general population, with a higher prevalence in women aged 45 to 60 years.[1] The clinical picture is characterized by pain and paraesthesia in the median nerve area with insidious onset and, in more severe cases, muscle weakness and atrophy of the thenar muscles.[2] The carpal tunnel is an osteofibrous, inelastic canal with the transverse carpal ligament as its roof, through which 10 structures pass, including nine tendons and the median nerve.

Surgical treatment of CTS involves release of the transverse ligament and decompression of the nerve.[3] Although it is a common procedure in hand surgery with high success rates, CTS surgery can have unsatisfactory outcomes for patients, including complications that cannot be prevented, such as the development of chronic postoperative pain.[4]

Complex regional pain syndrome (CRPS), also known as reflex sympathetic dystrophy or causalgia, is a chronic pain disorder with neuropathic features that are often out of proportion to the nociceptive stimulus and may or may not be accompanied by vasomotor changes.[5] It is more common in women and prolonged immobilization may act as a predisposing factor. The incidence of CRPS after carpal tunnel release surgery is about 8%[6], regardless of technique, and accounts for half of the complications after this type of surgery in some case series[7].

With the understanding of the central sensitization processes that lead to chronic pain, drugs from the gabapentinoid class, particularly pregabalin, have been investigated for the prevention of CRPS. Most studies in the literature analyzed the reduction in pain scores and opioid consumption in knee surgery when pregabalin was used preventively.[8,9] However, there is still no consensus on the dose or duration of use of these drugs. This study aims to evaluate the efficacy of pregabalin as an adjuvant in the preoperative phase of carpal tunnel release surgery.

MATERIALS AND METHODS

In this study, patients presenting to the hand surgery outpatient clinic of Santa Casa de Misericórdia de São Paulo with a diagnosis of CTS between June 2022 and June 2023 were analyzed and prospectively observed. The study was conducted with the approval of the Research Ethics Committee of the same institution, according to Resolution 196/96 (CAAE: 69653223.9.0000.5479), and all patients signed the informed consent form (ICF).

These patients were randomized into three groups:

- Patients who received placebo in the three weeks before surgery.
- Patients who received 75 mg/day of pregabalin in the three weeks before surgery.
- Patients who received 150 mg/day of pregabalin in the three weeks before surgery.

Patients of both sexes aged between 40 and 70 years who had a confirmed diagnosis of CTS by ultrasound, electromyography or clinical examination participated in the study. Surgical decompression of the median nerve was performed by the same surgeon using the mini-incision technique. Patients with previous surgery on the same hand, concomitant neuropathies, previous use of gabapentinoids and a history of CRPS were excluded from the study.

Data were collected and analyzed by the same researcher using the visual analog pain scale (VAS) and the DN4 neuropathic pain questionnaire. All patients followed the same follow-up protocol. Medication or placebo was started three weeks before the procedure, and examinations were carried out immediately after the procedure and one month and three months after the procedure. All patients wore an orthosis for immobilization until the stitches were removed, which took place two weeks after the procedure. They also received simple analgesia with NSAIDs and tramadol for pain relief for the first two weeks if needed. They were also supervised by the occupational therapy team until the last examination.

Patients were examined before the procedure, one month and three months postoperatively. Quantitative characteristics were described by group using summary measures (means, standard deviations, medians and quartiles) and compared between groups using analysis of variance (ANOVA) or the Kruskal-Wallis test. Qualitative characteristics were described by the group using absolute and relative frequencies and tested for association using the likelihood ratio test.[10]

Pain scores were described by the group across evaluation periods using summary measures and compared between groups and periods using generalized estimating equations (GEE) with normal marginal distribution and identity link function assuming a first-order autoregressive correlation matrix (AR(1)) between evaluation periods.[11] The analyses were followed by Bonferroni[12] multiple comparisons to test for differences between groups and periods. Analyses were performed using IBM-SPSS for Windows version 22.0, tabulated using Microsoft Excel 2013, and tests were performed at a 5% significance level.

RESULTS

Among the 45 patients diagnosed with CTS and indicated for surgical treatment, 18 patients were in group 1 (placebo in the three weeks before surgery), 15 patients were in group 2 (75 mg/day pregabalin in the three weeks before surgery), and 13 patients were in group 3 (150 mg/day pregabalin in the three weeks before surgery). Four patients were excluded due to prior use of gabapentin, loss to postoperative follow-up, and noncompliance with suggested medication before surgery.

Both the VAS and DN4 showed statistically similar mean behavior across the assessment periods (interaction $p > 0.05$). The VAS showed differences between groups regardless of assessment period (group $p = 0.007$) and the VAS and DN4 showed average differences across assessment periods regardless of group (period $p < 0.05$). (Table 1).

The VAS score was higher in the pregabalin 75mg group compared to the placebo group regardless of assessment time point ($p = 0.006$), and both the VAS and DN4 scores decreased from the preoperative period to subsequent time points, regardless of group ($p < 0.001$). When the statistical results are analyzed in this way, it is clear that patients showed similar results with a decrease in VAS and an improvement in DN4 at the postoperative assessments regardless of group. In addition, there was no evidence of the occurrence of CRPS in any of the three groups up to 3 months postoperatively (Table 2).

The remaining demographic data can be found in Table 3.

Table 1. Description of pain scores by group during the assessment time points and results of the comparisons.

Variable/Moment	Placebo	Group Pregabalin 75mg	Pregabalin 150mg	p Group	p Moment	p Interaction
VAS				**0.007**	**<0.001**	0.166
Pre-op.						
mean ± SD	7.9 ± 2	8.8 ± 1.8	8.4 ± 1.5			
median (p25; p75)	8 (6.3; 10)	10 (8; 10)	9 (7; 10)			
1 month						
mean ± SD	1.7 ± 2.4	2.9 ± 3.8	2.1 ± 1.8			
median (p25; p75)	0 (0; 4.8)	0 (0; 6.5)	2 (0; 4)			
3 months						
mean ± SD	0.4 ± 0.9	3.5 ± 2.8	0.8 ± 1.5			
median (p25; p75)	0 (0; 0)	3 (1; 6.5)	0 (0; 2)			
DN4				0.375	**<0.001**	0.456
Pre-op.						
mean ± SD	5.3 ± 2.1	6.2 ± 1.5	6 ± 2.4			
median (p25; p75)	4.5 (4; 7)	7 (5; 7.5)	7 (5; 8)			
1 month						
mean ± SD	1.3 ± 1.3	1.5 ± 2	1.8 ± 2			
median (p25; p75)	1 (0; 2)	1 (0; 2.5)	1 (0; 4)			
3 months						
mean ± SD	0.6 ± 1.1	1.6 ± 2	0.9 ± 1.3			
median (p25; p75)	0 (0; 1)	1 (0; 3)	0 (0; 2)			

EEG with normal distribution and identity link function, assuming an AR(1) correlation matrix between the time points

Table 2. Result of multiple comparisons of pain scores between groups and assessment

		Mean Difference	Standard error	Inferior	CI (95%)	
					Superior	
VAS Variable Comparison	Placebo - Pregabalina 75mg	-1.74	0.56	0.006	-3.09	-0.39
	Pregabalin Placebo - 150mg	-0.45	0.59	>0.999	-1.86	0.97
	Pregabalin 75mg Pregabalina - 150mg	1.29	0.62	0.110 <0.001	-0.19 5.12	2.78
	Pre-op. - 1 month	6.13	0.42	<0.001	5.62	7.14
	Pre-op. - 3 months	6.76	0.48	0.406	-0.38	7.90
DN4	1 month - 3 months	0.63	0.42	<0.001	1.64	3.66
	Pre-op. - 1 month	4.27	0.26		4.89	
	Pre-op. - 3 months	4.78	0.32	<0.001	4.00	5.55
	1 month - 3 months	0.51	0.26	0.146	-0.11	1.12

Table 3. Description of personal and clinical characteristics by group and results of the statistical tests.

Variable	Group			Total (N = 40)	P
	Placebo (N = 16)	Pregabalin 75mg (N = 13)	Pregabalin 150mg (N = 11)		
Age(years)					**0.162****
mean ± SD	61 ± 14.8	51.5 ± 8.2	56.2 ± 14.7	56.6 ± 13.3	
median(p25; p75)	60 (47.5; 75.8)	54 (47; 57.5)	52 (41.5; 71.5)	55 (47; 69)	

Sex					0.088
Female	15 (93.8)	12 (92.3)	7 (63.6)	34 (85)	
Male	1 (6.3)	1 (7.7)	4 (36.4)	6 (15)	
Laterality					**0.031**
Right	7 (43.8)	5 (38.5)	1 (9.1)	13 (32.5)	
Left	4 (25)	5 (38.5)	1 (9.1)	10 (25)	
Bilateral	5 (31.3)	3 (23.1)	9 (81.8)	17 (42.5)	
Symptom duration (years)					0.907£
mean ± SD	2.7 ± 2.5	2.6 ± 2.4	2.5 ± 2.5	2.6 2.4	
median (p25; p75)	2 (1; 3)	2 (1.5; 3)	2 (0.7; 3)	2 (1; 3)	

Likelihood ratio test; ** Unpaired Student's t-test; £ Kruskal-Wallis test

DISCUSSION

Pregabalin modulates calcium channels in neurons and has been shown to have antiepileptic and anxiolytic effects as well as analgesic effects in neuropathic pain.[13] These results suggested that this substance should be included in the present study to analyze its effect in the postoperative phase of patients with a proven diagnosis of CTS. All patients studied were already candidates for surgical treatment of CTS due to failure of clinical treatment or muscle hypotrophy in the thenar region. Although gabapentinoids are approved for the treatment of chronic neuropathic pain, this drug has not yet been shown to be effective in the treatment of postoperative pain in CTS. A study by Sadatsun[14] found that taking gabapentin, an anticonvulsant with similar effects to pregabalin, in a single dose of 600 mg one hour before induction of anesthesia did not produce significant results in CTS patients. Similar results were found in this study. Even when taking the drug for one month before surgery, only a few patients reported an improvement in symptoms before surgery without avoiding the procedure.

However, other studies have shown that gabapentinoids reduced the use of other medications such as opioids in coping with major surgery,[8] but this variable was not assessed in this study as patients continued to take analgesics regularly during postoperative follow-up.

Another aspect to consider in this study is the fact that all patients had a surgical indication before the administration of the medication. Since no statistical difference was found between the control group and the groups with the drug, it is hypothesized that patients with more severe CTS or refractory to conservative treatment did not benefit from the combined treatment of pregabalin and surgery, with the improvement being mainly due to the surgical intervention.

Regarding CRPS, although patients did not manifest this condition during the study period, the literature reports an approximate incidence of 8% in CTS patients. Therefore, a study with a larger patient population could lead to different results.

CONCLUSION

During the period studied, no significant difference was observed in the use of pregabalin in terms of pain perceived by patients using the VAS and the DN4 and in terms of the occurrence of CRPS.

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MEYER'S DYSPLASIA IN THE DIFFERENTIAL DIAGNOSIS OF HIP PAIN IN CHILDHOOD

DISPLASIA DE MEYER NO DIAGNÓSTICO DIFERENCIAL DA DOR NO QUADRIL NA INFÂNCIA

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ABSTRACT

Objective: This study reviews the literature and shares clinical experiences, emphasizing its diagnostic relevance in children under 5 years of age. Method: We examined 169 cases of Legg-Calvé-Perthes disease (LCPD) in patients in this age group. We analyzed medical records and images, observing variables such as age, gender, complaints, treatment, and outcomes. Results: We studied 20 patients with Meyer's dysplasia, representing 1.4% of LCPD cases in children. The majority were boys (85%) with symptom onset at 38 months. Claudication (25%) and mild pain (40%) were the main complaints. Radiographic findings showed a smaller, granular, or asymmetric nucleus. The average follow-up was 6.4 years, with interventional treatment in 5 cases. Most showed complete reossification and centralization of the femoral head. Conclusion: Meyer's dysplasia is a rare condition that affects the hip in children under 5 years of age, predominantly in boys. It usually does not require intensive treatment; clinical and radiological follow-up is sufficient. However, it is important to be aware of possible unfavorable progressions, requiring more aggressive treatment to prevent complications. ***Level of evidence III, Retrospective comparative study.***

Keywords: Legg-Calve-Perthes Disease. Hip. Intermittent Claudication. Hip Joint.

RESUMO

Objetivo: Este estudo objetiva revisar a literatura e compartilhar experiências clínicas, enfatizando sua relevância diagnóstica em crianças com menos de 5 anos. Método: Estudamos 169 casos de Doença de Legg-Calvé-Perthes (DLCP) em pacientes desta faixa etária. Analisamos prontuários e imagens, observando variáveis como idade, gênero, queixas, tratamento e resultados. Resultados: Estudamos 20 pacientes com displasia de Meyer, que representavam 1,4% dos casos de DLCP em crianças. A maioria eram meninos (85%) com início dos sintomas aos 38 meses. Claudicação (25%) e dor leve (40%) foram as principais queixas. Achados radiográficos mostraram núcleo menor, granular ou assimétrico. O acompanhamento médio foi de 6,4 anos, com tratamento intervencionista em cinco dos casos. A maioria apresentou reossificação completa e centralização da cabeça femoral. Conclusão: A Displasia de Meyer é uma condição rara que afeta o quadril em crianças menores de 5 anos, predominantemente em meninos. Geralmente, não requer tratamento intensivo; os acompanhamentos clínico e radiológico são suficientes. Contudo, é importante estar ciente de possíveis evoluções desfavoráveis, requerendo tratamento mais agressivo para evitar sequelas. ***Nível de Evidência III, Estudo restrospectivo comparativo.***

Descritores: *Doença de Legg-Calve-Perthes. Quadril. Claudicação Intermitente. Articulação do Quadril.*

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<< SUMÁRIO

INTRODUCTION

Meyer's dysplasia (MD) or "Dysplasia Epiphysealis Capitis Femoris" is a rare disorder that leads to a change in the proximal epiphyseal core of the femur. It was first described by Pedersen[1] in 1960 and later described in detail by Meyer[2] in 1964. It was based on observations in a group of patients with Legg-Calvé-Perthes disease (LCPD) with benign outcomes and younger age groups.

The patient may present with episodes of mild pain and limp as a defensive posture or remain asymptomatic.[1-11] On a plain radiograph, a reduced size of the affected epiphysis compared to the unaffected side may be observed with unilateral involvement, as described by Meyer, who described that ossification does not occur until about 2 years of age. When it happens, the small epiphyseal nucleus has a pathological appearance and irregular mineralization pattern resembling a "mulberry" or "flaky" appearance.[2]

Its clinical relevance lies in its importance as a differential diagnosis to other more serious hip disorders in preschool-aged children, such as infectious processes and especially LCPD.[3-6] Lack of awareness of its existence and evolutionary features for proper diagnostic clarification (of aetiology) can lead to unnecessary additional testing, hospitalization and surgery.[5-11]

In its natural course, Meyer's dysplasia is benign in the vast majority of cases, with symptoms improving and no functional or structural impairment occurring in adulthood. However, some cases may take an atypical course leading to deformities of the femoral head. Therefore, it is important to better understand the development and characteristics of the disease and to identify factors that may lead to a different prognosis than usual.[6-11]

We aimed to review the current literature on this condition, add our experience to its evolution, discuss its peculiarities and highlight the importance of its recognition in the differential diagnosis of hip pain in children under 5 years old.

MATERIAL AND METHODS

The research project was submitted to the ReserachEthics Committee of the Brazil Platform and approved for implementation under CAAE number 39750814.0.0000.5479.

In this retrospective study, we analyzed the medical records and imaging examinations of patients who were first diagnosed with LCPD in the Department of Orthopedics and Traumatology of Santa Casa de São Paulo between 1978 and 2023. A total of 169 records were reviewed.

Inclusion criteria were records and radiographs of patients with clinical information and radiologic features compatible with the disease, in children under 5 years old with a diagnostic hypothesis of MD. Exclusion criteria were patients without documentation in the outpatient follow-up, such as lack of radiographs until reossification of the proximal femoral epiphyseal nucleus or skeletal maturity, as well as incomplete or missing clinical data.

The variables analyzed were age, gender, laterality, complaints or reason for seeking medical care, duration of development, age at onset of complaints, radiograph, treatment applied, and joint outcome.

RESULTS

Twenty patients were diagnosed with Meyer's dysplasia, affecting 27 hips out of a total of 1322 children diagnosed with LCPD, representing 1.4% of the total cases. Of these, seventeen (85%) were boys and only three (15%) were girls. Seven (35%) children had bilateral involvement. The average age at first consultation was 38 months (with a range of 26 to 48 months).

The reason for seeking medical attention was limping in 5 (25%) patients, 8 children (40%) had mild hip pain, 7 (35%) had both symptoms and in 1 case (5%) it was an X-ray finding after a traumatic event. The mean duration of symptoms was 7.2 months (1-24 months). The mean age at onset of symptoms was 32.7 months (23-45 months).

Regarding the radiographic findings, we found that in 7 children (35%) the nucleus was smaller in size and height than on the healthy side (characterized as an asymmetric pattern), in two (10%) the pattern was granular and in 6 (30%) both aspects, generally affecting the entire epiphyseal nucleus (Figure 1).

Follow-up ranged from 3 to 14 years with a mean of 6.4 years. Five patients underwent interventional treatment, with two patients receiving skin traction followed by a cast in mid-abduction and three patients receiving an abduction cast without prior traction. In the remaining 15 patients, no intervention was performed, but only outpatient follow-up care was provided. Radiological follow-up revealed complete reossification and centralization of the femoral head in all cases. One notable case among the patients examined concerned a female patient who had been treated in our clinic at the age of 3 years. The initial radiographs showed a compaction of the epiphyseal ossification nucleus (Figure 2), which developed into a deformity of the femoral head during the follow-up examination (Figure 3). However, she maintained a centralized articulation with non-spherical congruency and did not undergo corrective surgery up to the time of the study.

Figure 1. Radiographs of pelvis in anteroposterior orientation illustrating the patterns of involvement in Meyer's epiphysitis - A – asymmetric pattern; B – granular pattern; C - mixed pattern.

Figure 2. X-ray of the pelvis (anteroposterior view) at the initial examination at 3 years and 8 months old.

Figure 3. Radiograph of the pelvis (anteroposterior view) at the final examination at 11 years and 11 months.

DISCUSSION

Meyer's dysplasia is a rare disorder described by Pedersen in 1960 and later defined more precisely by Meyer in 1964. According to the observations of these authors, it is a disorder with features that differ from those observed in a group of patients originally diagnosed with LCPD.

The symptoms of MD are usually milder, onset occurs at a younger age, usually under five years, and bilateral cases are more common.[1-11] When present, symptoms can range from complaints of limping, mild pain, changes in a sitting position, "waddling" gait" – external rotation and abduction - to asymptomatic cases found on examination for other reasons.[4,6,7,8] Pain, either isolated or associated with limping, was the most common reason for seeking medical attention and accounted for 40% of the cases examined in our series. Only one patient was identified as an X-ray finding in a child being examined for abdominal disease.

The etiology remains undetermined, there are various possibilities. A vascular cause has been proposed by Meyer due to ischemia as well as by Batory, who theorizes about a congenital vascular malformation.[2,4] However, since the advent and availability of investigations such as angiography, it is no longer possible to identify changes in the vascularization of the secondary epiphyseal nucleus of the proximal femur, which deviates from these hypotheses.[3,4] Because the disorder occurs in a bone development zone, an endocrinologic etiology has been proposed,[4] but we have found no conclusive studies on this etiology.

Other authors consider MD to be a precursor to LCPD, an earlier stage,[2] a theory that differs from the more accepted literature that distinguishes them as two distinct pathologies.[3-11] When the diagnoses overlap, the typical radiographic changes of MD initially occur without the typical LCPD changes such as subchondral bone fractures and lateral subluxation. Subsequently, these changes occur and merge with the MD changes, with extensive and massive necrosis noted. The well-established chronologic study supports the theory that these are different conditions and not stages of the same disease,[4-9] a theory with which we agree.

The radiographic features of MD can be described as changes in the bony nucleus with evidence of delayed ossification compared to the contralateral side, showing marked asymmetry in the size and height of this nucleus.[2,6] Another characteristic shape is the stippled and granular pattern described as "mulberry-like" or "golf ball".[2,4] In addition to the various radiologic presentations of MD, other types of changes have been found in the literature. Khermosh analyzed the distance between the upper edge of the metaphysis and the Hilgenreiner line and found a reduction (about 30-50% in his case series) on the affected side in unilateral cases.[8] Necrosis can occur in Meyer's disease, as observed in our study, but more subtly than in LCPD, where there is extensive, homogeneous, and dense necrosis. Other features of LCPD that are not found in MD are lateral subluxation, subchondral fracture and changes in the femoral neck.[2,6] Other investigation methods such as scintigraphy show normal results and MRI shows only fragmentation and reduction of the epiphysis.[3,4,8] In our patients, the asymmetric pattern was most common, followed by the mixed type, where both asymmetry and granulation were present in the ossification.

