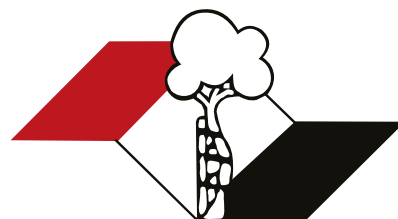


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EFFECT OF REPETITIVE PERIPHERAL MAGNETIC STIMULATION ON POSTOPERATIVE PAIN CONTROL IN FOOT AND ANKLE SURGERY

EFEITO DA ESTIMULAÇÃO MAGNÉTICA PERIFÉRICA REPETITIVA NO CONTROLE DA DOR PÓS-OPERATÓRIA EM CIRURGIAS DO PÉ E TORNOZELO

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ABSTRACT

Objective: This study aimed to investigate the effects of Repetitive Peripheral Magnetic Stimulation (rPMS) treatment on postoperative pain control after foot and ankle surgeries. **Methods:** A controlled, randomized clinical trial conducted at a tertiary hospital. 67 patients who underwent foot and ankle surgeries were randomized into two groups: a control group (CG) – placebo stimulation; and an experimental group (EG) – rPMS for 10 minutes using an intermittent stimulation protocol (10 cycles/5 seconds; 100 Hz; 55 seconds of rest). Stimulation was received for 5 consecutive days in the immediate postoperative period. Neuropathic Pain Score 4 (DN4), Visual Analog Scale (VAS), Brief Pain Inventory (BPI), and American Orthopedic Foot and Ankle Score (AOFAS) were administered on days D0, D5, D14, D30, and D90. Postoperative opioid consumption was compared between the groups. **Results:** The most prevalent surgeries were in the forefoot ($n=25$). On DN4, the predominant pain was nociceptive (3.40 ± 1.54). Regarding pain, the VAS, BPI, and AOFAS scores demonstrated superior improvement in pain perception in the EG compared to the CG, with statistical significance. rPMS reduced postoperative opioid consumption. **Conclusion:** rPMS contributes to the control and reduction of pain perception and opioid consumption in the postoperative period of foot and ankle surgeries. **Level of Evidence I; Randomized Clinical Trial.**

RESUMO

Objetivo: Este estudo teve como objetivo investigar os efeitos do tratamento com Estimulação Magnética Periférica Repetitiva (rMPS) no controle da dor pós-operatória em cirurgias de pé e tornozelo. **Métodos:** Ensaio clínico controlado e randomizado, realizado em um hospital terciário. Sessenta e sete pacientes submetidos a cirurgias de pé e tornozelo foram randomizados em dois grupos: grupo controle (GC) – estimulação placebo; e grupo experimental (GE) – EMpr por 10 minutos com protocolo de estimulação intermitente (10 ciclos/5 segundos; 100 Hz; 55 segundos de repouso). A estimulação foi aplicada por 5 dias consecutivos no pós-operatório imediato. O Neuropathic Pain Score 4 (DN4), a Escala Visual Analógica (EVA), o Brief Pain Inventory (BPI) e o American Orthopedic Foot and Ankle Score (AOFAS) foram administrados nos dias D0, D5, D14, D30 e D90. O consumo de opioides no pós-operatório foi comparado entre os grupos. **Resultados:** As cirurgias mais prevalentes foram no antepé ($n=25$). No DN4, a dor predominante foi nociceptiva ($3,40; \pm 1,54$). Em relação à dor, os escores EVA, BPI e AOFAS demonstraram melhora superior na percepção dolorosa no GE em comparação ao GC, com significância estatística. A rMPS reduziu o consumo de opioides no pós-operatório. **Conclusão:** A rMPS contribui para o controle e a redução da percepção dolorosa e do consumo de opioides no pós-operatório de cirurgias de pé e tornozelo. **Nível de Evidência I; Ensaio Clínico Randomizado.**

Keywords: Surgery; Pain; Magnetic Field Therapy; Foot; Ankle.

Descritores: Cirurgia; Dor; Magnetoterapia; Pé; Tornozelo.