Delayed ossification of the secondary nucleus of the proximal femur or even its "absence", seen on radiographs of 2-year-old children, can occur in MD. This fact inspired theories that the etiology of MD is related to an ossification disorder rather than changes in blood supply and necrosis of the epiphyseal nucleus, as occurs in LCPD.[4-6] In MD, the nucleus would already be altered at the onset of ossification, whereas in LCPD this structure is completely normal before necrosis.[2,4] In MD, the epiphyseal nucleus would have an as-yet-unknown ability to normalize, favoring natural resolution.[4]

The delay in bone age has also been observed in MD by different authors, although the methodology was evaluated differently, making this observation difficult to compare. However, it remains a consistent finding in this disease. In the study by Xiao-Tang Sun, the method of Tanner and Whitehouse 3 (TW3) was applied and a decrease in bone age in the relationship between radius-ulna and other bones as well as the age of carpal bones in Meyer dysplasia was observed following the pattern of "delay and then recovery".[3] Compared to LCPD, MD was noted to have a greater initial delay in bone maturation and a more pronounced decrease in the relationship between radius-ulna and other bones. However, in MD, bone age normalized at around five years of age, which was noted for both the carpal bones and the relationship between the radius and ulna

and other bones, whereas in LCPD this normalization did not occur until around eight years of age. The finding that the delay in bone age resolves more rapidly in Meyer dysplasia is consistent with the milder course of the disease.[3]

The epidemiologic profile of the 20 patients enrolled in this study was similar to that found in the literature, with a higher incidence in males and an earlier onset of the disease compared to LCPD. The average age at diagnosis was slightly higher than reported in the literature, averaging 38 months, while other authors reported values between 24 and 36 months.[4,8] This can be justified by the duration of the complaints and the resulting delay in seeking medical care and clarification of the diagnosis, as the patients in this study reported that the clinical condition had manifested itself on average 7.2 months earlier, increasing the average age of onset to 32.7 months. Bilaterality, which varies between 42 and 59%[2,6] in the literature, was observed in 35% of the cases analyzed here.

In addition to LCPD, the differential diagnoses of MD can also include epiphyseal dysplasia, hypothyroidism and the consequences of infectious processes in the hip.[3-11]

The natural course of MD is usually benign and requires no treatment. Immobilization, plaster casts, orthoses and traction have been mentioned in some of the literature. Nevertheless, it is important to emphasize that there is a possibility of an unfavorable course that can lead to secondary conditions, chronic pain and joint restrictions. Therefore, appropriate treatment is essential to support patients with such a progression, [4,10,11]which sometimes requires corrective surgery.

Such conditions can be treated in the active phase with conservative strategies such as immobilization, offloading, skin or skeletal traction. In the chronic phase, surgical approaches such as osteotomies and even joint prostheses can be used to relieve pain, improve mobility or correct the deformities of secondary conditions.[1-11] The change in the shape of the femoral head may be characterized by a certain flattening or reduction of its residual volume, the coxa vara, and a widening of the femoral neck.[3,4,7-11] Appropriate follow-up after the initial resolution of the condition, even if benign, is essential to monitor for the development of sequelae or new symptoms.

Of the patients we studied, seven received a cast with the lower limbs in abduction, one received percutaneous traction and two others received traction followed by a cast in abduction. However, we believe that clinical follow-up and observation are sufficient in the vast majority of cases.[3-6,8-11] Reossification, with the disappearance of radiographic changes, occurs completely on average three years after the onset of the disease, unlike LCPD, which takes an average of 5-7 years.[2,11] The final result is generally a spherical and centralized hip joint with good results in terms of Stulberg parameters and concentric circles of Mose. [6,12,13] One of the cases studied had a more severe deformity but showed no symptoms or limitation of range of motion and did not require surgical treatment during the eight years of follow-up. Despite the generally good outcome, it is worth noting that follow-up of our patients and appropriate treatment may have prevented the worsening of sequelae and the resulting need for more invasive measures.

CONCLUSION

MD is a rare disease that affects the hip in children of younger age (under 5 years), occurs predominantly in males, has more bilateral involvement and a more favorable course compared to LCPD. The diagnosis is made based on clinical/epidemiologic aspects and simple radiology. Due to the favorable prognosis, more restrictive treatment or hospitalization is usually not required as clinical/orthopedic observation and follow-up are sufficient. However, the possibility of an unfavorable outcome must be taken into account, which requires rapid and efficient therapeutic intervention to prevent secondary damage and the need for more aggressive procedures.

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OUTCOMES OF SURGICAL TREATMENT OF DIAPHYSEAL FEMUR FRACTURES IN POLYTRAUMATIZED CHILDREN

DESFECHOS DO TRATAMENTO CIRÚRGICO DA FRATURA DIAFISÁRIA DO FÊMUR NA CRIANÇA POLITRAUMATIZADA

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ABSTRACT

Objective: This study aimed to evaluate the surgical treatment of diaphyseal femur fractures in polytraumatized children, considering consolidation rate, complications, and function as outcomes of interest. Methods: This is a quantitative, cross-sectional, and retrospective study of medical records of patients treated from 2012 to 2021. The 39 patients (41 femurs) were divided into four groups according to the method of osteosynthesis. We used the IBM SPSS Statistics software, version 20 (SPSS Inc, Chicago, IL), and performed Chi-square, Fisher, Kruskal-Wallis, and Shapiro-Wilk tests with a significance level of 5%. Results: We observed six complications among patients. Functional outcomes were satisfactory in 40 cases (97.6%) and unsatisfactory in one case (2.40%) according to the adopted criteria. We found one case (2.40%) of non-union and one case (2.40%) of malunion, whereas 39 cases (95.20%) achieved full consolidation. Conclusions: Flexible intramedullary nails and external fixators are the preferred options for patients aged 5 to 10 years. Intramedullary nails, plates, or external fixators are prioritized for patients over 11 years old. The type and pattern of fractures were considered relevant for treatment selection. ***Level of evidence III, Therapeutic study - Investigation of outcomes and treatment. Comparative retrospective study.***

Keywords: Child. Child Hospitalized. Femoral Fractures. Fracture Fixation. External Fixators. Intramedullary Fracture Fixation.

RESUMO

Objetivo: Este trabalho teve como objetivo avaliar o tratamento cirúrgico das fraturas diafisárias do fêmur, em crianças politraumatizadas, considerando os desfechos: taxa de consolidação, complicações e função. Métodos: Trata-se de estudo quantitativo, transversal, retrospectivo de prontuários de pacientes atendidos entre 2012 e 2021. Os 39 pacientes (41 fêmures) foram divididos em quatro grupos de acordo com o método de osteossíntese. Utilizamos o Software IBM SPSS Statistics, versão 20 (SPSS Inc, Chicago, IL) e os testes do Qui-quadrado, Fisher, Kruskal-Wallis e Shapiro-Wilk com significância de 5%. Resultados: Obtivemos seis complicações entre os pacientes. O resultado funcional foi satisfatório em 40 (97,6%) situações e insatisfatório em uma (2,40%) de acordo com os critérios adotados. Tivemos um (2,40%) pseudartrose e uma (2,40%) consolidação viciosa; 39 (95,20%) casos obtiveram plena consolidação. Conclusões: As hastes intramedulares flexíveis e o fixador externo são as opções preferenciais para pacientes com idade de 5 a 10 anos. As hastes intramedulares, placas ou fixadores externos são prioritários para pacientes com mais de 11 anos. O tipo e o padrão das fraturas foram considerados relevantes para a escolha do tratamento. ***Nível de evidência III, Estudo terapêutico – Investigação dos resultados e tratamento. Retrospectivo comparativo.***

Descritores: *Criança. Criança Hospitalizada. Fraturas do Fêmur. Fixação de Fratura. Fixadores Externos. Fixação Intramedular de Fraturas.*

INTRODUCTION

Treatment choice for diaphyseal femur fractures (DFF) in the pediatric age group depends on the age, size, and pattern of injury in the patients involved[1].

Success depends on the careful selection of methods to achieve the best possible outcomes. Surgery is generally indicated for the following clinical situations: fractures associated with multiple injuries, such as polytrauma, multiple fractures, floating knee, open fractures, fractures associated with extensive skin and soft tissue injuries, pathological fractures, and fractures associated with head injuries.[2]

The socioeconomic conditions of the family and the treatment environment are also important factors guiding treatment choices,

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<< SUMÁRIO

in addition to the cost of treatment and the availability of different types of osteosynthesis. The patients' caregivers usually work, and their absence from work can result in undesirable financial burdens. Prolonged absence from school can also affect the educational needs of the children.[3]

Surgical treatment using osteosynthesis falls into three modalities: plate and screws, external fixation, and intramedullary fixation. The use of these devices has been shown to prevent many complications that can be caused by prolonged immobilization with casts, as well as psychological and financial damage due to extended hospital stays.[3]

The use of plates and screws is indicated for the treatment of comminuted fractures in which the maintenance of bone length is compromised, thus considered unstable, or in children with a body weight exceeding 49 kg. The intrinsic benefits of this modality include a lower rate of malunion, greater axial and torsional stability when the body weight is placed on the operated lower limb, and reduced exposure and less muscle damage when the submuscular technique is used. Some authors advocate the use of bridge technique for comminuted and unstable fractures to maintain or restore femoral bone length.[4]

On the other hand, the use of these implants by traditional methods shows some disadvantages as they require extensive exposure, causing more damage to the soft tissues surrounding the fracture.[4]

In recent years, flexible intramedullary nailing has become the preferred method for osteosynthesis, initially developed in Nancy, France. With the introduction of this method, many advantages have been recognized, such as the use of minimally invasive approaches, shorter hospital stays, early mobilization and rehabilitation, and a lower rate of complications. Its indication is for stable length DFF patterns, such as transverse and short oblique fractures, and can be performed by retrograde or antegrade insertion. This approach avoids osteonecrosis of the femoral head and premature closure of the growth plates, especially the greater trochanter, when trochanteric insertion nails are used. There are also rigid Ender nails that can be used to prevent shortening at the fracture site. However, complications such as skin irritation due to the prominence of the distal ends of the nails and migration due to premature implant loosening have also been reported.[5]

The use of external fixation methods offers several advantages. They are simple to apply, quick to install, and allow for temporary or permanent treatment of femoral fractures in patients kept in an intensive care environment. However, it is reported that complications associated with external fixation are more common, especially in children with multiple injuries.[6]

When researching the literature, there is a scarcity of studies comparing the advantages and disadvantages of different surgical treatment methods in terms of consolidation rates, complications, and functional outcomes.[7]

When comparing different methods of surgical stabilization, a systematic review by Madhuri et al.[8] found three trials that showed that the compiled studies were of low quality in determining the rate of complications such as malunion, serious adverse events, time to return to school, parental satisfaction, and children's satisfaction in fractures treated with elastic intramedullary nails versus external fixation. The rates of serious adverse events and time to full weight-bearing in patients treated with dynamic versus static external fixation were also inconclusive. The authors found very low-quality evidence when comparing intramedullary fixation and submuscular plating regarding differences in malunion rates, serious adverse events, and time to weight-bearing.[1,9]

In the association between pediatric DFF and polytrauma, it is known that injuries to the head, chest, and abdomen can occur. The Waddell triad is described in association with high-energy kinetic injuries, such as high-speed motor vehicle accidents or pedestrian accidents. In healthy children, there can be an acute loss of blood volume of approximately 25 to 30% before changes in blood pressure can be recognized, resulting in hypovolemia and a potential state of shock. A child with DFF and hypotension should be carefully investigated for bleeding.[6]

Thus, the ideal treatment for femoral fractures in polytrauma depends strictly on the child's age and severity of other injuries. Within the principles of care, there is evidence suggesting that early surgical stabilization of fractures results in a lower rate of complications due to shorter periods of ventilatory support, intensive care unit stays, and hospitalization.[10]

Based on the above, this study aimed to evaluate the surgical treatment of DFF in polytraumatized children using four different therapeutic stabilization methods, considering outcomes such as consolidation rate, complications, and function.

MATERIALS AND METHODS

This is a quantitative, retrospective cross-sectional study based on the review of medical records of patients diagnosed as polytraumatized with diaphyseal femur fractures (DFF) in the pediatric age group who were treated at the Hospital Geral de Pirajussara (a reference center for the municipalities of Embu das Artes and Taboão da Serra, São Paulo, Brazil, operating under the Brazilian Unified Health System - SUS) from January 2012 to December 2021.

The study was developed as an extension of a project previously approved by the Research Ethics Committee (CEP) of the Federal University of São Paulo - UNIFESP, with Ethical Review Presentation Certificate number 59474522200005505, and approved for execution under the CAAE number 5.612.632. The procedures followed the guidelines of the UNIFESP Research Ethics Committee for experiments involving human subjects, in accordance with the Helsinki Declaration of 1995.

Inclusion criteria were:

- Patients of both sexes.
- Age from 2 to17 years.
- Patients undergoing surgical treatment.
- Diagnosed with polytrauma and DFF.
- Simple, complex, closed, or open fractures.
- Complete medical records.
- Minimum outpatient follow-up = outpatient discharge or six months.
- Signing an informed consent form.

Meanwhile, exclusion criteria were:

- Patients with pathological fractures.
- Femoral fractures in other segments.
- Incomplete medical records.
- Failure to sign an informed consent form.

The patients were divided into four groups based on the osteosynthesis method used for fracture treatment. Group A consisted of 13 (31.70%) patients treated with linear or circular external fixators; Group B included six (14.63%) patients treated with plates and screws; Group C included 13 (31.71%) patients treated with intramedullary fixation. These were subdivided into C1 (blocked intramedullary nail) with nine (21.95%) and C2 (flexible intramedullary nail) with four (9.76%). Group D comprised nine (21.95%) patients who initially underwent surgical treatment with an external fixator and later converted to internal fixation.

Thus, after applying the eligibility criteria, 39 patients with DFF were included for analysis. Cases with bilateral fractures were considered individually (N=2). Thus, the overall sample size of cases evaluated was 41 operated femurs. Of the total, 11 (28.21%) patients were female, and 28 (71.79%) were male. Table 1 provides an overview of the sample, considering age and sex. Epidemiological characterization was also conducted for individual cases (Table 1).

Table 1. Characterization of the overall sample and by fixation method by age and sex (N=41)

	Total		Sexo			
		Male		Female		
	N (%)	Age (years) Mean (SD)	N (%)	Age (years) Mean (SD)	N (%)	Age (years) Mean (SD)
Overall sample	41	11,8 (5,01)	28 (68,29)	12,54 (4,62)	13 (31,7)	10,23 (5,61)
Fixator*	13 (31,7)	6,85 (5)	8 (19,51)	8,13 (4,76)	5 (12,2)	4,8 (5,17)
* Circular external fixator	1 (2,44)	15	1 (2,44)	15	0 (0)	
*Linear external fixator	12 (29,27)	6,17 (4,55)	7 (17,07)	7,14 (4,18)	5 (12,2)	4,8 (5,17)
Plate	6 (14,63)	12,17 (2,93)	5 (12,2)	12,2 (3,27)	1 (2,44)	12
Locked nail	9 (21,95)	16 (1,41)	7 (17,07)	16 (1,53)	2 (4,88)	16 (1,41)
Flexible nail	4 (9,76)	11,75 (5,12)	3 (7,32)	12 (6,24)	1 (2,44)	11
Method conversion	9 (21,95)	14,56 (1,51)	5 (12,2)	15,4 (0,55)	4 (9,76)	13,5 (1,73)

1- For categorization purposes, the overall group included both circular and linear external fixators

A spreadsheet was created to tabulate relevant information collected in our sample, including sex, age at the time of the accident, fracture type, fracture pattern, treatment type, consolidation time, post-recovery function, and postoperative complications.

Injuries were classified according to fracture pattern as simple (transverse, oblique, or spiral) and complex (wedge, segmental, and comminuted), and as closed or open, following the Gustillo and Anderson classification.[11]

The consolidation process of injuries and function after therapeutic intervention were also assessed. Good outcomes were defined for individuals who exhibited complete fracture consolidation, a normal range of joint motion, normal muscle tone, grade V strength, absence of pain, limb length discrepancy less than 2 cm, and proper gait as determined by visual analysis. A poor outcome was defined if any of these criteria were not met. Sequelae and complications were analyzed in each of the studied groups, being subdivided into major (refracture, malunion, deep infection, non-union, shortening greater than 2 cm, limited joint range of motion, and/or infection such as osteomyelitis and septic arthritis) and minor (pin tract infection, screw breakage, nail migration, and/or implant-related tendinitis). The groups were compared based on age, fracture type and pattern, consolidation success, functional analysis (using criteria adopted by the researchers), and complications, checking for statistical significance when possible.

The data obtained were analyzed by a specialized medical statistician using the IBM SPSS Statistics software version 20 (SPSS Inc, Chicago, IL). Categorical data were presented in the form of frequencies and percentages, and continuous numerical data were presented as means and standard deviations. For categorical data, the Chi-square test and Fisher's Exact test were used. The Kruskal-Wallis test was applied for non-homogeneous and non-parametric numerical data comparisons. Analyses were conducted to determine whether there was a statistical association between the different methods of surgical treatment for the studied variables, with a significance level of 5%. Normality of the variables was tested using the Shapiro-Wilk test, assuming non-normality when the result was $p < 0.05$. Confidence interval was set at 95%. We used 2×N tables to assess the association between treatments and other variables. The Cramer's V coefficient was applied to evaluate the association between non-square tables. To specifically iscriminate statistical differences within the groups for the evaluated categories, adjusted residuals were analyzed (the difference between observed and expected frequencies adjusted according to the Z-score for Fisher's Exact test, with a reference value of 1.96, corresponding to a significance level of 5%). Residuals > 1.96 or < 1.96 were considered statistically significant.[12]

RESULTS

For cases of method conversion (Group D), there was a need for conversion from external fixation to intramedullary nail (IN) in seven situations. Among these, six conversions from external linear fixator to nail occurred. In one of these patients, delayed consolidation occurred, with removal of the synthesis material being performed after 2.5 years. In another case, a strategic change from a plate to an IN was made due to loss of reduction. Additionally, there was one instance in which conversion from external linear fixator to bilateral plates was required. Finally, in yet another of these cases, although the osteosynthesis method was not changed, a reoperation was necessary to perform a femoral wedge osteotomy due to malunion, a complication associated with a reduction in the range of motion of the ipsilateral knee.

In the comparison between groups, according to different fixation systems versus age, the Kruskal-Wallis test demonstrated an effect of the group on age [$X^2(4) = 22.315$; $P < 0.001$], indicating a statistical difference in age among the groups (Table 2). In order to identify which groups presented a statistically significant difference, pairwise comparisons were made for the groups considering the age of the participants. Pairwise comparisons showed a statistically significant difference between the "fixator-flexible nail" group ($P = 0.019$) and the "fixator-locked nail" group ($P < 0.001$). The others did not show significant differences considering the age of the samples. It should be noted that sample size (N) was higher for groups B, C, and D, accounting for 31.7%, 21.95%, and 21.95% of the overall sample, respectively.

Table 2. Comparison of age versus fixation method (N=41)

	df	Chi-square (X)	P-value*
Age vs. Fixation method	4	22,315	<0,001

2 - *Kruskal-Wallis test
Pairwise comparisons showed a statistically significant difference between the "fixator-conversion" groups ($P = 0.019$) and "fixator-locked nail" groups ($p < 0.001$). The other comparisons did not show significance for age.

Table 3 shows the comparisons between the groups and fracture patterns, consolidation, function, and complications (we marked YES or NO for positive cases among major and minor complications). When evaluating the consolidation category, we excluded two patients, one due to transfer to a private healthcare service and the other due to loss of follow-up. Only one case (in which there was a conversion from plate to nail due to loss of reduction) was considered a consolidation failure. Regarding complications,

we found six positive situations, with three classified as major (malunion, limitation of joint range of motion, and pyoarthritis) and three as minor (pin tract infection, screw breakage in the nail without compromising consolidation or function, and secondary tendinitis at the implant insertion site). We highlight that 50% of the complication cases (N = 3) occurred in Group D, with two major complications (limitation of joint range of motion and pyoarthritis) and one minor (tendinitis). In Group A, we found one minor complication (pin tract infection) and one major complication (malunion); in Group C1, we found one minor complication (screw breakage in the nail).

The functional outcome was satisfactory in 40 cases (97.6%) and unsatisfactory in one case (2.4%) according to our criteria. Regarding fracture consolidation, we found one case (2.4%) of non-union and one case (2.4%) of malunion. In total, 39 cases (95.2%) achieved full and satisfactory consolidation of their injuries.

For the analyses between the studied groups, only comparisons between fracture pattern (simple vs. complex) and fracture type (open Gustillo 3A vs. closed) showed statistical significance. The Fisher's Exact Test showed an association between fracture pattern and fixation method ($X^2(4) = 13.232$; $P = 0.007$) and between fracture type and osteosynthesis type ($X^2(4) = 7.361$; $p = 0.029$), with no association for comparisons of consolidation, function, and complications with $p > 0.05$ (Table 3).

Table 3. Comparison of fracture, consolidation, function, and complications versus fixation method (N=41)

		Fixation method N (%)					p-Valor*	Cramer' s V % (p-value)
		Group A	Group B	Group C1	Group C2	Group D		
Fracture type (N=41)	Open	0 (0)	0 (0)	0 (0)	1 (2,4)	3 (7,3)	0,029[a]	48,8 (0,045)
	Closed	13 (31,7)	6 (14,6)	9 (22)	3 (7,3)	6 (14,6)		
Fracture pattern (N=41)	Simple	9 (22)	2 (4,9)	5 (12,2)	3 (7,3)	0 (0)	0,007[b]	55,3 (0,014)
	Complex	4 (9,8)	4 (9,8)	4 (9,8)	1 (2,4)	9 (22)		
	Total	13 (31,7)	6 (14,6)	9 (22)	4 (9,8)	9 (22)		
Consoli dation (N=39)	Yes	12 (30,8)	6 (15,4)	8 (20,5)	4 (10,3)	8 (20,5)	0,692	29,6 (0,490)
	No	0 (0)	0 (0)	0 (0)	0 (0)	1 (2,6)		
	Total	12 (30,8)	6 (15,4)	8 (20,5)	4 (10,3)	9 (23,1)		
Function (N=31)	Normal	11 (35,5)	5 (16,1)	5 (16,1)	4 (12,9)	5 (16,1)	0,645	37,3 (0,366)
	Sequela	0 (0)	0 (0)	0 (0)	0 (0)	1 (3,2)		
	Total	11 (35,5)	5 (16,1)	5 (16,1)	4 (12,9)	6 (19,4)		
Complications (N=33)	Yes**	2 (6,1)	0 (0)	1 (3)	0 (0)	3 (9,1)	0,389	38,5 (0,298)
	No	10 (30,3)	5 (15,2)	4 (12,1)	4 (12,1)	4 (12,1)		
	Total	12 (36,4)	5 (15,2)	5 (15,2)	4 (12,1)	7 (21,2)		
Yes** (N=6)	Major	1 (16,7)	0 (0)	0 (0)	0 (0)	2 (33,3)	1	47,1 (0,513)
	Minor	1 (16,7)	0 (0)	1 (16,7)	0 (0)	1 (16,7)		

*Fisher's exact test
a = Adjusted residues indicate a statistical difference in the "method conversion" comparison
b = Adjusted residues indicate a statistical difference in both the "method conversion" and "fixator" comparisons

For specific discrimination of statistical differences between treatment groups for the evaluated categories, adjusted residuals were analyzed. The number of individuals with open and/or complex fractures in the "Method Conversion" group was higher than expected (observed frequency 3 and expected 0.9 with adjusted residual = 2.7; and observed frequency 9 and expected 4.8 with adjusted residual = 3.2, respectively), and the number of complex fractures in Group A was lower than expected (observed frequency = 4 and expected = 7, with adjusted residual = −2). The adjusted residuals did not show a statistically significant difference between observed and expected frequencies for the other cells.

DISCUSSION

The definitive treatment of diaphyseal femur fractures (DFF) in the pediatric population remains undefined in the literature. This assertion is based on studies in which the levels of scientific evidence attained are still not ideal.[2] We observed that management is primarily based on the patient's age, although skeletal age, pattern and type of injury, child size, and the expertise of the medical team are also considered determining factors for therapeutic choice.[14]

Our study showed a direct association between the age of the children involved and the method of fixation, corroborating the hypothesis predicted in numerous previous studies.[13–15]

We believe that there are numerous advantages associated with surgical treatment of femoral fractures, especially in polytraumatized individuals who require very specific care. Among the benefits of this modality are ease and early patient mobilization, improved respiratory capacity, prevention of bedsores, minimization of the risk of pulmonary infection, appropriate stabilization, reduced hospitalization periods, lower therapeutic costs, ease of hygiene, and mobility.[11]

Moreover, the superiority of surgical treatment has been reported for this population when compared to conservative methods. We noted that this theme has been the subject of discussion by various authors.[7,11,16] Regarding the various aspects of treatment with plaster casts, we can mention knee joint stiffness, malunion, shortening, delayed consolidation, refracture, muscle hypotrophy, and weakness, among others.[17]

In our view, another relevant and significant aspect of this topic is the socioeconomic factors, such as the length of in-hospital stay, the

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burden on the institution, the impact on the family budget, absence from school, absence of parents or guardians from work, and job loss. Other issues have also been reported, such as transportation difficulties, hygiene problems, reduced social contact, total dependence for feeding care, psychological changes, and restricted visual field.[17]

Our services are provided in a public referral facility for more complex treatments in the municipalities of Embu das Artes and Taboão da Serra, São Paulo, Brazil, which are affiliated with the Brazilian Unified Health System (SUS). Thus, optimizing the use of beds and hospitalization time is a constant concern, requiring the best possible management.

Considering surgical treatment, the American Academy of Orthopaedic Surgeons (AAOS)[13] published a series of recommendations for the treatment of DFF in 2010. These recommend flexible intramedullary nailing as a therapeutic option for children aged five to 11 based on level III evidence and grade C recommendation. The use of rigid trochanteric intramedullary nailing, plate and screws, and flexible intramedullary nailing is recommended for individuals older than 11 based on level IV evidence and grade C recommendation. There is no evidence to recommend for or against the following situations: removal of surgical implants from asymptomatic patients after operative treatment of DFF (level IV evidence and inconclusive recommendation grade); outpatient physical therapy to improve function (level V evidence and inconclusive recommendation grade); and use of blocked plates versus unblocked plates for fracture fixation (level IV evidence and inconclusive recommendation grade).

Considering these assumptions, we agree with the recommendations proposed by AAOS.[15] Our study showed that the mean ages for choosing blocked intramedullary nails were higher compared to the other groups in our casuistry (N = 16). The mean ages for using plates and screws were 12.17 years, 11.75 for using flexible nails, and 6.85 for external fixation. However, we did not adopt the conservative therapeutic approach for children older than five when possible.

We highlight the work by Luo Y et al., who advocate for the choice of flexible nails over plate and screw fixation in low-energy comminuted fractures, reporting advantages such as shorter surgical time, intraoperative bleeding, and hospitalization costs.[5] Of the nine cases observed in children aged ≤ 5 years, eight were treated with linear external fixation, and one with a flexible intramedullary nail. Our study demonstrated statistical significance in comparisons between fixation methods when considering the type of injury (Gustillo 3A open vs. closed) and fracture pattern (simple vs. complex), indicating that these variables are also invaluable factors in choosing the fixation method.

When judging the choice between external fixation and intramedullary nailing, the literature has not established a consensus. Our results, in pairwise evaluations, showed that the comparison between groups A and C did not present statistical significance ($P < 0.001$) when considering the age of the participants. Although our study did not demonstrate a positive association in the comparison between these groups and age, we believe that there is a tendency to assert that the use of external fixation may have superiority in patients with more distal or proximal fractures, older age, and body weight above 45 kg, compared to the use of flexible nails.[18]

In this study, there were six conversions in which external fixation was replaced by intramedullary nailing, four of which showed significant associated injuries (head, chest, cervical, or abdominal trauma). This is a common approach, as the implementation of external fixation is fast and effective, allowing for quick stabilization of the bone injury and enabling care for other systems and organs.[19] However, we emphasize that there are proponents of using external fixation definitively, especially in the pediatric population.[13,20] The more severe profile of patients undergoing external fixator therapy[19,20] could explain the higher number of individuals with open and/or complex fractures in Group D in our study.

Regarding complications, Group D showed a higher number of cases, with 50% showing complications, including one patient who developed non-union. The work of Lascombes et al. reports minimal complications, with one case of osteomyelitis, two refractures, five length discrepancies > 2 cm, and 12% skin irritation in over 350 treated fractures. They argue that the use of nails is superior to plates and external fixators.[21] Our study is in line with these findings, but our sample is limited, which may bias our results.

The length of hospitalization for our patients corresponded to the standard of care for polytraumatized individuals. A considerable rate of complications and adverse events, including mortality, is inherent in polytrauma cases among adolescents and pediatric patients. The severity of trauma is closely related to lower body weight and bone structure. In older children, thoracic and cranial trauma may be important predictive factors for outcomes in these patients, although extremities, the chest, and the abdomen are more frequently affected in this population. Besides the complications listed, we did not observe any fatal cases.[22]

We suggest that higher treatment costs are related to the severity of injuries. When comparing the financial demand, operative methods appear to be more advantageous when compared to conservative treatment, which could entail avoiding the risks of surgery.[16]

The main limitation of our study is the small sample size, despite data collection spanning over 10 years (from January 2012 to December 2021). We consider the strong points to be the collection of data in a referral hospital for pediatric musculoskeletal injuries in the region. We believe that additional or multicenter studies could provide a larger sample size and offer more evidence on the subject.

CONCLUSIONS

We conclude that the correct therapeutic choice in the management of diaphyseal femur fractures (DFF) in children and adolescents remains inconclusive in the literature, and it continues to be a topic of great relevance to the academic and scientific community. Our study confirms the association between age and fixation methods. Flexible intramedullary nails (INs) and external fixation were found to be the preferred options for patients of intermediate age, whereas locked INs, flexible INs, plates, and/or external fixation are prioritized for patients over 11 years old. The type and pattern of fractures are considered important factors in the choice of treatment. Despite complications being observed, the use of INs should not be discouraged. Finally, individual factors should be considered when choosing the best therapeutic approach. The functional outcome was satisfactory in 40 cases (97.6%) and unsatisfactory in one case (2.4%). Regarding fracture consolidation, we found one case (2.4%) of non-union and one case (2.4%) of malunion. In total, 39 cases (95.2%) achieved full and satisfactory healing of their injuries. Regarding complications, we noted that 50% of cases (N=3) occurred in Group D, with two major complications (joint motion limitation and pyoarthritis) and one categorized as minor (tendonitis). Moreover, in Group A, we found one minor complication (pin tract infection) and one major complication (malunion), whereas in Group C1, we found one minor complication (screw breakage in the nail).

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DECREASED SURGICAL DURATION, LESS COMPLICATIONS, AND FASTER RETURN TO ACTIVITIES ACROSS THE LEARNING CURVE FOR THE ARTHROSCOPIC LATARJET TECHNIQUE

MENOR TEMPO CIRÚRGICO, MENOS COMPLICAÇÕES E RETORNO MAIS RÁPIDO ÀS ATIVIDADES AO LONGO DA CURVA DE APRENDIZADO PARA A TÉCNICA ARTROSCÓPICA DE LATARJET

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ABSTRACT

Objetive: This study aims to analyze the learning curves in performing the arthroscopic Latarjet surgery. Methods: This was an observational, retrospective, single-center study. All cases of arthroscopic Latarjet performed in this institution from 2016 to 2021 were included. The data analyzed were surgical time (of the chief surgeon alone and the group of surgeons), complications, and time until the return to sports activities. Technical observations about the learning process were also reported. Results: In total, 50 consecutive cases were included (93% retention of the initial sample identified at the institution). The decrease in surgical time was presented logarithmically and showed a decrease in time both for the individualized analysis of the senior surgeon ($r = -0.67$, $p < 0.001$) and for the surgical group ($r = -0.476$, $p < 0.001$). Mean operating time (and standard deviation) dropped from 235 minutes (73) in the first 10 cases to 156 minutes (34) for the subsequent cases ($p < 0.001$). In the first 20 cases, five intercurrences were recorded and three reoperations were performed, whereas subsequent cases presented only one intercurrence requiring surgical intervention ($p = 0.032$). The median time to return to sport was nine months for the first 20 cases versus six months for subsequent cases ($p = 0.001$). Conclusion: The learning curve for the arthroscopic Latarjet procedure showed a progressive decrease in operative time, complications, and time to return to sports activities. This suggests that the surgeon developed the necessary skills and confidence to reach a plateau of expertise to perform the surgical procedure. ***Level of evidence IV, Observational retrospective.***

Keywords: Instability. Shoulder. Surgeon Experience. Learning Curve.

RESUMO

Objetivo: Analisar a curva de aprendizado para a realização artroscópica da cirurgia de Latarjet. Métodos: Este foi um estudo observacional, retrospectivo e unicêntrico. Foram incluídos todos os casos de Latarjet artroscópico realizados nesta instituição, de 2016 a 2021. Os dados analisados foram: tempo cirúrgico (somente do cirurgião chefe e do grupo de cirurgiões), complicações e tempo até o retorno às atividades esportivas. Observações técnicas sobre o processo de aprendizagem também foram relatadas. Resultados: Foram incluídos 50 casos consecutivos (retenção de 93% da amostra inicial identificada na instituição). A diminuição do tempo cirúrgico foi apresentada de forma logarítmica e mostrou redução do tempo, tanto para a análise individualizada do cirurgião sênior ($r = -0,67$, $p < 0,001$) quanto para o grupo cirúrgico ($r = -0,476$, $p < 0,001$). O tempo operatório médio (e desvio padrão) caiu de 235 minutos (73) nos primeiros 10 casos para 156 minutos (34) nos casos subsequentes ($p < 0,001$). Nos primeiros 20 casos foram documentadas cinco intercorrências e realizadas três reoperações, enquanto nos casos subsequentes ocorreu apenas uma intercorrência com necessidade de intervenção cirúrgica ($p = 0,032$). O tempo médio para retorno ao esporte foi de nove meses para os primeiros 20 casos versus seis meses para os casos subsequentes ($p = 0,001$). Conclusão: Durante a adoção inicial do Latarjet artroscópico, houve diminuição progressiva do tempo operatório, das complicações e do tempo de retorno às atividades esportivas até que o cirurgião ganhasse a habilidade e a confiança necessárias para atingir o patamar de expertise para realização do procedimento cirúrgico. ***Nível de evidência IV, Retrospectivo observacional.***

Descritores: *Instabilidade. Ombro. Experiência do Cirurgião. Curva de Aprendizado.*

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INTRODUCTION

Anterior glenohumeral dislocation is the most common type of shoulder dislocation, accounting for 90% of cases. It is a potentially disabling injury and frequently affects young athletes, which encourages continuous improvement in the development of techniques to treat this pathology.[1]

Considering the high rates of recurrences described, Balg and Boileau designed the Instability Severity Index Score (ISIS), which considers patient's characteristics, type of activity, and radiological images. Scores below 4 show recurrence rate of approximately 10%, whereas scores greater than or equal to 4 have an approximate recurrence rate of 70%, thus requiring further techniques for repair, with the need for bone blocks, such as the Bristow-Latarjet surgery.[2]

The Bristow-Latarjet technique involves osteotomy of the coracoid apophysis and its transfer, along with the conjoined tendon, to address the bone defect in the anteroinferior portion of the glenoid.[3,4] In 2007, Lafosse et al. first described arthroscopic Latarjet surgery, finding fewer complications compared to open surgery.[5]

The literature have suggested that the arthroscopic technique shows potential benefits, including less damage to the adjacent tissues, less postoperative stiffness, and faster rehabilitation.[6] However, it is technically challenging due to concerns about potential surgical risks during the initial phase of the learning curve.[7–9] Thus, this study aimed to analyze the learning curve for performing arthroscopic Latarjet surgery.

MATERIALS AND METHODS

After approval by the Research Ethics Committee, an observational, retrospective, single-center study of a series of cases was conducted. Screening of the participants was accomplished by searching the medical records of the institution. Inclusion criteria were: individuals who underwent arthroscopic Latarjet surgery from April 2016 to July 2021 to treat anterior glenoid bone defects greater than 20%, an engaging Hill-Sachs lesion with ISIS score greater than four[10], or a failed Bankart repair. Exclusion criteria included the presence of rotator cuff injuries, fractures of the proximal third of the humerus, and/or insufficient medical records for the required analyses.

The data collected and analyzed were sex, age, surgical time, need for reverting to open surgery, surgical or perioperative complications, reoperation, and time to return to physical activities.

The study was approved by Instituto Fleury under the number 48639121.0.0000.5474.

Surgical technique

The arthroscopy was performed with 0.9% saline solution with half an ampoule of adrenaline with vasoconstrictor for each liter of saline. The pressure in the infusion pump in the arthroscope was maintained at 45 to 50 mmHg, and 1 g of tranexamic acid was administered during anesthetic induction. Arm support was provided by an articulated mechanical arm (Trimano) and bipolar radiofrequency was used. The arthroscopic portals were used as recommended by Lafosse[5] and as previously described.[11]

Once the kit for performing the arthroscopic Latarjet technique became available in our country, the institution where this research was conducted began to treat cases using this surgical technique. A senior surgeon from the group took the lead as head surgeon in the first cases. To ensure the safety of the coracoid osteotomy and its positioning, the first 10 cases were completely performed using the arthroscopic technique with subsequent open surgery for checking and making final adjustments when necessary, as previously suggested for this surgical technique[12]. The patients were previously informed that the arthroscopic and open surgery were going to be programmed and performed.

As the surgical group gained experience, after the first 10 cases, the procedure was completely performed arthroscopically and other surgeons began to take on their first cases as the lead surgeon, accompanied by the senior surgeon.

Data analysis

A descriptive and inferential presentation of the data was prepared. Technical observations about the learning process were compiled in descriptive form.

For learning curve, three models were considered: (A) chronological order with only the senior surgeon cases, (B) chronological order with all group cases, and (C) order considering the number of cases for each surgeon individually. The learning rate was calculated for model (A) using the learning curve data for the single surgeon cases only. The Kolmogorov-Smirnov test was used to evaluate the normality of the data. Parametric correlation analysis (Pearson's correlation) between the case number and the surgical time was conducted using the least squares method (logarithmic transformation of the variables involved). Group case series were divided into five consecutive strata in chronological order and the mean surgical times of the blocks were compared using analysis of variance (ANOVA) and the two-sample Student's t-test to evaluate change between the blocks during the learning process. A 2×2 contingency table was used with Pearson's test for the comparison between the blocks of cases with or without complications. Moreover, the Mann-Whitney test was used to compare the times to return to physical activities. The SPSS Statistics 22 (IBM®) software program was used for data analysis, and the significance level was set at 0.05.

RESULTS

From the initial sample of 54 identified cases, we obtained the necessary data for 50 individuals (93% retention). In total, 44 patients were male (88% of the total), and the mean patient age was 32 years (standard deviation, SD 11). A total of 34 surgeries were performed by the primary author as the lead surgeon. The other procedures were performed by four other surgeons in the group as the leads, but always with the primary author as the supervisor.

Figure 1 shows the operating time spent per number of consecutive cases and the estimated time based on the learning curve model. The decrease in surgical time is evident over the course of consecutive cases across the learning curve for this surgical technique.

The correlation model observed between the surgical time (in log) and the secondary evolution of the cases operated only by the senior surgeon demonstrated a significant statistical correlation, in which a decrease in surgical time was observed (Pearson's linear correlation coefficient, $r = -0.67$, $p < 0.001$, Figures 1a and 1b).

In our analysis of the group learning curve, we also observed a statistically significant decrease in the surgical time over the course of the cases operated ($r = -0.476$, $p < 0.001$, Figures 1c and 1d). By separating the cases into consecutive chronological blocks of 10, it was possible to observe that the mean surgical time of the cases after the tenth dropped significantly (Figure 2, $p < 0.001$) from 235 minutes (cases 1–10) to 151 (11–20), 165 (21–30), 150 (31–40), and 157 (41–54). After the tenth case, the variability (standard deviation) of the surgical times dropped from 73 minutes (95% CI 182–287, cases 1–10) to 34 minutes (95% CI 145–167, cases 11–54), showing trends to follow the estimated time curve more faithfully, in a plateau projection.

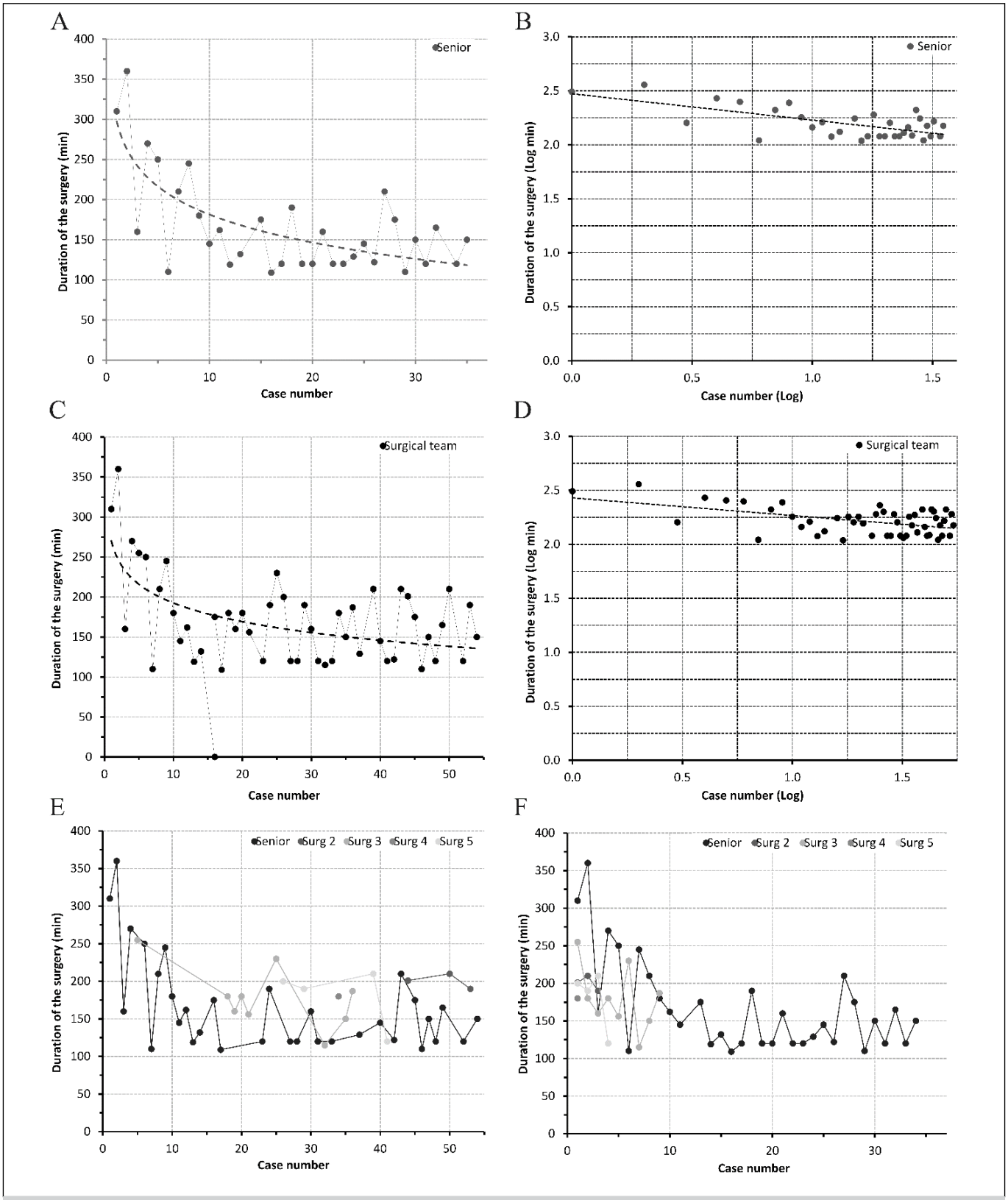

Figure 1. Learning curves created by plotting surgical time by case number. (a) Learning curve of the senior surgeon with raw data and in (b) logarithmic transformation. The learning curve was estimated as 84% ($2^{-0.163}$). (c) Learning curve of all cases of the surgical group directed by the senior surgeon with raw data and in (d) logarithmic transformation. The learning curve was estimated as 89% ($2^{-0.244}$). Graphs A and C show logarithmic trendlines and graphs B and D show linear trendlines. (e) Learning curve of the surgical group in the chronological and cumulative order in which the cases were operated. (f) Learning curve of the different lead surgeons of the same surgical group (the cases were not cumulatively counted among the different surgeons).

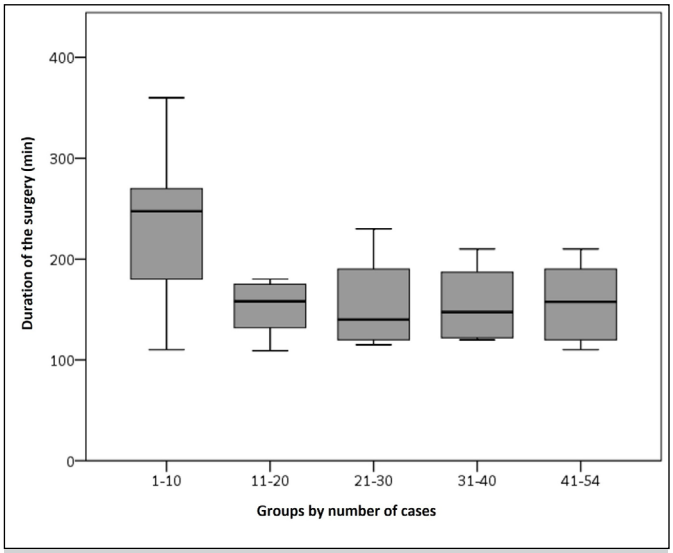

Figure 2. Comparison of surgical times by consecutive groups of cases included in this study. ANOVA ($p < 0.001$), * Group 1–10 statistically significant in Student's t-test compared to the other groups ($p = 0.006$: 1–10 vs. 11–20, $p = 0.011$: 1–10 vs. 21–30, $p = 0.010$: 1–10 vs. 31–40, $p = 0.011$: 1–10 vs. 41–54)

In the first 10 cases, a total of five complications were found, with two cases of neurapraxia of the musculocutaneous nerves, with spontaneous resolution, a case of coracoid graft fracture, resolved intraoperatively with graft fixation using a screw, and two cases of grafts in a highly lateralized position, requiring thinning of the graft and removal of the screws. All cases progressed well, without sequelae. In this study, in our analysis of cases 30 to 50, we encountered only one complication. Breakage of the coracoid graft occurred in case 43, which was fixed with only one screw and was resolved intraoperatively, requiring only conversion to open surgery, without complications or future sequelae for the patient. We observed a change in pattern after the 20th case ($p = 0.032$). The median time to return to physical activities in the first 20 cases was nine months (min.-max., 4–18) versus six months (min.-max., 4–9) for subsequent cases ($p = 0.001$).

As qualitative observations, we noted some recurring challenges from the first surgical procedure. First, we noticed a high split in the subscapularis muscle, leaving only a narrow upper layer, which could lead to muscle weakness. Another issue was related to the size of the coracoid. During the osteotomy, the graft often was found to be quite small at the base, with excess coracoid, which could cause an internal impact in the future or, if the grafts were smaller than 1 cm, they might not be sufficient to stabilize the humeral head against the glenoid. Moreover, when the graft was fixed arthroscopically, we noted that it was usually positioned excessively at the base of the glenoid and excessively lateralized, which could generate impact and chondral injury on the humeral head.

After the first 10 surgeries, we were able to make the necessary adjustments so that all the procedures were performed solely by arthroscopy without checking via open visualization. This was made possible with the subscapularis split in the proper location, the coracoid tip with the correct size, and the more medialized positioning of the graft, preventing impact with the humeral head and adequately stabilizing the glenohumeral joint.

DISCUSSION

In our study, we observed a reduction in the required surgical time, a decrease in the number of complications, and an acceleration of the return to physical activities accompanying the learning curve. These findings corroborate the fact that the arthroscopic Latarjet technique can show favorable clinical results, even better when performed by experienced surgeons.[6,9]

As previously discussed in the literature,[12,13] the technical challenges recurrent during a surgeon's first cases operating via arthroscopic Latarjet surgery should be noted and include the subscapularis split and the preparation and proper positioning of the coracoid graft.[11] These challenges can be attributed to the inadequate placement of the portals. For example, while the midsub portal exposes the entire extension of the subscapularis muscle, facilitating a proper split, and the pectoral portal, also known as the "suicidal portal," provides a good view for positioning the coracoid on the glenoid, these are details that require training and careful attention of the surgeon performing these operations.[9,11,14]

According to Kany et al., 50% of open Latarjet procedures evolve with poor positioning of the bone graft. They also state that, after conducting surgical planning using computed tomography of the shoulder, 81% of the patients who underwent arthroscopic Latarjet had good positioning of the coracoid, which corroborates the fact that graft positioning may be related to surgical planning and adequate reproduction of the arthroscopic Latarjet technique.[15] In our study, we had only two cases of poor graft positioning out of 50, which is lower than the values normally found in the literature both for open and arthroscopic Latarjet. The decline in the number of complications from the open technique had already been documented,[16,17] but unlike other previous reports using the arthroscopic technique,[7,10,12,18] the present study was able to also attest to such a decline in the minimally invasive technique.

In fact, the negative correlation between surgical time and surgeon's experience is the most commonly studied outcome in the initial adoption of both the open and arthroscopic Latarjet techniques.[17] In 2018, a systematic review[17] estimated a number that can be defined as the case volume necessary to achieve proficiency in the arthroscopic procedure. By grouping the data from three studies[10,12,18], they observed that the surgical time was greater in the 1st to 42nd cases than in the subsequent cases (43–105). In a study with 12 surgeons in five different countries[9], the authors concluded that, with a high volume of cases, surgeons reach a learning curve plateau at around 30 to 50 cases.

After that review article, and in addition to a mere decline, in 2020, Getz and Joyce concluded that the arthroscopic Latarjet procedure, after a learning curve of 20 to 25 patients, may be advantageous over the open procedure by reducing the time to return to sports, scar size, and joint stiffness, in addition to showing no statistical difference in relation to the number of complications.[19] Surgical time and incidence of complications were found to significantly decreased after the first 25 and 30 cases in two other studies.[20,21] In this article, we observed a decrease in the three outcomes studied starting with the 21st case, a result consistent with the findings in a more recently study published by Leuzingher et al.[7] We highlight that the surgeon was already familiar with the technique, as has completed observational internships and undergone training, which may have optimized the adoption of the technique.

When comparing the open and arthroscopic techniques, there are no significant differences in terms of complications or outcomes, although it is necessary to traverse the arthroscopic surgery learning and experience curve.[22] A limitation related to the arthroscopic Latarjet technique is the increased total cost of the surgery since it requires specific instruments, which can limit its use.[22] Arthroscopic Latarjet surgery is a highly complex technique; however, when performed by surgeons with extensive experience in arthroscopy and shoulder surgery, it is reproducible and safe, as well as advantageous, especially for athletes and sportspersons who want

<< SUMÁRIO

an earlier return to sports.[19,22] As far as we know, this was the first article documenting the reduced time to return to sports activities. This work was a retrospective study that analyzed the initial learning curve for the arthroscopic Latarjet technique performed by a senior surgeon and a surgical team. A long-term analysis of these learning curves may be important to determine whether the observed plateau trend in surgical time will be sustained. In this article, clinical outcomes across the learning curve were not studied, but a previous study found no significant differences in Walch-Duplay scores, Rowe scores, or patient satisfaction levels.[9]

CONCLUSION

In conclusion, during the initial adoption of the arthroscopic Latarjet procedure, we observed a progressive decrease in surgical time, a reduction in the number of complications, and a shorter time before patients were allowed to return to sports activities. As surgeons progress in this learning curve, they become more familiar with the procedure, overcome technical difficulties, and develop the skills and confidence necessary to optimally perform the surgical treatment.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. WC Conceptualization; Data curation; Project administration; Resources; Writing - review & editing; JRM Data curation; Formal analysis; Visualization; Writing - original draft; Writing - review & editing; FHBA Data curation; Writing - review & editing; ACB Methodology; Writing - review & editing; AGPG Methodology; Writing - review & editing; BS Methodology; Writing - review & editing.

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COMBINED TECHNIQUES OF CAUDAL EPIDURAL BLOCK AND TRANSFORAMINAL NERVE ROOT BLOCK IN THE TREATMENT OF DEGENERATIVE DISEASES OF THE LUMBAR SPINE: A COST-EFFECTIVENESS ANALYSIS

TÉCNICAS COMBINADAS DE BLOQUEIO PERIDURAL SACRAL E BLOQUEIO FORAMINAL NO TRATAMENTO DE DOENÇAS DEGENERATIVAS DA COLUNA LOMBAR: UMA ANÁLISE DE CUSTO-EFETIVIDADE

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ABSTRACT

Objective: This study aims to assess cost-effectiveness of caudal epidural block with transforaminal nerve root block in the treatment of degenerative diseases of the lumbar spine. Methods: A total of 47 patients with lumbar sciatica symptoms were included. Low back pain and leg pain were assessed using the visual analogue scale (VAS), both in the pre-procedure and one week after. The cost-effectiveness and value required to improve each point on the VAS were estimated using addition, division, and rule of three calculations. Results: For low back pain, scores ranging from 2 to 10 were found before the procedure, with a mean of 7.5 ± 2.14 (95%CI: 6.8–8.1). A week after, these scores ranged from 0 to 10, with a mean of 3.1±2.8 (95%CI: 2.3–4.0; $p < 0.0001$). Regarding leg pain, scores ranging from 1 to 10 were noted before the procedure, with a mean of 6.8 ± 2.5 (95%CI: 6.1–7.4). A week after, these scores ranged from 0 to 9, with mean of 2.4 ± 2.5 (95%CI: 1.8–3.1; $p < 0.0001$). The cost of the materials used during the procedure was 214.72 BRL. Conclusion: Caudal epidural with transforaminal nerve root block were a cost-effective treatment modality for patients with degenerative diseases of the lumbar spine. ***Level of evidence III, Retrospective cohort study.***

Keyword: Cost-Effectiveness Evaluation. Local Anesthetics. Low Back Pain. Pain Measurement. Spinal Diseases. Visual Analog Scale.

RESUMO

Objetivo: Testa a avaliação de custo-efetividade do bloqueio epidural sacral com bloqueio foraminal no tratamento de doenças degenerativas da coluna lombar. Métodos: Foram incluídos 47 pacientes com sintomas de ciática lombar. A avaliação da dor lombar e dor nas pernas foi quantificada pelo uso da escala visual analógica (VAS), antes do procedimento e uma semana depois. A custo-efetividade e o valor necessário para melhorar um ponto na VAS foram calculados usando adição, divisão e regra de três. Resultados: Para a dor lombar, foi observada uma variação de 2 a 10, com média de 7,5±2,14 (IC95%: 6,8-8,1) antes do procedimento; e uma variação de 0 a 10, com média de 3,1±2,8 (IC95%: 2,3-4,0) uma semana após ($p < 0,0001$). Para dor nas pernas, uma variação de 1 a 10 foi observada, com média de 6,8 ± 2,5 (IC95%: 6,1-7,4) antes da intervenção; e uma variação de 0 a 9, com média de 2,4 ± 2,5 (IC95%: 1,8-3,1) uma semana depois ($p < 0,0001$). O custo dos materiais utilizados durante o procedimento foi de 214,72 reais. Conclusão: O bloqueio epidural sacral e o bloqueio foraminal foram modalidades de tratamento com custo-efetividade para pacientes com doenças degenerativas da coluna lombar. ***Nível de evidência III, Estudo de coorte retrospectivo.***

Descritores: *Avaliação de Custo-Efetividade. Anestésicos Locais. Dor Lombar. Medição da Dor. Doenças da Coluna Vertebral. Escala Analógica Visual.*

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The study was conducted at Universidade de São Paulo, Faculdade de Medicina, Orthopedics and Traumatology.
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INTRODUCTION

Spinal degenerative diseases can affect up to 65% of the world's population annually and up to 84% of people at some moment in their lives.[1,] The most common symptoms are low back pain and sciatica.[2] Such symptomatology depends on which findings are present, such as facet joint arthrosis, spondylolysis, foraminal stenosis, disc herniation, spondylolisthesis, and degenerative disease of the intervertebral disc.[2,3]

Several authors have demonstrated an association between the symptoms resulting from these alterations and the reduction in the patient's quality of life.[5,6] Thus, the treatment aims to improve the patient's clinical conditions and quality of life.[5] Concerning therapeutic options, there is a diversity of treatments available, ranging from fixations with arthrodesis to non-surgical measures such as medication and physiotherapy.[8] It is well-defined that Each diagnosis require a particular treatment, which should be pointed out based on the patient's symptoms and complementary exams.[8,9]

A treatment that has been increasingly used for symptoms resulting from degenerative spinal disease involves administering facet-joint and epidural injections, emphasizing the caudal epidural injection and transforaminal injection.[7,11] The terminology used to define epidural injections is already challenge among spine and pain specialists.[14,18] Terms such as facet denervation, percutaneous rhizotomy, paraspinous infiltration, nerve injection, percutaneous neurolysis, sympathetic infiltration, foraminal infiltration, facet injection, sacral injection, and epidural infiltration are some of the terms in the Brazilian Unified Supplementary Health Terminology (TUSS) table, thus recognized by the Brazilian National Supplementary Health Agency (ANS), which are used to designate a type of percutaneous intervention aimed at treating low back pain.[16,20] This difficulty results in heterogeneity in the analysis of results after infiltrations when we look for evidence in the literature that supports its prognosis.[12,15,17]

Currently, there are several specific materials available that can be used to carry out such interventions, ranging from spinal anesthesia needles, available at any health unit, to cooled radiofrequency cannulas, which are expensive, with varying costs, and less available on the market, impacting the necessary expense to treat a patient.[19,20]

Despite being considered a less invasive pain management technique, epidural injection is not exempt from complications.[12] Pain worsening, neuropraxia, meningeal lesions, abscess formation, and even paraplegia are described as complications of epidural injections and must be considered when indicating a specific procedure.[17,20]

Thus, this study aims to investigate the cost-effectiveness and complications of combining procedures, transforaminal and caudal injections, in treating patients with degenerative lumbar spine diseases associated with low back pain and sciatica.

METHODS

Ethical aspects

This study is an observational, retrospective cohort study with a quantitative and qualitative approach and was approved by the Research Ethics Committee of the institution where the study was carried out (CAAE:48835721.8.0000.8098), fulfilling the prerogatives of Resolution no. 466/2012 of the Brazilian National Health Council regarding the parameters of research with human beings.

Sample characteristics

In total, 47 patients diagnosed with degenerative lumbar spine disease and symptoms of low back pain associated with sciatica were included in the study. All data were obtained from the medical records of patients treated at the same private clinic by the same physician with more than 10 years of specialization in spine surgery and pain management.

Patients of both sexes, aged over 18 years, with low back pain and/or pain radiating to the leg that was refractory to conservative treatment with analgesic medication and physiotherapy for more than four weeks were included. All patients underwent a combination of caudal epidural and transforaminal injections. Exclusion criteria included patients under 18 years, those diagnosed with a tumor disorder, infection, or spinal trauma, and those with a history of previous lumbar spine surgery. Complementary imaging, such as radiography and magnetic resonance imaging (MRI) of the spine, was used in all cases to confirm the diagnosis.

Analyzed variables

The information collected from the patient's medical record included age, sex, diagnosis, occurrence of complications resulting from the procedure, initial pain intensity (iVAS), and pain intensity one week after the procedure (fVAS). Pain levels were assessed using Visual Analog Scale (VAS). VAS scores were recorded for both low back pain and leg pain.

Moreover, data on the total time and cost of the procedure were collected from hospital records. The procedure cost was estimated from the sum of all devices, materials, and medications used to treat each patient. Information was also obtained from the patient's medical records.

The cost-effectiveness (CE) was estimated by dividing the procedure cost by the mean difference between the iVAS and the fVAS, as shown below:

Cost-effectiveness (CE) = Total cost (TC) / (iVAS − fVAS)

The cost required to improve by one point on the VAS was estimated using the rule of three, as presented below:

Total procedure cost (TC) ---------- (iVAS − fVAS)

Cost of X ---------- 1 point on VAS

The cost of X is the cost required to improve one point on the visual analog pain scale (VAS).

Procedures

The procedures were performed at the same hospital by the same spine surgeon, using the same mobile C-arm device (Model: GE OCE Fluorostar Compact; Manufacturer: GE OCE MEDICAL SYSTEMS GMBH; Serial number: FCDxxA18120685; Date of manufacture: December/2018; Made in Germany). All patients were administered transforaminal injection (1.5 to 2 ml of solution per foramen) using a solution containing 1 ml of 2% lidocaine 20 mg/ml without vasoconstrictor (xylestesin) and 1 ml of triamcinolone hexacetonin 20 mg/ml (Triancil). For caudal epidural injection, a solution containing one ampoule of betamethasone diproptonate 5 mg + disodium phosphate 2 mg (Eurofarma) and one ampoule of lidocaine 2% 20 mg/ml without vasoconstrictor (xylestesin).

Before performing the procedure, the attending physician met the patient in the waiting room and asked about the intensity of pain using the VAS, recorded as the iVAS. Then, the patient was taken to the operating room, positioned in the horizontal prone position, and submitted to anesthetic sedation. Thus, asepsis was performed, and appropriate sterile fields were placed. With the positioning and use of the mobile C-arm in the anteroposterior view, the desired lumbar level was identified and, with the oblique view, the needle was inserted into the foramen, and after confirming its proper positioning, the analgesic solution was injected. These steps were repeated according to the number of foramina affected.

Afterwards, the mobile C-arm was positioned on the lateral view at the level of the sacrococcygeal region, and the sacral hiatus was palpated. The needle was inserted into the sacral hiatus, and its proper positioning was confirmed by administering radiopaque contrast 300 mg/ml (Omnipaque 50 ml), and the analgesic solution was subsequently injected.
The patient was then directed to the post-anesthesia recovery room and discharged according to the criteria of the anesthesia team. A week after the procedure, the attending physician in charge scheduled a new appointment with the patient and recorded the fVAS.

Statistical analysis

Data tabulation was performed using the Microsoft Excel® 2016 software. The data obtained were statistically analyzed using the Stata ® 2018 software, and the mean and standard deviations were used. For inferential analysis, the Student's t-test for paired samples was used.

RESULTS

A total of 47 patients with degenerative spine diseases associated with low back pain and sciatica met the inclusion criteria and were selected for the study. In total, 17 males and 30 females were included, aged 24 to 86 years, with a mean age of 56.4±17.23 years. The age of female patients ranged from 26 to 84 years, with a mean of 60.13 years, whereas male patients' age ranged from 24 to 86 years, with a mean of 49.17 years. Among the diagnoses of the evaluated patients, we found facet degeneration, intervertebral disc degeneration, spinal canal stenosis, disc herniation, and patients with grade 1 spondylolisthesis. Regarding the complications, no occurrences were identified.
Low back pain assessment using the VAS found values ranging from 2 to 10, with a mean of 7.5 ± 2.14 (95%CI 6.8 – 8.1) before the procedure (iVAS). A week after (fVAS), it ranged from 0 to 10, with a mean of 3.1 ± 2.8 (95%CI 2.3 – 4.0; p < 0.0001) . (Table 1)
Meanwhile, leg pain assessment using the VAS found values ranging from 1 to 10, with a mean of 6.8 ± 2.5 (95%CI 6.1 – 7.4) before the procedure (iVAS). A week after (fVAS), it ranged from 0 to 9, with a mean of 2.4 ± 2.5 (95%CI 1.8 – 3.1; p<0.0001). (Table 1)
The total cost of the procedure was 214.75 BRL, remaining the same for all patients included in the study (Table 2). The cost-effectiveness (CE) for improving one point on the VAS for low back pain was 73.62 BRL (Table 3) (Figure 1), whereas that for leg pain was 114.51 BRL (Table 4) (Figure 2).

Table 1. Assessment of lumbar pain (n = 45) and sciatica (n = 56) using the visual analog scale in patients undergoing epidural infiltration.

Pain	Preoperative	Postoperative	p
Lumbar Spine	7.5 ± 2.14 (IC95% 6.8 – 8.1)	3.1 ± 2.8 (IC95% 2.3 – 4.0)	< 0.0001
Lower limbs	6.8 ± 2.5 (IC95% 6.1 – 7.4)	2.4 ± 2.5 (IC95% 1.8 – 3.1)	< 0.0001

Table 2. Materials used to perform caudal epidural and transforaminal injection with respective amounts and values in reais.

The material used	Quantity	Unit value (BRL)	Total value (BRL)
Alfenthalin 0.5 mg/ml	1 ampoule	14.99	14.99
Midazolam 1 mg/ml	1 ampoule	5.27	5.27
Ringer lactate 500 ml	1 bag	2.14	2.14
Abocath 24G (0.7×119 mm)	1 unit	2.53	2.53
Nasal oxygen catheter	1 unit	0.91	0.91
Microdropper equipment	1 unit	3.82	3.82
Tegaderm peripheral cateter	1 unit	5.45	5.45
Needle 25 mm × 8 mm	1 unit	0.1	0.1
Spinal needle	3 units	13.56	40.68
10 ml syringe with thread	2 units	0.5	1
5 ml syringe with thread	1 unit	0.33	0.33
5 ml syringe without thread	1 unit	0.33	0.33
Betamethasone dipropionate + disodium phosphate 5 mg + 2 mg	1 unit	3.25	3.25
Non- ionic iodine contrast 300 mgi/ml	1 unit	34.68	34.68
Lidocaine 2%	1 unit	6.11	6.11
Triamcinolone 20 mg/ml	1 unit	81.2	81.2
Sterile operation field	1 unit	7.06	7.06
Chlorhexidine 0.5% alcoholic solution 100 m	1 unit	1.87	1.87
Sterile gauze	2 units	0.7	1.4
Surgical glove	1 unit	1.63	1.63
	-	-	214.75

mg: milligrams; ml: milliliter; mm: millimeters; % = percentage; BRL: Brazilian reais.

Table 3. Cost-effectiveness for improving lumbar spine pain after epidural injection.

Number of patients	Pain improvement	Cost of X	Disease
45	4.33	73.63	Overall Average
4	4.50	79.36	Facet Degeneration
11	2.09	116.94	Discopathy
16	5.25	51.81	Stenosis
10	4.90	61.94	Hernia
4	5.25	65.32	Spondylolisthesis

Cost of X: cost needed to improve one point on the visual analog scale.

Table 4. Cost-effectiveness for improving pain in lower limbs after epidural block.

Number of patients	Pain improvement	Cost of X	Disease
52	2.60	114.52	
3	1.67	139.76	Facet Degeneration
10	1.90	120.56	Discopathy
25	2.28	126.48	Stenosis
10	4.60	74.12	Hernia
4	2.00	106.69	Spondylolisthesis

Cost of X: cost needed to improve one point on the visual analog scale.

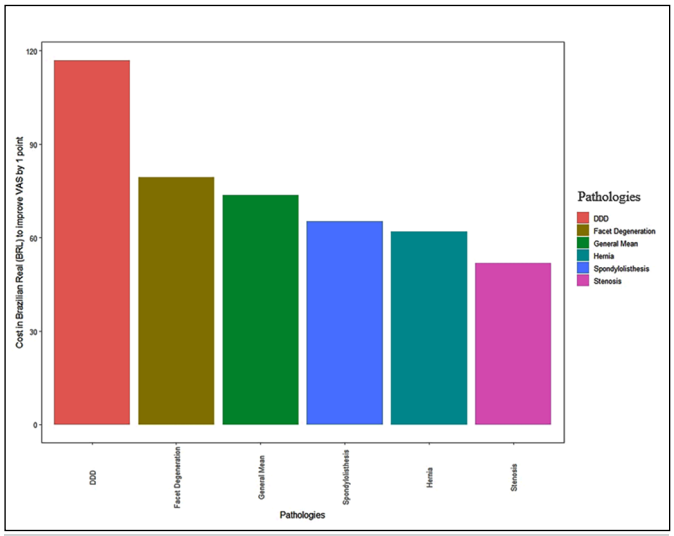

Figure 1. Cost-effectiveness for improving lumbar spine pain after epidural injection. Legend: DDD = degenerated disc disease.

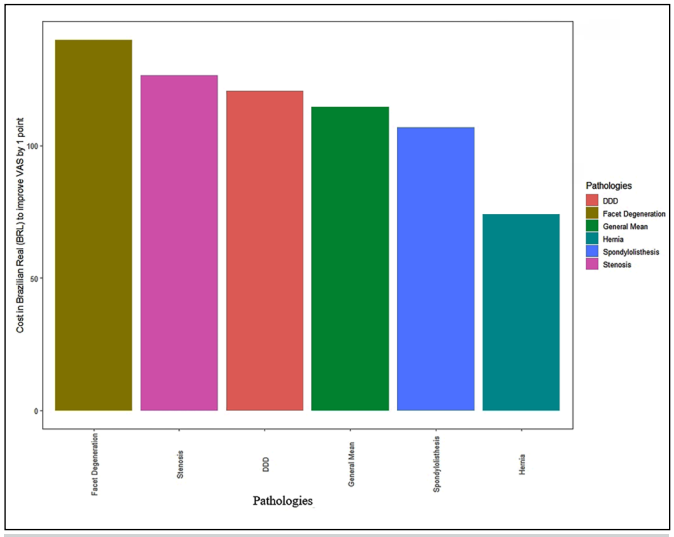

Figure 2. Cost-effectiveness for improving pain in lower limbs after epidural block. Legend: DDD = degenerated disc disease.

DISCUSSION

The combination of caudal epidural and transforaminal injections proved to be, in this study, a cost-effective treatment modality with a low complication rate for patients with degenerative diseases of the lumbar spine.

Similar studies have demonstrated that epidural injections do not change the evolutionary process of the disease,[11,14,17] but rather offer immediate relief of the patient's pain, allowing earlier rehabilitation.[10,20] Moreover, it can be considered a minimally invasive and low-cost procedure compared to invasive surgical procedures, with a low risk of complications.[10] Among the injections, the lumbar transforaminal and the caudal epidural injection have been used in treating low back pain and sciatica caused by degenerative diseases of the spine.[18,20]

Numerous studies, including contemporary publications by Manchikant, Lee, and Chou, have highlighted that epidural injection provides moderate short-term pain improvement.[8,16] However, epidural injections are not superior in the long term compared to conservative treatment alone.[19] Similar results were found in studies by Pennington, in which, after performing the injection, improvements were noted in the patient's quality of life during the first three months, which was not maintained during the six months of follow-up.[20] Our results align with these findings, as we observed a considerable improvement in pain one week after the procedure, both for low back pain and sciatica. Despite this, long-term pain improvement was not considered in this study since, with short-term improvement, patients could more easily perform rehabilitation and strengthening exercises in physiotherapy sessions.

A variable that we studied but found no comparable research, was the cost necessary to improve the patient's quality of life, represented by the VAS. We demonstrated that a small cost would be required to improve one point on the VAS for low back and leg pain, respectively 73.62 BRL and 114.51 BRL.

We highlight that our study shows limitations. Firstly, we underscore that this is an observational analysis that used medical records of patients with symptoms resulting from the degenerative spinal disease who had unsuccessfully submitted to treatment with physiotherapy and oral medications. Secondly, we did not apply any quality of life questionnaires, which could provide more information about the impact of the disease and resulting symptoms on patients' daily routines. Finally, the diversity of diagnoses and possible sources of similar symptoms hinder generalization of results.

However, our study also presents strengths, as we used a standardized treatment for low back pain and sciatica for degenerative diseases of the lumbar spine, using the same devices and mobile C-arm for all injections. Moreover, the same spine surgeon performed all procedures in the same hospital, and data were collected by the same assistant.

CONCLUSION

Our results showed that combining caudal epidural and transforaminal injection procedures is a cost-effective treatment modality for patients with degenerative lumbar spine diseases associated with symptoms of low back pain and sciatica for a short period. In addition, the procedure proved to be safe, with a low complication rate.

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QUANTITATIVE AND QUALITATIVE INVESTIGATION OF THREE-DIMENSIONAL GAIT ANALYSIS IN PATIENTS WITH CERVICAL MYELOPATHY

INVESTIGAÇÃO QUANTITATIVA E QUALITATIVA DA ANÁLISE TRIDIMENSIONAL DA MARCHA EM PACIENTES COM MIELOPATIA CERVICAL

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ABSTRACT

Objective: This study aims to describe a kinematic gait assessment protocol and identify its main alterations in individuals with cervical spondylotic myelopathy (CSM) compared to healthy patients. Methods: In total, 14 patients diagnosed with CSM were enrolled and submitted to a three-dimensional gait analysis. The movement of patients was captured with infrared emission cameras that identified tracking markers placed on the lower limbs. Reference positions were used, and the patients walked along a rubberized walkway. The Gait Profile Score (GPS) and Movement Analysis Profile (MAP) were used to analyze variables. Results were subjected to a Student's t-test at 95% confidence interval. The R Core Team (2016) software was used for statistical analysis, graphically comparing the study results with data from healthy patients. Results: When comparing the kinematic data bilaterally, no statistical differences were found. However, graphical analysis showed changes in the gait of patients with CSM compared to healthy individuals. There were differences in all movements, with a more significant discrepancy in hip and knee flexion and extension, dorsiflexion and plantar flexion, and internal and external hip rotation. Conclusion: We describe a protocol for gait kinematics assessment using GPS and MAP, and we presented the differences in gait kinematics in patients with CSM compared to healthy individuals. ***Level of Evidence II, Prospective study.***

Keywords: Gait. Gait Analysis. Myelopathy. Movement.

RESUMO

Objetivo: Descrever um protocolo de avaliação cinemática da marcha e identificar suas principais alterações, em indivíduos com mielopatia espondilótica cervical (MEC), em comparação com pacientes saudáveis. Métodos: 14 pacientes com diagnóstico de MEC foram incluídos e submetidos à análise tridimensional da marcha. Capturamos o movimento dos pacientes com câmeras de emissão infravermelha, que identificaram marcadores de rastreamento posicionados nos membros inferiores. Adquirimos sua posição de referência e os pacientes caminharam por uma passarela emborrachada. As variáveis foram analisadas pelo Gait Profile Score (GPS) e Movement Analysis Profile (MAP), sendo seus resultados analisados pelo teste t de Student com intervalo de confiança de 95%. Utilizamos o software R Core Team (2016) para análise estatística. Comparamos graficamente nossos resultados com dados de pacientes saudáveis. Resultados: Ao comparar os dados cinemáticos bilateralmente, não houve diferenças estatísticas. A análise gráfica evidenciou alterações na marcha do paciente em comparação a indivíduos saudáveis. Houve diferenças em todos os movimentos, com discrepância mais significativa na flexão e extensão do quadril e joelho, dorsiflexão e flexão plantar e rotação interna e externa do quadril. Conclusão: Descrevemos um protocolo de avaliação cinemática da marcha utilizando GPS e MAP e apresentamos as diferenças da marcha de pacientes com MEC, em comparação com indivíduos saudáveis. ***Nível de Evidência II, Estudo prospectivo.***

Descritores: *Marcha. Análise da Marcha. Mielopatia. Movimento.*

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The study was conducted at Universidade de São Paulo, na Faculdade de Medicina de Ribeirao Preto.
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INTRODUCTION

Cervical spondylotic myelopathy (CSM) results from degeneration of the cervical spine. It is characterized by spinal canal narrowing and consequent spinal cord compression, the leading cause of spinal cord dysfunction in adult patients, especially those over 60.[1,2] Clinical presentation of CSM may include motor dysfunction, gait disturbance, upper limb paresthesia, lower limb weakness or numbness, balance problems, neck pain, and stiffness.[3]

Previous studies have shown that most patients diagnosed with CSM have significant dysfunctions at some point in the gait cycle compared to healthy individuals.[4] Some of the findings already reported in the literature include slower gait speed, reduced step and gait length, and increased stride width.[5] Some researchers have also observed a greater range of motion (ROM) of the ankle and a lower ROM of the knee.[5]

Gait analysis in patients with CSM allows a better understanding of gait biomechanics.[6] It may provide specific parameters that can be analyzed and compared between the pre and postoperative period, acknowledging a more detailed analysis of the muscle activity and limb movement during all gait phases.[6]

The gait parameters of patients with CSM still need to be well established in the literature due to their variability and lack of a defined pattern.[7,8,9] Previous studies have analyzed the gait of patients with CSM.[8,9,10] However, there is a gap in the detailed quantitative and qualitative assessment of the functional performance of these individuals at all phases of the gait cycle. Therefore, this study aimed to identify the main changes in the gait parameters of patients diagnosed with CSM, as well as describe a protocol for kinematic gait assessment.

MATERIALS AND METHODS

This prospective study was conducted at the Rehabilitation Center of our institution, received approval by the Institutional Research Ethics Committee (4,026,013) and followed the prerogatives regarding the parameters of research with human beings. The patients who agreed to participate in the study signed an informed consent form. Patients recruited at the Rehabilitation Center of the Hospital were individuals with CSM diagnoses who were in the evaluation process before surgical treatment. Inclusion criteria were individuals of both sexes, over 18 years of age, who were clinically diagnosed with CSM and confirmed by magnetic resonance imaging, and who agreed to participate by signing an informed consent form. The exclusion criteria included the presence of severe cardiac and respiratory disorders, neurological diseases concomitant with CSM, and/or symptomatic musculoskeletal conditions that could impact gait performance.

Before the surgical procedure, the subjects underwent a three-dimensional gait analysis in a laboratory specialized in gait analysis (LGA). The LGA presents eight infrared emission cameras (Qualisys model Oqus 300) positioned and fixed at approximately 2.6 m from the ground to capture body movement by placing reflective markers on the skin.

In total, two types of markers were placed tracking markers and reference markers, which allowed building the biomechanical model by the segments' length and the joint axes' location.[11,12] The constructed elements were the pelvis, thigh, leg, and foot. The anatomical points where markers were placed included the anterosuperior iliac spine, the midpoint of the sacrum between the posterosuperior iliac spines, the lateral femoral epicondyles, the lateral malleolus, the calcaneal tuberosity, and the center between the II and III metatarsal bones, previously identified via palpation, as shown in Figure 1. The purpose of tracking markers is to follow the trajectory of each segment during movement.[11,12] Tracking markers were used in the thigh, leg, and foot segments, fixed laterally at the midpoint of the thigh and leg (Figure 1).

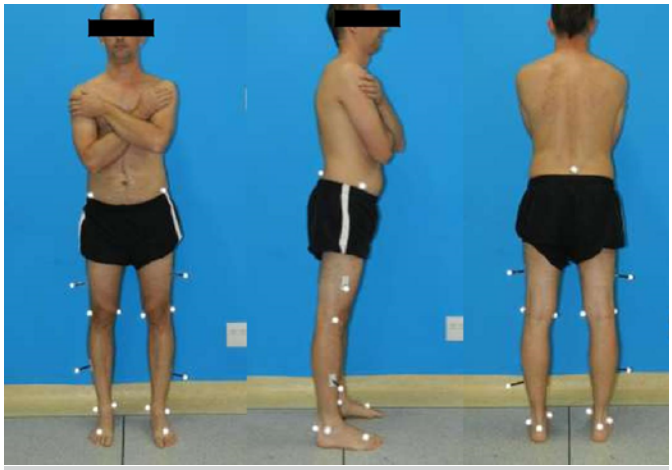

Figure 1. Placement of reflective reference and tracking markers at anatomical points.

To identify the segments, the reference points were obtained by instructing participants to remain in an orthostatic position, with their feet parallel in the center of the walkway for 5 seconds. After this acquisition, the reference markers were removed, continuing with tracking markers. Then, the subjects were instructed to walk barefoot at a comfortable speed along the rubberized walkway. The patients walked at least five times along the entire walkway and performed eight to twelve steps each turn, according to their step size.

The tracking markers were used to obtain nine kinematic variables and generate the Gait Profile Score (GPS) to facilitate the understanding of the gait analysis.[13] From the division of the GPS results, the Gait Variable Score (GVS) was obtained, an index that measures the variable deviation of a normal gait.[14] Lastly, the Movement Analysis Profile (MAP) was created from the GVS results. The MAP describes the magnitude of deviation of the nine individual variables estimated over the gait cycle, which shows which variables contribute to altered GPS.[15]

The statistical data processing was performed using R (R Core Team, 2016), a language and environment for statistical computing, provided by the R Foundation for Statistical Computing, Vienna, Austria. The results were compared using the Student's t-test for paired samples at a 95% confidence interval for the differences between the sides. The mean values obtained from each evaluation were plotted on a graph to compare with those obtained from healthy individuals.

RESULTS

Our sample consisted of 14 patients diagnosed with CSM with a mean age of 56 ± 14.85, with 78.57% male (3 women and 11 men). The mean weight was 76.6 Kg ± 14.10 Kg, and the mean height was 1.66 cm ± 0.08 cm. The control group was composed of 19 volunteers with a mean age of 32 years (SD 6.69), mean weight of 61.2 (SD 13.19) and height of 1.70 cm (SD 10.1).

Table 1 shows the results obtained from the kinematic evaluation GPS and MAP. When we compare the means between the sides (right and left), the only joint evaluated that presented a statistically significant difference was the ankle joint (p-value: 0.0204) with a confidence interval from −4.44 to −0.33 (Table 1).

Figure 2 compares the GPS and MAP data obtained in our sample of CSM patients with the GPS and MAP values of a sample of healthy individuals. From the graphic, we identified differences in all the movements studied by kinematic evaluation, with a more significant discrepancy in hip flexion and extension, knee flexion and extension, ankle dorsiflexion and plantar flexion, and internal and external hip rotation (Figure 2).

Table 1. Gait Profile Score and Movement Analysis Profile values of individuals with cervical spondylotic myelopathy and healthy individuals.

Variable*	Right		Left		P value	Confidence Interval 95%		Healthy individuals
	Mean	Standard Deviation	Mean	Standard Deviation		Inferior Limit	Upper Limit	
G	10.51	2.7872	10.51	2.7872	NaN	NaN	NaN	4.21
PO	6.36	3.891	6.83	4.7155	0.4337	−1.72	0.78	1.87
HFE	13	4.9047	12.83	5.3324	0.8138	−1.33	1.66	3.5
KFE	12.76	4.4356	14.55	5.355	0.1628	−4.4	0.82	4.37
ADPF	8.76	2.9999	11.14	2.589	0.0264	−4.44	−0.33	3.89
PT	3.14	1.3039	3.41	1.4509	0.116	−0.63	0.08	1.44
HAA	4.66	1.6082	5.59	2.9295	0.2226	−2.51	0.64	1.91
PR	4.01	2.7065	4.8	3.0339	0.2102	−2.08	0.5	2.46
HIER	9.11	4.621	11.42	6.4778	0.3173	−7.09	2.48	5.27
F	8.79	4.8826	9.03	8.0509	0.934	−6.41	5.93	3.8

*G = general; PO = pelvic obliquity; HFE = hip flexion and extension; KFE = knee flexion and extension; ADPF = ankle dorsiflexion and plantar flexion; PT = pelvic tilt; HAA = hip adduction and abduction; PR = pelvic rotation; HIER = hip internal and external rotation; F = foot progression.

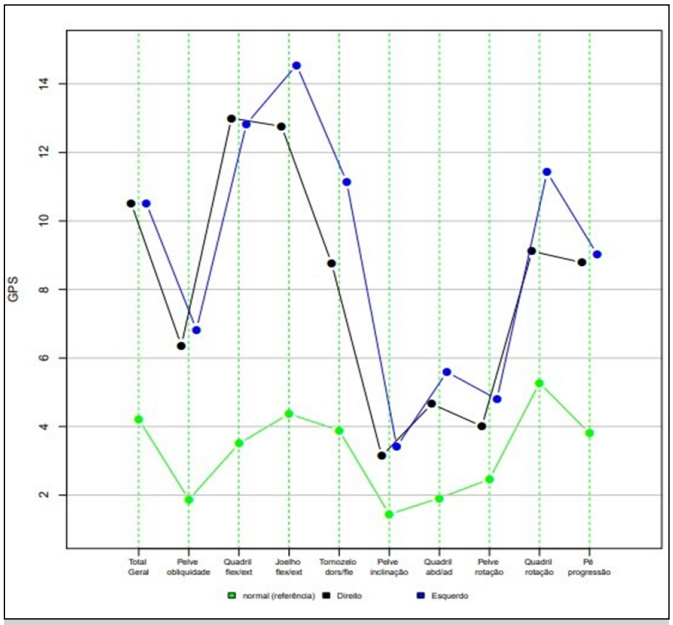

Figure 2. Gait Profile Score and Movement Analysis Profile of individuals with cervical spondylotic myelopathy compared to healthy individuals.

DISCUSSION

Several studies have shown that individuals diagnosed with CSM present alterations during the gait cycle compared to healthy individuals due to spinal cord compression.[4,10] Nevertheless, typical signs and symptoms of CSM are pain in the neck, shoulder, and subscapular areas; numbness or tingling in the upper extremities; motor weakness in the upper or lower extremities; sensory changes in the lower extremities; and gait disturbances represented most commonly by a spastic gait.[16] On the other hand, subtle or unusual gait presentations can make the diagnosis of CSM challenging. Thus, three-dimensional gait analysis can be a helpful tool by providing detailed data on the biomechanics and gait impairment in patients with CSM.[17] Therefore, our study aimed to analyze the kinematic changes during gait in individuals diagnosed with CSM before the surgical treatment and to describe a gait assessment protocol.

This study, by assessing gait of 14 patients with CSM, identified the main kinematic gait alterations and presented an assessment protocol based on three-dimensional gait analysis using specific tools (GPS and MAP). It has been reported that this analysis is important for a better prognosis of CSM after surgery and the prevention of possible falls related to gait impairment, consequently maintaining a good quality of life for patients.[18]

GPS consists of nine main kinematic variables that a single number can represent. Its measurement is presented in degrees, and higher values point to greater deviations from a gait considered normal.[13] We chose this tool because its results are easy to interpret, and the minimal clinically detectable difference is 1.6°. Thus, angular changes considered clinically undetectable could show statistically significant differences.

Additionally, the GPS can be decomposed to provide the Gait Variable Score (GVS). The GVS represents parameters that estimate the gait deviation variation. From the GVS, the Movement Analysis Profile (MAP) is created to describe the magnitude of the deviation of the nine individual variables estimated via the gait cycle, thus providing a view of which variables contribute to a high GPS.[14] Thus, we chose MAP due to its capacity of providing additional helpful information to the GPS. To support the value of these tools in analyzing gait parameters, we compared the results found on both sides. Then, except for the ankle joint ($p = 0.0204$), our results regarding the GPS and the MAP did not show statistically significant differences when comparing both sides. The interpretation of our results suggests a symmetry in the findings on both sides, both statistical and clinical since the minimum difference clinically detectable by GPS is only 1.6°, as mentioned above.

The graphic comparison of GPS and MAP values obtained from our sample of patients with CSM with the values of individuals considered healthy showed a difference in all parameters studied, with a more significant discrepancy in hip flexion and extension, flexion and extension knee, dorsiflexion and plantar flexion of the ankle, and internal and external rotation of the hip. The interpretation of our results suggests that, although we did not find a statistically significant difference between the sides, the GPS and the MAP allowed us to identify changes in the gait kinematics of patients with CSM.

Our study shows some limitations. Firstly, we highlight the small sample size. As this assessment is not part of the patient's preoperative protocol routine, we obtained authorization from a small portion of individuals operated in our services during the study period. Secondly, this study lacks a statistical comparison of our results with the findings of individuals considered healthy since we did not have access to the detailed data of the patients

involved in the study from which we acquired the values. However, we believe the graphical difference was substantial in all segments studied, reinforcing the importance of evaluating gait kinematics in patients with CSM. Finally, we believe that the increased age of patients can contribute to changes found in the assessment of individuals' gait, which makes room for a new study proposal. Since subtle changes may occur between the gait of patients with CSM and patients with advanced age, detailed assessment techniques may be extremely relevant.

Thus, we were able to design a protocol for kinematic gait assessment of patients with CSM, identifying possible changes in the gait pattern of these patients. Based on these findings, studies can be developed, including a kinematic gait assessment in the postoperative period, which can serve as an additional tool in evaluating the effectiveness of surgical treatment.

CONCLUSION

From the study, it was possible to describe a protocol for gait kinematics assessment using GPS and MAP to identify the main alterations, in addition to presenting the differences in gait kinematics of patients with CSM compared to healthy individuals.

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SMOKING AND MODIC CHANGES IN PATIENTS WITH CHRONIC LOW BACK PAIN: A COMPARATIVE STUDY

TABAGISMO E ALTERAÇÕES DE MODIC EM PACIENTES COM LOMBALGIA CRÔNICA: UM ESTUDO COMPARATIVO

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ABSTRACT

Objective: To compare the prevalence of smokers among patients with chronic low back pain, in the presence and absence of Modic changes, also the correlation between smoking history and progression of the Modic scale. Methods: Observational study, case-control type, with the inclusion of 340 vertebral segments in a total of 68 patients, separated into groups: with Modic (case group) and without Modic (control group). The odds ratio between the groups was verified using the Chi-Square test. Degree of correlation between smoking history (packs/year) and the degree of disc degeneration using Max-Modic and Sum-Modic, using Spearman's non-parametric test. Results: The Modic group (MG) was 54% female and 46% male, with an average smoking history of 13.84 pack-years and an average of 1.42 altered segments per patient. Conclusion: An increased risk for Modic changes was found among smoking patients (odds ratio [OR] 4.09; 95% CI, 1.26-12.31; $p < 0.01$) and significant correlation between Max-Modic, sum-Modic and smoking history. ***Level of Evidence III, Retrospective comparative study.***

Keywords: Intervertebral Disc Degeneration. Intervertebral Disc. Tobacco Smoking. Low Back Pain. Magnetic Resonance Imaging.

RESUMO

Objetivo: Comparar a prevalência de tabagistas entre os pacientes com lombalgia crônica, na presença e na ausência de alterações de Modic, bem como a correlação entre carga tabágica e progressão da escala de Modic. Método: Estudo observacional, tipo caso-controle, com a inclusão de 340 segmentos vertebrais em um total de 68 pacientes, separados em grupos: com alterações de Modic (grupo caso) e sem alterações de Modic (grupo controle). A razão de chances entre os grupos foi verificada por meio do teste Qui-Quadrado. Grau de correlação entre a carga tabágica (maços/ano) e o grau de degeneração discal através do Máximo-Modic e a Soma-Modic, por meio de teste não paramétrico de Spearman. Resultados: O grupo Modic (GM) foi composto por 54% de pacientes do sexo feminino e 46% masculino, com média da carga tabágica de 13,84 anos/maço e média de 1,42 segmentos alterados por paciente. Conclusão: Foi encontrado um risco aumentado para alterações de Modic entre os pacientes tabagistas (razão de chances [OR] 4,09; IC 95%, 1,26-12,31; $p < 0,01$) e correlação significativa entre Máximo-Modic (r 0,3 p 0,01) e carga tabágica, assim como soma-Modic e carga tabágica (r 0,32 p 0,007). ***Nível de Evidência III, Estudo comparativo retrospectivo.***

Descritores: *Degeneração do Disco Intervertebral. Dor Lombar. Disco Intervertebral. Tabagismo. Imagem por Ressonância Magnética.*

INTRODUCTION

The clinical consequences of intervertebral disc degeneration have been highlighted as one of the main causes of pain and disability in the world[1] due to its potential role in chronic low back pain.[2,3]

Many theories suggest a causal relationship between smoking and chronic low back pain. Those theories include increased intra-abdominal pressure as a reflection of coughing,[4] changes in the perfusion of the intervertebral disc,[5] endocrine changes due to the

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The study was conducted at Universidade Estadual de Campinas, Pós-graduação da Faculdade de Ciências Médicas.
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effect of tobacco,[6] and changes in bone microtubular structures resulting from microfractures of the vertebral body.[6,7].
Among the sequelae of disc degeneration, the signal intensity changes found in the vertebral endplates in magnetic resonance examination of the lumbar spine were proposed as a potential marker of chronic low back pain. The study published by Modic et coll. in 1988 found changes that were classified as Type I, with evidence of an increase in T2-weighted signal and a decrease in T1 signal, while Type II was characterized by an increased signal in T2 and T1.[8,9]
Histologically in Type I lesions, the continuity of the endplate is disrupted, fibrous tissue replaces the bone marrow in this region amid thickened trabeculae, and the disc-bone interface is filled with vascularized granulation tissue. These changes represent edema and inflammation of the bone marrow. In addition to the above-mentioned findings of Modic Type I, samples of Modic type II also show replacement of bone marrow with adipose tissue. These findings represent the conversion of normal hematopoietic marrow into fatty, yellow bone marrow. Modic Type III is characterized by hypointense signs in both T1 and T2, related to subchondral bone sclerosis.
Although there is extensive research on the relationship between smoking and degenerative changes in the intervertebral disc, few studies specifically address the relationship between tobacco and Modic changes (MC), a fact that justifies research on the subject. The objective of this study was to compare the prevalence of smokers among patients with chronic low back pain, with and without the existence of Modic changes. As a secondary objective, we evaluated the existence of a correlation between higher smoking loads and a greater progression of the Modic scale.

METHODOLOGY

Study Type

This is an observational case-control study conducted at the Spine Orthopedics Outpatient Clinic at Carapicuíba General Hospital (HGC). We recruited patients in follow-up for chronic low back pain who received care sequentially between June 2018 and July 2019 and were not referred to surgical treatment. The study was approved by the Research Ethics Committee (CAAE 90700618.8.0000.0062). All research participants signed the Informed Consent Form (ICF – Appendix 1).
Inclusion criteria:

- Patients with low back pain for more than 12 weeks and;
- Having had an MRI examination of the lumbar spine with at least one degenerated ID.
- Exclusion criteria:
- Patients who did not wish to participate in the study;
- Previous brain and/or spinal surgeries;
- Spine disorders that lead to image changes on MRI examinations, such as vertebral fractures, spondylolisthesis, tumors or discitis.

Clinical data

Firstly, socio-demographic data were collected by two orthopedists in personal, face-to-face interviews. In addition, the patients were asked if they had a smoking habit and, if they did, they were asked about their smoking loads. The smoking load was estimated as follows: "pack"/day x years. For example: 2 packs a day x 30 years = smoking load = 60 The body mass index was estimated by dividing mass by square height.

Evaluation of magnetic resonance imaging

After the initial interview, patients were referred to another office where their MRI exams were evaluated by two orthopedists familiar with spine disorders. The orthopedists were blind to the initial interview. Each intervertebral segment of the lumbar spine was analyzed individually.
T1 and T2-weighted MR images were analyzed in the sagittal plane and classified according to the study published by Modic et al.[8] For standardization purposes, when more than 5 lumbar vertebrae or transitional vertebrae characteristics were found, the last segment included in the study was L5-S1.

Statistical analysis

Initially, the data were analyzed by comparing the groups. The existence of Modic changes was considered the outcome. Patients who met the inclusion criteria and did not have exclusion criteria were separated into 2 groups: Modic (case group) and no Modic (control group). The odds ratio between the groups was evaluated using the Chi-Square test. Descriptive statistics were presented in absolute and relative frequencies, mean and standard deviation, median and interquartile, when appropriate.
The existence and the degree of correlation between smoking load (years/pack) and the degree of disc degeneration was also analyzed in two ways: maximum degree of Modic found in the vertebral segments (max-Modic) and the sum of the degrees of Modic of each individual (sum-Modic). Spearman's nonparametric test was used.
Correlations with adequate significance index ($p < 0.05$) were considered significant, and the Spearman coefficient was used to assess the strength of the correlation. Statistical analyses were performed in the *IBM SPSS Statistics v 23* software.

RESULTS

A total of 340 vertebral segments in 68 patients were included in the study (Figure 1).

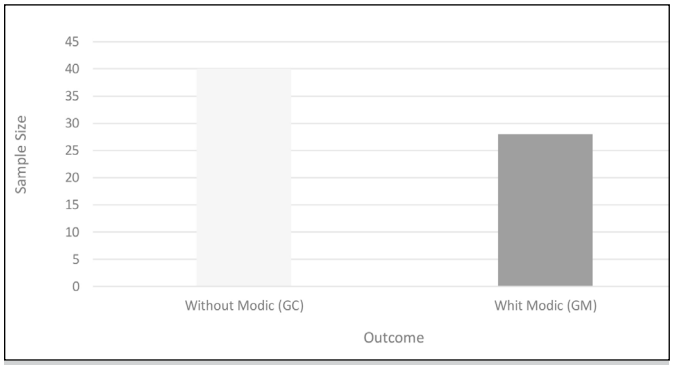

Figure 1. Sample size by outcome.

The control group (CG) had 40 patients, with 30 female patients (75%) and 10 male patients (25%) (table1).

Table 1. Gender Vs Modic.

		MODIC		
GENDER		No	Yes	Total
F	Frequency	30	15	45
	Col pct	75.00	53.57	
M	Frequency	10	13	23
	Col pct	25.00	46.43	
Total		40	28	68

CHI-SQUARE TEST: X2=3.38; GL=1; P=0.066

<< SUMÁRIO

The mean age of this group was 50.7 years with SD of 10.2 (19-69). The group had 33 non-smoking patients (82.5%) and 7 smokers (17.5%). The average smoking load in this group of 4.73 years/pack. The mean BMI was 27.46, SD 4.34 (18.9-37.3).
The Modic Group (MG) had 28 patients, with 15 female patients (54%) and 13 male patients (46%). The mean age was 50.57 years, with SD of 9.2 (32-69). In this group, 15 patients (54%) were non-smokers and 13 patients (46%) were smokers (Table 2). The mean smoking load was 13.84 years/pack (Figure 2). The mean BMI was 27.3, SD of 3.94 (20.6-37.6).

Table 2. Smokers Vs Modic.

Smoker No		MODIC		Total
		Yes		
No	Frequency	33 **(82.5%)**	15 (53.5%)	48
Yes	Frequency	7 (17.5%)	13 (**46.4%**)	20
Total		40	28	68

CHI-SQUARE TEST: X2 = 6.64; GL = 1; **P = 0.010**
OR=4.09; 95% CI OR: (1.36; 12.31)

Among these 28 patients, 40 vertebral segments with MC were found (mean of 1.42 changed segments per patient) (Table 3). The most affected was L5S1, accounting for 42.5% (17 cases) of the total MC, followed respectively by L4L5 with 30% of segments (12 cases), L3L4 and L2L3 with 12.5% of segments (5 cases), and L1L2 with 2.5% (1 case) (figure3).

Considering the types of changes, Modic Type 2 was the most frequent with 42% of the total MC, followed by Type 1 with 35% (14 cases), and Type 3 with 22.5% (9 cases) (Figure 4).
An increased risk for Modic changes was found among smoking patients (odds ratio [OR] 4.09; 95% CI, 1.26-12.31; $p < 0.01$).
The correlation tests between smoking load and max-Modic per patient showed a Spearman's r of 0.3 with a significance index of 0.01 (Figure 5), while the correlation tests between smoking load and sum-Modic showed a Spearman's r of 0.32 with a significance index of 0.007 (Figure 6)

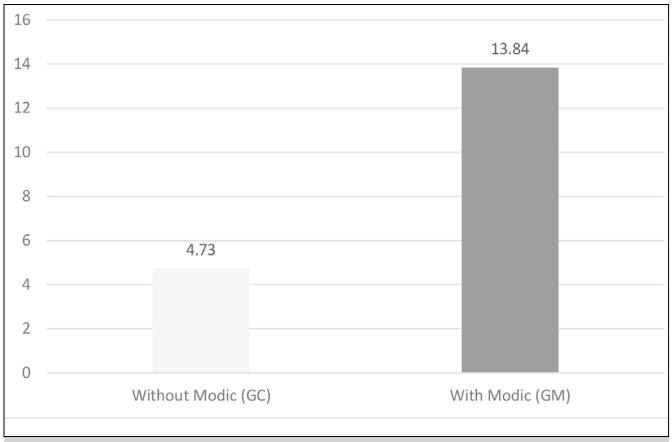

Figure 2. Average smoking load (packs/year).

Table 3. Modic distribution (frequency and percentage).

Modic-Frequency					Modic-Percentage				
	0	1	2	3		0	1	2	3
L1-L2	67	1			L1-L2	98.53	1.47		
L2-L3	63	3	1	1	L2-L3	92.65	4.41	1.47	1.47
L3-L4	63	2	1	2	L3-L4	92.65	2.94	1.47	2.94
L4-L5	56	4	5	3	L4-L5	82.35	5.88	7.35	4.41
L5-S1	51	4	10	3	L5-S1	75.00	5.88	14.71	4.41
Max Modic	40	8	15	5	Max Modic	58.82	11.76	22.06	7.35

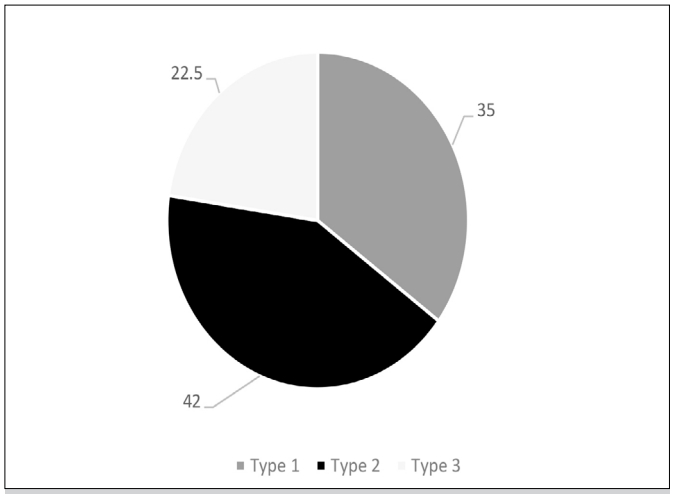

Figure 3. Frequency of Modic change type in sample.

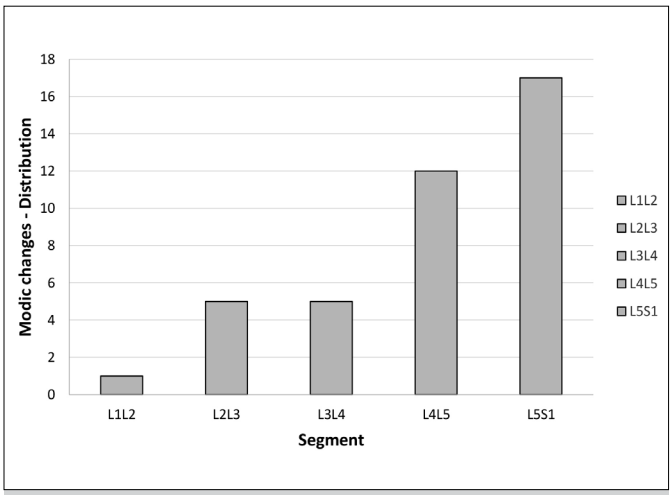

Figure 4. Modic changes (distribution per segment).

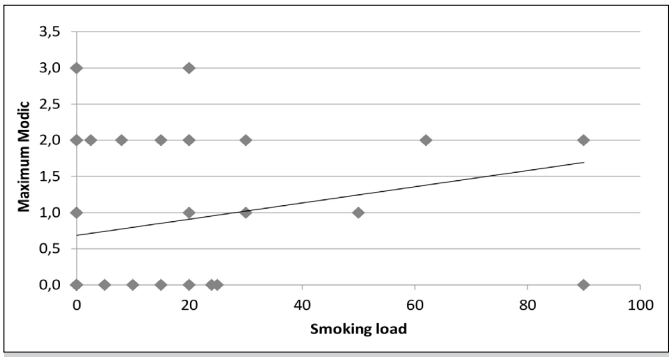

Figure 5. Correlation between Smoking Load and Maximum Modic.

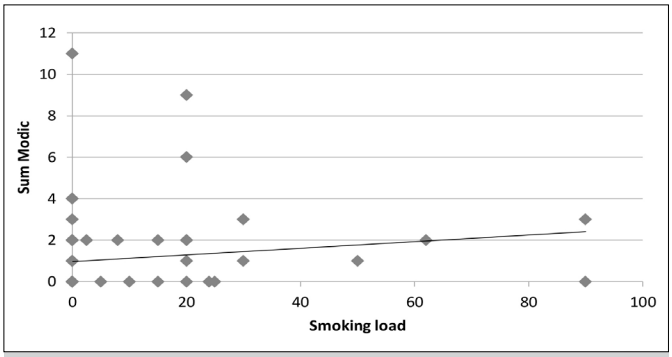

Figure 6. Sum Modic Vs Smoking Load.

DISCUSSION

There has been a long discussion about the potential role of smoking in the etiology of chronic low back pain. A study in Finland compared disc degeneration rates between 20 pairs of monozygotic twins, with and without a history of smoking[10]. The study found 18% more disc degeneration among smokers and an important difference between the degree of obstruction by arteriosclerosis in carotid ultrasound. Therefore, it is believed that that situation may lead to lower tissue blood flow and subsequent lower repair power of the tissue around the intervertebral disc.[11]

The results showed a degree of homogeneity between the groups regarding demographic factors. This ruled out confounding factors that are frequent in studies on the etiology of degeneration of vertebral elements. Prevalence between sexes, for example, is a controversial topic usually based on exposure factors more commonly associated to each sex, such as heavy work, obesity and smoking.[7,12–14] Similarly, the mean age of the groups (both 50.7 years old) ruled out a possible confounding bias in the comparison, considering the association between age and MC to be common.[7] The percentage of smokers in the Modic group was significantly higher, as was the smoking load, compared to the control group. The smoking load of the studied group was almost three times higher than that of the control group. This datum was the most discrepant between the groups, given that the other commonly studied association factors did not differ statistically from each other in this study.

Studies involving patients with Modic changes are usually cross-sectional and non-comparative. Among them, Arana et al.[13] found MC in 81% of their sample, composed of clinical patients with 50% smokers, while Mera et al. showed 65% prevalence, but did not evaluate smoking.[12] Although our prevalence of MC was lower in the total sample (41%), we found 46% prevalence of smokers in the outcome group.

Regarding the distribution of MC by segments, increased prevalence was found at more caudal levels (72.5% of cases were located between L4L5 and L5S1). This suggests that the load and mobility to which the vertebral segments are subjected have an effect on the formation of MC. This finding was similar to studies published in the field, in which a higher prevalence of MC is found in more caudal segments.[7,13,15,16].

Among the types of changes, Modic type 2 was the most frequent. This change was described as an intermediate process with a degree of chronicity.[9] Many authors[13,14,17] have described a higher prevalence of Modic type 2, possibly related to the progressive nature of the degeneration process. It is also known that samples containing patients with low back pain for a shorter time or higher degrees of pain have increased levels of Modic type 1 due to its greater inflammatory nature.[12].

Other authors had already evaluated the odds ratio of the association between MC and smoking. Leboeuf-Yde et al. showed a relationship between MC involving heavy work in combination with heavy smoking[14]. The odds ratio for MC in smokers was 4.9, similar to that found in our study, but this analysis was performed by dividing smoking into heavy, light and non-smoking groups. Our study used the smoking load in years/pack, as did Arana et al.[13]. However, unlike all others, we correlated the variables using Spearman's test. Thus, the most important datum in this study was the correlation between higher smoking loads and higher degrees of Modic. This is relevant because it shows that, in addition to the association between the variables, a correlation can be further investigated, thus showing that smoking can have an effect not only on the formation of MC, but also on their evolution to endplates turning fatty and sclerotic. This analysis allows for more objectivity in the interpretation of results and in the replication of the methods in new studies.

As limitations, we can mention the retrospective nature of this study, which, along with the absence of sample calculation, does not allow a detailed analysis of the several risk factors that may be involved in the etiology of MC. Although there is good inter and intraobserver agreement for the Modic classification described in the literature,[18] it was not performed in this study. Nevertheless, the results clearly show that smoking has a more important role in patients with MC, demonstrating that complementary research may be welcome.

CONCLUSION

In the studied sample, there was a higher chance for the existence of smokers among patients with Modic changes. A correlation was found between higher smoking loads and higher degrees of Modic.

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SHOULDER INJURY IN SURFING: A SYSTEMATIC REVIEW WITH META-ANALYSIS

LESÃO DE OMBRO NO SURFE: UMA REVISÃO SISTEMÁTICA COM METANÁLISE

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ABSTRACT

Objective: To establish the epidemiological profile of shoulder injuries suffered by surfers, through the injury proportion rate, type, mechanism and/or severity, caused by surfing. Methods: This systematic review was conducted and written in accordance with the guidelines for systematic reviews– PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The bibliographic research was carried out between January 2020 and January 2022 in journals indexed in the Web of Science, SPORTDiscus, PubMed, Scopus, Cochrane and Embase databases. Data were analyzed in RStudio, and the methodological quality of the studies was assessed. Results: Ten studies were included, all of which were retrospective in cross-sectional design and had an average methodological quality of 75%. The meta-analysis showed an injury incidence rate of 14.88%. Odds ratio analysis showed that injuries of joint origin are 7.26 times significantly higher in individuals with shoulder injuries, and injuries of bone origin and skin injuries had reduced odds of 70% and 89%, respectively. The most common mechanism of injury was the movement of paddling (57,68%), with the average prevalence of acute injuries being 31.53% and chronic injuries being 68.47%. Conclusion: There was a scarcity and/or variation in the categorization of data regarding injuries in the shoulder region resulting from surfing, with injuries of joint and musculotendinous origin being frequent; and rowing, the most overloading factor. ***Level of evidence II, Systematic Review.***

Keywords: Surf. Injuries. Shoulder. Water Sports.

RESUMO

Objetivo: O objetivo desta revisão sistemática foi estabelecer o perfil epidemiológico de lesões no ombro sofridas por surfistas, por meio da taxa de proporção, tipo, mecanismo e/ou gravidade de lesões ocasionadas pela prática do surfe. Métodos: A presente revisão sistemática foi conduzida e redigida de acordo com as diretrizes para revisões sistemáticas – Prisma (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). A pesquisa bibliográfica foi realizada entre janeiro de 2020 e janeiro de 2022, nos periódicos indexados nas bases de dados Web of Science, SPORTDiscus, PubMed, Scopus, Cochrane e Embase. Os dados foram analisados no RStudio, além disso também foi avaliada a qualidade metodológica dos estudos. Resultados: 10 estudos foram incluídos, sendo todos de delineamento transversal retrospectivos e de qualidade metodológica média de 75%. A meta-análise apresentou uma proporção de incidência de lesões de 14,88%. A análise de razão de chances mostrou que lesões de origem articulares são 7,26 vezes significativamente maiores em indivíduos com lesões no ombro, e lesões de origem óssea e as lesões na pele apresentaram chances reduzidas em 70% e 89%, respectivamente. O mecanismo de lesão mais comumente relatado foi o movimento da remada (57,68%), sendo a prevalência média de lesões aguda de 31,53%, e de lesões crônicas 68,47%. Conclusão: Observou-se uma escassez e/ou variação de categorização de dados referentes às lesões na região do ombro decorrentes do surfe, sendo frequentes lesões de origem articular e musculotendínea; a remada foi considerada o principal fator de sobrecarga. ***Nível de Evidência II, Revisão Sistemática.***

Descritores: *Surfe. Lesões. Ombro. Esportes aquáticos.*

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INTRODUCTION

Surfing is a water sport that has become increasingly popular in recent years. IBRASURF estimates that there are three million surfers in Brazil and over 35 million worldwide, with an annual growth rate of 11.5%.[1,2] Global participation is expected to increase even further following the sport's debut at the Tokyo Olympics in 2021, as well as medical and scientific interest in the sport.[3] The increasing global spread of surfing is accompanied by an increase in the level of competition and consequently the frequency of injuries, which reinforces the need to understand the pathogenesis.

Studies conducted with competitive and recreational surfers have shown an overall incidence rate of 0.74 to 1.79 injuries per 1,000 hours of surfing.[4–6] In a review looking at acute injuries in surfers, it was noted that injuries to the head, face and neck were the most common and that impact with the surfboard was the most common mechanism.[6] More recently, a new study by the same group, focusing on gradually developing conditions that became chronic, found that the most commonly reported injury sites were the spine at 29.3%, the shoulder at 22.9% and the head, face and neck at 17.5%, with the most common mechanism being paddling, which accounted for 37.1% of injuries.[3]

Time and motion analyses have shown that surfing is an intermittent sport and that part of the time, on average 51% (25–70%), is spent paddling.[7] Therefore, it is reasonable to assume that overuse injuries in the shoulder are related to the repetitive motion of the paddle stroke and the body position while paddling.[8] In addition, the paddling movement can lead to muscular imbalances and thus impair joint movements.[9,10]

Although the shoulder is related to the most time-consuming activity in surfing and is the region where most surgical procedures are performed, there is little research that examines and summarizes these data.[2,11]

Given the significant growth of this sport and the lack of specific studies on its injuries, there is a recognized need for research such as this study to estimate the proportion of injuries, types, mechanisms and/or severity of shoulder injuries.

MATERIALS AND METHODS

This study was written according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) guidelines.[12] The protocol was published in the PROSPERO registry (CRD42021252228).

Search strategy

The search was conducted between January 2020 and May 2022 in journals indexed in the Web of Science, SPORTDiscus, PubMed, Scopus, Cochrane and Embase databases. The different search syntaxes are listed in Appendix 1 and can be accessed at https://www.crd.york.ac.uk/PROSPEROFILES/252228_STRATEGY_20210429.pdf. All records were imported into the Mendeley management software and duplicate publications were removed. The articles in question were also identified by bibliographic linking.

Inclusion and exclusion criteria

The inclusion criteria were: (1) studies involving surfers of any age, both genders, and any experience level; (2) studies that mentioned surfing-related injuries; (3) studies that categorized shoulder-specific injuries; (4) studies that reported at least one of the following outcomes: Frequency of shoulder injury, types of injuries, severity, and/or mechanisms; (5) Studies published between 2000 and 2021. There was no restriction in the search: injury stage, language or study design.

Exclusion criteria were studies that: (1) focused on different water sports such as wakeboarding, water polo, or water skiing; (2) did not include surfing injuries; (3) categorized the shoulder along with other upper limb regions such as the elbow or arm or used only general terms such as upper limb; (4) were reviews or secondary analyses; (5) were incomplete or did not include sufficient data on the outcomes of interest.

Data extraction

Two independent reviewers used Rayyan software to check the results for selecting eligible studies against the pre-specified inclusion and exclusion criteria. Discrepancies were discussed with a third reviewer.

Assessment of methodological quality and risk of bias

The risk of methodological bias was assessed using the Appraisal for Cross-Sectional Studies (AXIS tool).[13] The choice of tool followed the current recommendations on evidence-based medicine and methodological quality.[14]

Data analysis

For the type of injury, a meta-analysis was performed to estimate the odds ratio (OR) of the dichotomous outcome "shoulder injuries" versus "injuries in other regions" by injury subgroup. Due to the variety of injury type names and presentations, common occurrences were grouped into: (1) "articular": ligament strains, cartilage damage, dislocations, subluxations; (2) "musculotendinous": strains, sprains, inflammation, and ruptures; (3) "bone": fractures and others (avulsions, bone edema); (4) "skin injuries": Lacerations, abrasions, contusions and wounds; (5) "Nerve injury": Nerve compression, stretching or other; (6) "Other": not identified by the study.

For severity and mechanism, the relative frequencies were summed and divided by the absolute sample to obtain the total frequency. Data were analyzed with R software (v.4.0.5) and RStudio (v.1.4.1106) using the 'metaprop' and 'metabin' packages.

RESULTS

Study selection

A total of 225 studies were identified using the search terms. After applying the inclusion and exclusion criteria, the included studies are shown in Figure 1.

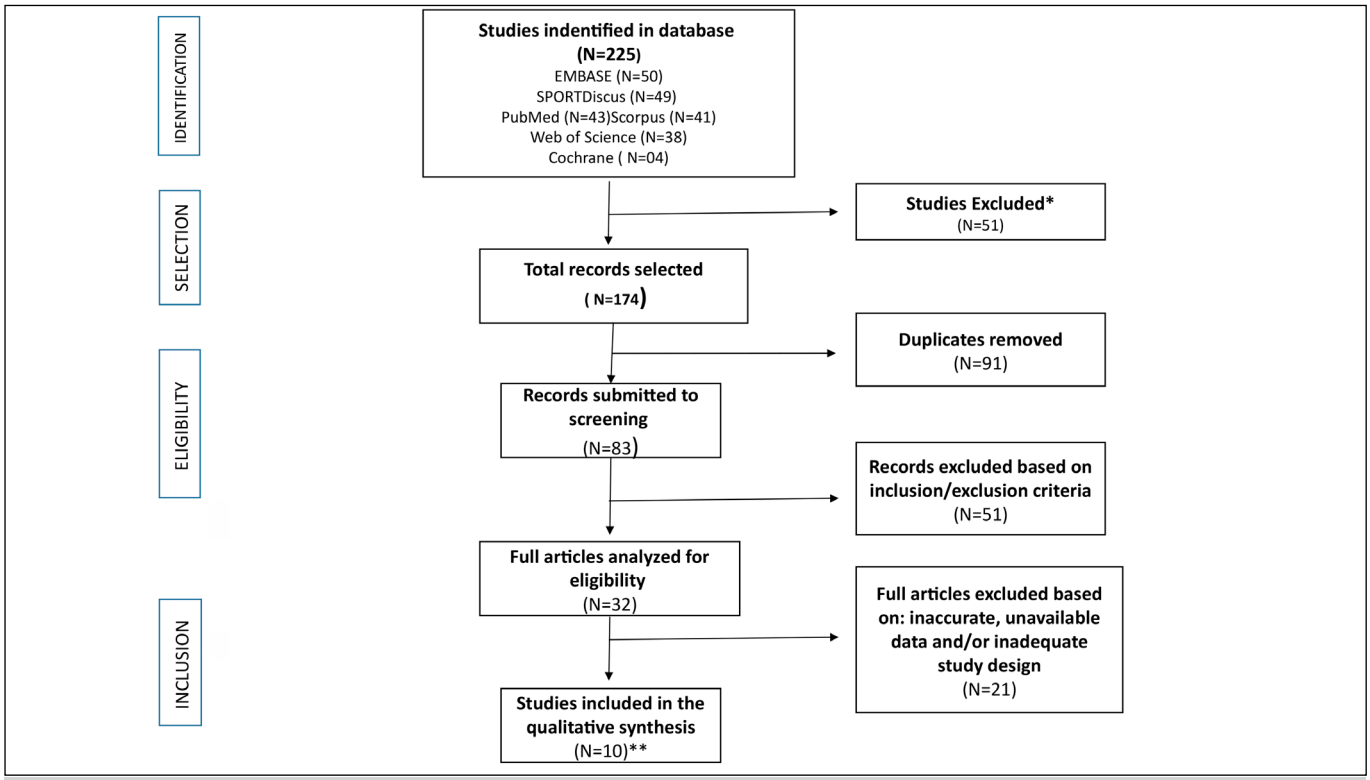

Figure 1. Flowchart of the article search in databases. (*Not within the specified search limits; **Two included studies were combined as they included the same cohort of individuals).

Analysis of included studies

The included studies were retrospective cross-sectional studies published between 2004 and 2021. Four studies were from Australia, two from the United States and one each from the United Kingdom, Japan, New Zealand and Brazil. After quality assessment, six were rated as 'good' and four as 'fair'," with an average score of 75% (SD ±7.82%), ranging from 65% to 85%. The final results are in Table 1.

In terms of data collection, only one study strictly referred to shoulder injuries, while the other nine studies quantified the total number of injuries and categorized the location according to the region of occurrence, with shoulder being one of them.[15] Four studies used medical records,[11,16-18] while the other five used questionnaires administered by the research group either online or by interview.[2,4,18-21] Only one study collected data in person through standardized physical assessments after the online application.[15]

Overall, 70% of the studies provided information on the type of injury,[4,11,15,16,19,20] and only 20% reported on the mechanism of injury occurrence.[2,4] In terms of injury severity, 80% of studies followed some criteria for grouping events, although inclusion criteria and definitions varied.

The average age of the surfers was 34.6 years with a standard deviation of 12.4 years. The gender distribution was 85.6% male and 14% female. Only three of the included studies did not specify the level of experience of the surfers, two considered a large proportion of the cohort to be recreational surfers, three restricted the study to professionals, one to amateurs, while the last specified as a criterion people who had at least 12 months experience. The descriptive characteristics are listed in Table 1.

Based on the evaluation of the included studies, a total of 5,201 surfing practitioners were observed, with 3,280, approximately 63%, experiencing some type of injury. Of these, 519 were shoulder injuries.

For the analysis of relative and absolute proportions, a study with *outlier* results, which evaluated a population of surfers exclusively with shoulder injuries, was excluded.[15] Thus, a meta-analysis with nine included studies (n = 498), weighting injury frequencies by study size, is presented in Figure 2.

The summary of the meta-analysis showed an incidence of shoulder injuries of 14.88% (95% CI, 10.30 - 20.12). The lowest proportion of shoulder injuries in relation to total injuries was observed in the oldest study by Taylor et al.,[19] with 5.75% (95% CI, 3.75 – 8.37). The highest proportions were found in more recent studies, with 26.55% (95% CI, 22.90 – 30.45) in Remnant et al.[2], and 27.52% (95% CI, 19.40 – 36.90) in Patel et al.[18] The heterogeneity between them, as measured by the I^2 statistic, was significant at 93%.

Types of injuries

Broad classifications were used to simplify the amount of data on the type of injuries. Of the ten studies, only seven reported the type of occurrence in their sample, representing an absolute total of 326 shoulder injuries.[4,11,15,16,18-20] Joint injuries accounted for 51% (n = 166), muscle-tendon injuries 30% (n = 97), bone injuries 4% (n = 14), skin injuries 3% (n = 11), nerve injuries 3% (n = 10) and unspecified, 'other' 9% (n = 28).

Dichotomous random-effects analyses were performed to examine whether the odds ratios (ORs) of individuals with shoulder injuries and those with injuries in other regions, i.e. without the outcome of interest, had similar distributions with respect to the type of injury event. The analysis is shown in Figure 3.

The meta-analysis showed that individuals with shoulder injuries were 7.26 times more likely to have joint-related injuries than those with injuries in other regions (OR 7.26; 95% CI 2.79 – 18.92; p = 0.0001). The likelihood of muscle-tendon injuries was also 2.4 times higher in people with shoulder injuries, without statistical significance (OR 2.41; 95% CI 1.03 – 5.64; p = 0.06). In contrast,

the likelihood of bone and skin injuries was reduced by 70% and 89%, respectively, in people with shoulder injuries (OR 0.30; 95% CI 0.17 – 0.54; p < 0.0001 / OR 0.11; 95% CI 0.04 – 0.28; p < 0.00001).Nerve injury and other species were on the zero line, hence a similar relationship (OR 0.89; 95% CI 0.46 – 1.75; p = 0.75 / OR 0.32; 95% CI 0.05 – 1.93; p = 0.22). The summary showed that the probability of occurrence in the shoulder region or in other regions was the same (OR 0.82; 95% CI 0.45 – 1.50; p = 0.53). However, heterogeneity was significant (p < 0.00001), a factor indicating low quality of the cohort.

Table 1. Assessment of methodological quality and descriptive characteristics of the included studies

Author, year	AXIS tool points	Quality assessment	Data collection method	Population demographics			Number of participants (N)	Total shoulder injuries/total study injuries	Competition level
			Average Age (X ± SD)		Sex (M/F%)				
Taylor et al., 2004[19]	15/20	Good	Interview Questionnaire	28.2 ± 7.9		90.2/9.8	Research: 646	13/168	N/D
					Emergency: 267		12/267		
Hay et al., 2009[16]	13/20	Fair	Medical Records	27		80/20	212	21/212	N/D
Meir et al., 2011[20]	17/20	Good	Online Survey	31.7 ± 12.85		85.4/14*	685	51/389	71.5% recreational
Furness et al., 2015[4]	16/20	Good	Online Survey	35.8 ± 13.1		91.3/8.7	1348	154/1047	Active surfers with at least 12 months experience
Inada et al., 2018[20]	13/20	Fair	Medical Records	N/D		N/D	Championships and Clinic: 65	4/65	Professional
					Clinic: 62		17/62		
Hohn et al, 2018[11]	17/20	Good	Medical Records	28.5		92.6/7.4	86	31/163	Professional
Burgess et al, 2019[21]	15/20	Good	Online Survey	35 ± 13.2		77/23	227	19/227	Professional
Patel et al, 2019[18]	14/20	Fair	Medical Records	36		74/26	109	30/109	N/D
Remnant et al, 2020[2]	16/20	Good	Online Survey	34.6 ± 11.9		82/18	1473	146/550	63% recreational
Gomes et al., 2020[15]	13/20	Fair	Online Survey	28 ± 5		100/0	21	21/21	Amateur athletes
Average	**75 % (SD ±7.82%)**			**34.6 ± 12.4**		**85.6/14**	**5201**	**519/3280**	

N/D: Not declared; *Meir et al., 2011 reported a total of 0.6% (4) transgender individuals participating in the survey.

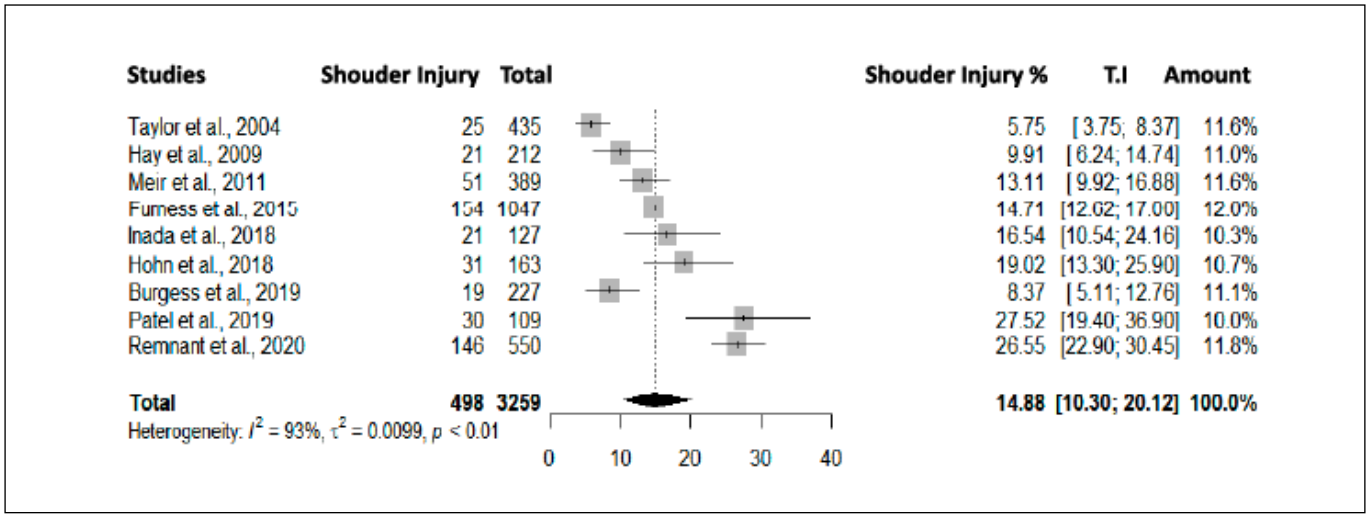

Figure 2. Forest plot comparison of shoulder injuries in surfing practitioners. The columns present the studies sequenced by year; number of shoulder injuries; total injuries in studies; shoulder injuries %; 95% CI; study weight in the overall meta-analysis.

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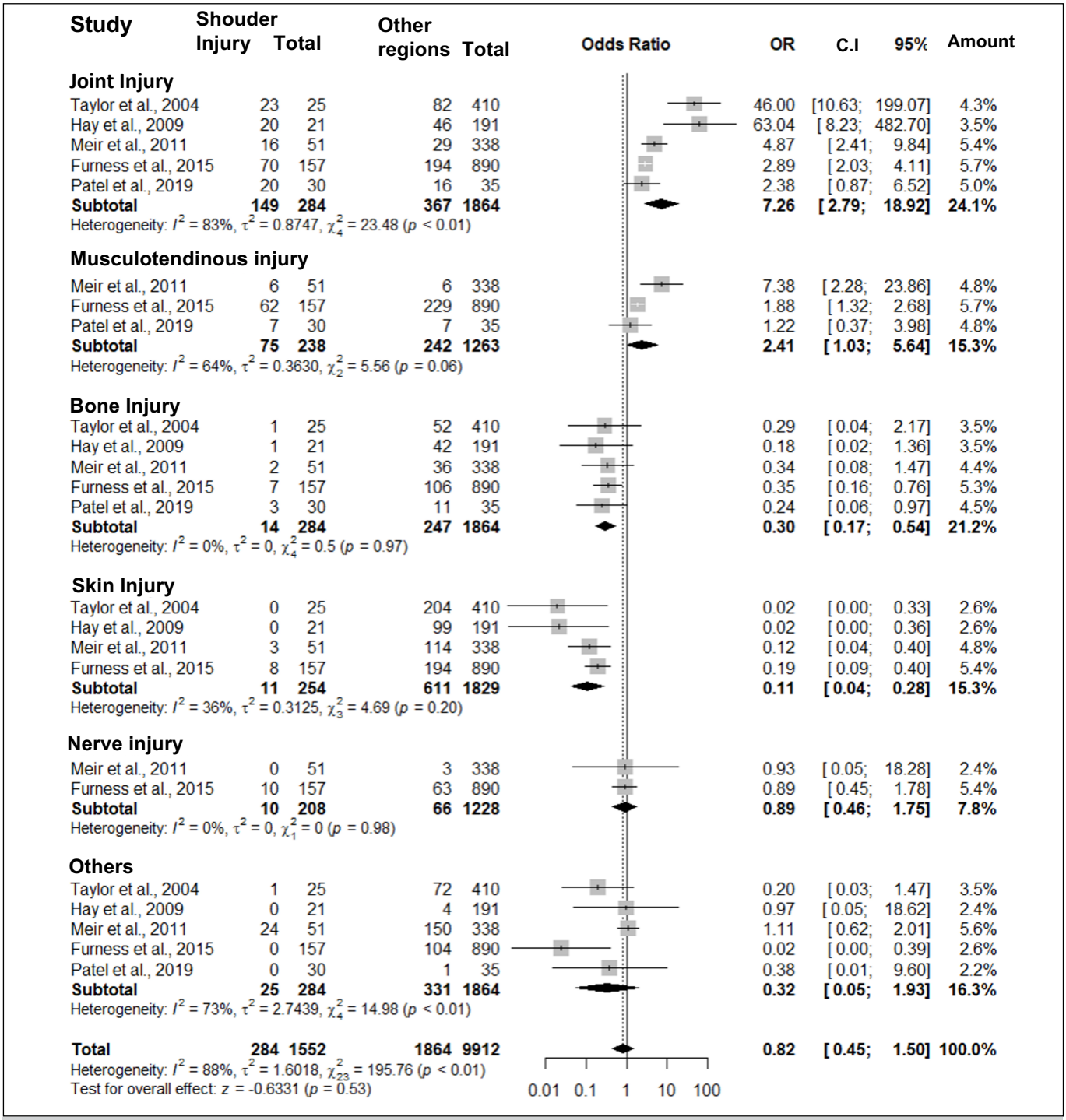

Figure 3. Forest plot of odds ratio (OR) of dichotomous data (Shoulder Injuries vs. Injuries in Other Regions) according to authors/injury subgroup.

Mechanism of injury

Two studies directly reported the mechanism of injury by region, totaling 345.[2,4] Rowing motion was the most commonly reported, followed by injuries related to maneuvers and contact or direct trauma injuries. The others include duck jumping and unknown causes.

Severity

Eight articles reported on the severity of injuries, with widely varying classification criteria. Three studies divided them into chronic and acute.[2,17,19] Two others differentiated them according to surgical or non-surgical intervention.[11,18] Hay et al.[16] and Furness et al.[4] analyzed the incidences as mild or severe, with different criteria. Gomes et al.[15] quantified pain intensity using a numerical scale (NRS). Due to the notable differences in definitions/nomenclature and details, it was decided to stratify the cases as reported and group only the similar cases. The severity of the injuries is shown in Table 2.

Four methods of distinguishing the severity of injury were observed in the studies. Due to the different classifications, only the subgroup that distinguished between acute and chronic injuries was suitable for comparison. We observed 31.53% acute injuries and 68.47% chronic injuries.

Table 2. Frequency of injury severity according to categorization and definitions.

Author, Year	Shoulder Injuries % (N)		Definition Described by the Study
	Acute	Chronic	
Taylor et al., 2004[22]	40% (10)	60% (15)	Acute: Individual treated by someone other than the surfer or time off activities. Chronic: Disorders not related to an acute injury requiring treatment.
Inada et al.,2018[20]	19% (4)	81% (17)	Acute: Injuries treated in outpatient care. Chronic: Non-surgical treatments such as medication or physical therapy.
Remnant et al.,2020[2]	35.6% (52)	64.4% (94)	Acute: Injury duration less than 3 months. Chronic: Injury duration of 3 months or more.
	Surgical	**Non-Surgical**	
Hohn et al.,2020[11]	73% (20)	27% (7)	Surgical: An acute injury due to a traumatic event with primary surgical treatment. Non-surgical: An acute injury due to a traumatic event or a chronic injury due to overuse with non-surgical treatment.
Patel et al.,2019[25]	23.3% (7)	76.7% (23)	Surgical: Surgical procedure data that has been entered into the electronic medical record system. Non-surgical: Injuries caused by trauma in patients who presented to the facility less than 6 months after the surfing injury.
	Severe/	**Mild**	
Hay et al., 2009[19]	4.5% (1)	95.5% (21)	Mild: patients who could be discharged after treatment, i.e. injuries that did not require hospitalization. Severe: Injuries requiring hospitalization.
Furness et al., 2015[4]	78.6% (121)	21.4% (33)	Mild: Did not interfere with work or surfing or did not require treatment by medical professionals. Severe: The participant required one or more days off work and/or surfing and/or required treatment by a medical professional.
	Pain Yes (NPS)*	**Pain No (NPS)***	
Gomes et al.,2020[18]	42.9% (9)	57.1% (12)	The intensity of shoulder pain at the time of data collection was assessed using the Numerical Pain Scale (NPS).

* NPS: Numerical Pain Scale. ** SD: Scapular dyskinesia.

DISCUSSION

he proportion of shoulder injuries compared with other regions was 14.88% (95% CI, 10.30-20.12), depending on the size of the studies, and ranged from 5.75% (95% CI, 3.75–8.37) in Taylor et al, 2004[19], to 27.52% (95% CI, 19.40 – 36.90) in Patel et al[18]. The variability in incidence can be attributed to different data collection methods or the level of experience of the surfers.

The percentage increase in injuries probably reflects the increasing global spread of surfing and the simultaneous increase in the level of competition. The complexity of the maneuvers and the difficulty of execution have increased.[22] One of the most famous maneuvers is the aerial, which is associated with high performance and high risk.[23] In addition, advances in design and materials have led to lighter, smaller boards that improve performance.

Furness et al.[4] studied 194 surfers who regularly perform aerial maneuvers, from which 94 suffered serious acute injuries over a 12-month period. The author also found a significant increase in serious injuries in this group, with an increased strain on ligaments and contractile tissue and an increase in muscle and joint injuries. According to Bickley et al,[24] riskier maneuvers or larger waves contribute to higher injury rates in professionals.

The high incidence of shoulder joint injuries, which is 7.26 times higher than in other regions, and of muscle-tendon origin injuries, which is 2.4 times higher than in other regions, is attributed to the overload caused by the repetitive strokes and the body posture during paddling. The causes are thought to include hyperextension of the cervical and lumbar spine, continuous isometric contraction of the neck and scapular muscles, and medial rotation during paddling. [7]

Furness et al,[25] who examined the strength profile of medial and lateral rotation, concluded that professionals have greater strength in the medial rotation muscles than in the lateral ones. When identifying an asymmetry between the sides for the lateral rotators, the non-dominant arm was weaker. It is therefore hypothesized that paddling promotes unbalanced muscle development that may lead to scapular dyskinesia (SD).[9] Gomes et al.[15] who studied the prevalence of SD concluded that it was present in 71.4%, with a higher prevalence of dyskinesia with a protrusion at the medial edge of the scapula (57.1%), and that 23.8% had SD at rest. Decreased thoracic extension alters the risk of dyskinesia of the scapula and increases the risk of impingement around/d the glenohumeral joint.[8]

There is also an increase in overuse injuries as surfers are surfing more frequently and for longer periods in wetsuits that insulate the body in cold water.[26]

A systematic review of the epidemiology of injuries found that skin injuries (abrasions, lacerations, burns, hematomas, bruises) were the most common at 46%[6]. In the same study, the most frequently injured region was the head (33.8%), followed by the lower limbs (33.0%). Arm injuries accounted for 16.5%.[6]

The most reported mechanism was paddling (57.68%), followed by maneuvers (14.49%). It is estimated that 54% of surfing time is spent paddling, which would explain the propensity for shoulder injuries.[27]

Another factor that may be associated with paddling injuries is the type of board. Remnant et al.[2] concluded that longboards pose a greater risk than shortboards, possibly because longboards require a greater elbow angle and greater abduction of the shoulder during recovery to avoid collision with the edge.[2]

Studies on the mechanism of injury found that the most common cause was collision between surfer and board, followed by approaching the wave or performing a maneuver.[6,28] Subsequently, when Hanchard et al.[3] studied the same population but for chronic injuries, they found a higher percentage caused by paddling. This result suggests a link between paddling-related injuries and chronic disease.

Nathanson et al.[29] reported that musculoskeletal injuries account for 60% of chronic surfing injuries, with the shoulder being the

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most affected joint. It is concluded that chronic injuries of gradual onset related to the rotator cuff are more common in surfers due to the repetitive nature of paddling.[30] This analysis is supported by Remnant et al,[2] who found rotator cuff injuries and/or bursitis in 80% of individuals.

In terms of injury severity, only acute and chronic injuries were comparable, with chronic injuries being twice as common as acute injuries. A further classification of severity would be surgical or non-surgical. Hohn et al.[11] described that shoulder injuries were the most operated on (73%) compared to other regions. These were usually instability, rotator cuff or SLAP lesions. Similarly, Patel et al.[18] observed surgical intervention in cases of anterior shoulder dislocation with persistent symptoms of instability, rotator cuff, SLAP lesion, traumatic osteolysis of the acromioclavicular joint and chondral shear injury of the humeral head.

Compared to other modalities, surf training is not yet sufficiently developed and widespread.

This review was limited by the availability of studies with only retrospective cross-sectional designs. Another limiting factor lies in the method of data collection: an online questionnaire that depends solely on the participants' memory and is therefore subject to recall errors. The recall rate decreases with increasing detail, with accuracy decreasing by up to 61%.[31,32] In addition, injured surfers are more likely to respond to surveys than uninjured surfers, leading to inaccurate incidence rates.[6]

Although hospital records were collected in four studies, there was no consistency in reporting professional surfing experience, a factor that could improve diagnostic accuracy and injury presentation. In addition, the cohort of patients included in this study provides greater statistical power, which facilitates validation of conclusions.

CONCLUSION

There is little data in the literature on shoulder injuries during surfing. The incidence of shoulder injuries compared to other regions is 14.88%, with joint and muscle-tendon origins being more common. These incidences can be attributed to overuse of the shoulder due to the repetitive paddling action and posture of paddling, suggesting that the practice of this sport appears to promote imbalanced muscle development.

Further research focusing exclusively on sports practitioners is needed.

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Appendix 1. search syntax used in databases.

Databases	Search strategy	Total
Embase	('injuries'/exp OR 'injuries' OR 'athletic injuries'/exp OR 'athletic injuries' OR 'lesion'/exp OR 'lesion' OR 'biomechanical phenomena'/exp OR 'biomechanical phenomena' OR 'cumulative trauma disorders'/exp OR 'cumulative trauma disorders' OR 'ligaments, articular/injuries' OR 'lacerations'/exp OR 'lacerations') AND('shoulder' OR 'shoulder injuries' OR 'shoulder pain/physiopathology' OR 'shoulder pain/epidemiology' OR 'shoulder pain/etiology' OR 'rotator cuff injuries' OR 'shoulder dislocation' OR 'shoulder fractures' OR 'bankart lesions' OR 'shoulder impingement syndrome') AND('surfing water sport'/exp OR 'surfing water sport' OR 'surf' OR 'surfing'/exp OR 'surfing' OR 'recreational water'/exp OR 'recreational water' OR 'recreational athlete'/exp OR 'recreational athlete' OR 'surfing (water sport)'/exp OR 'surfing (water sport)')	**50**
SPORTDiscus	All_fields:(("Injuries" OR "Athletic Injuries" OR "Lesion" OR "Biomechanical Phenomena" OR "Cumulative Trauma Disorders" OR "Ligaments, Articular/injuries" OR "Lacerations")) AND all_fields:("Shoulder" OR "Shoulder Injuries" OR "Shoulder Pain/physiopathology" OR "Shoulder Pain/epidemiology" OR "Shoulder Pain/etiology" OR "Rotator Cuff Injuries" OR "Shoulder Dislocation" OR "Shoulder Fractures" OR "Bankart Lesions" OR "Shoulder Impingement Syndrome")) AND title:(("Water Sports" OR "Wave Surfing" OR "Surfing, Wave" OR "Surfboarding" OR "Surfing" OR "Surf")	**49**
Pubmed	("Injuries"[All Fields] OR "Athletic Injuries"[All Fields] OR "Lesion"[All Fields] OR "Biomechanical Phenomena"[All Fields] OR "Cumulative Trauma Disorders"[All Fields] OR "ligaments articular injuries"[All Fields] OR "Lacerations"[All Fields]) AND ("Shoulder"[All Fields] OR "Shoulder Injuries"[All Fields] OR "Shoulder Pain/physiopathology"[All Fields] OR "Shoulder Pain/epidemiology"[All Fields] OR "Shoulder Pain/etiology"[All Fields] OR "Rotator Cuff Injuries"[All Fields] OR "Shoulder Dislocation"[All Fields] OR "Shoulder Fractures"[All Fields] OR "Bankart Lesions"[All Fields] OR "Shoulder Impingement Syndrome"[All Fields]) AND ("Water Sports"[All Fields] OR "Wave Surfing"[All Fields] OR "Surfboarding"[All Fields] OR "Surfing"[All Fields] OR "Surf"[All Fields])	**43**
Scopus	(ALL (("Injuries" OR "Athletic Injuries" OR "Lesion" OR "Biomechanical Phenomena" OR "Cumulative Trauma Disorders" OR "Ligaments, Articular/injuries" OR "Lacerations"))) AND (ALL (("Shoulder" OR "Shoulder Injuries" OR "Shoulder Pain/physiopathology" OR "Shoulder Pain/epidemiology" OR "Shoulder Pain/etiology" OR "Rotator Cuff Injuries" OR "Shoulder Dislocation" OR "Shoulder Fractures" OR "Bankart Lesions" OR "Shoulder Impingement Syndrome"))) AND (TITLE-ABS-KEY (("Surfboarding" OR "Surfing" OR "Surf")))	**41**
Web of Science	"(""Injuries"" OR ""Athletic Injuries"" OR ""Lesion"" OR ""Biomechanical Phenomena"" OR ""Cumulative Trauma Disorders"" OR ""Ligaments, Articular/injuries"" OR ""Lacerations"") AND (""Shoulder"" OR ""Shoulder Injuries"" OR ""Shoulder Pain/physiopathology"" OR ""Shoulder Pain/epidemiology"" OR ""Shoulder Pain/etiology"" OR ""Rotator Cuff Injuries"" OR ""Shoulder Dislocation"" OR ""Shoulder Fractures"" OR ""Bankart Lesions"" OR ""Shoulder Impingement Syndrome"") AND (""Water Sports"" OR ""Wave Surfing"" OR ""Surfing, Wave"" OR ""Surfboarding"" OR ""Recreation"" OR ""Surfing"" OR ""Surf"")"	**38**
Cochrane	(("Injuries" OR "Athletic Injuries" OR "Lesion" OR "Biomechanical Phenomena" OR "Cumulative Trauma Disorders" OR "Ligaments, Articular/injuries" OR "Lacerations")) AND (("Shoulder" OR "Shoulder Injuries" OR "Shoulder Pain/physiopathology" OR "Shoulder Pain/epidemiology" OR "Shoulder Pain/etiology" OR "Rotator Cuff Injuries" OR "Shoulder Dislocation" OR "Shoulder Fractures" OR "Bankart Lesions" OR "Shoulder Impingement Syndrome")) AND (("Water Sports" OR "Wave Surfing" OR "Surfing, Wave" OR "Surfboarding" OR "Surfing" OR "Surf")) (Word variations have been searched)"	**4**