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INTRODUCTION

Foot and ankle surgical pain can greatly impact recovery^{1,2}. Postoperative pain levels depend on surgery type, patient factors, and pain management effectiveness³. Inadequate postoperative pain

control is associated with longer postoperative recovery room stays and longer hospital stays^{4,5}, impacting mobility, rehabilitation progress, and quality of life³. Despite advances in multimodal

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The study was conducted at the Faculdade de Medicina, Universidade Federal de Alfenas, Alfenas, Minas Gerais, Brazil.

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<< SUMÁRIO

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analgesia, moderate to severe postoperative pain affects up to 80% of patients⁶.

In the management of postoperative pain after foot and ankle surgeries, measures such as peripheral nerve blocks, wound infiltrations, joint infiltration with glucocorticoids, and oral medications (paracetamol, nonsteroidal anti-inflammatory drugs, selective cyclooxygenase-2 inhibitors, and opioids) are considered^{5,7,8}.

Repetitive Peripheral Magnetic Stimulation (rPMS) is an innovative therapeutic modality for pain control through peripheral neuromodulation. It is a non-invasive treatment method developed for therapeutic neuromodulation in movement disorders.

In rPMS, an electromagnetic coil generates a strong magnetic field that induces electrical currents to influence nearby neurons. The effects vary based on coil type and orientation, application site, stimulation frequency, and session number⁹. rPMS therapy provides pain-free stimulation to deep muscle tissues¹⁰. It can activate peripheral nerves and muscle spindles even through layers of skin, fat, bone, clothing, or other materials. The technique is painless, non-invasive, and simple to use^{11,12}, making it a safe way to target deeper muscles without discomfort. These advantages make the technique suitable for safely stimulating postoperative areas^{12,13}. The aim of the study is to investigate the effects of rPMS treatment on postoperative pain control after foot and ankle surgeries.

MATERIAL AND METHODS

Study design and setting

Controlled, randomized clinical trial with sixty-seven individuals treated in a tertiary hospital in Brazil.

Participants

Inclusion criteria: Individuals in the immediate postoperative period of foot and ankle surgeries; individuals 18 years of age or older. Exclusion criteria: Individuals under 18 years of age; those not experiencing postoperative pain; those with malignant neoplasms or infections; pregnancy; vascular, neurological, or skin diseases affecting the lower limbs; and individuals with cognitive impairment were excluded from the study.

Randomization and sample size

The sample size calculation was based on a pilot study of 24 individuals. Statistical analyses were performed using R software,

considering $\alpha = 5\%$ and $\beta = 80\%$. The minimal sample size was determined for each variable (VAS, IBD, and AOFAS) according to their standard deviations and desired mean differences. The VAS variable required the largest sample, resulting in a minimum of 33 participants per group ($n = 66$ total) to ensure adequate statistical power.

Participants were assigned to either the control group (CG) or experimental group (EG) using simple randomization via Research Randomizer (version 4.0)¹⁴. Random numbers ensured balanced allocation, and a researcher uninvolved in data collection or analysis conducted the process for sequence concealment and reduced selection bias. The following variables were considered to characterize the sample: sex; age; type of surgery (bone vs. soft tissue); area (ankle, hindfoot, midfoot, forefoot); smoking status; functionality; surgical history; duration of surgery; anesthesia; tourniquet use.

Clinical setting and procedures

All patients included in the study received a standardized analgesic prescription for the postoperative period to ensure homogeneity in pain management between groups: 1g dipyrone every 6 hours, plus 50 mg tramadol every 8 hours if severe pain occurred. Patients were informed of the regimen and instructed to track tramadol use during the first two weeks after surgery. These records were submitted to the lead researcher for opioid consumption analysis. Repeated Peripheral Magnetic Stimulation (rPMS): Study participants were randomized into two groups: EG ($n=34$) and CG ($n=33$). Both groups used the rPMS device. Peripheral electromagnetic neuromodulation sessions were performed in an outpatient setting, with the patient comfortably positioned supine on a stretcher, maintaining the operated limb in a neutral position. The coil used was a figure-of-eight coil, coupled to the NEURO-MSX stimulator (Neurosoft®, UK), and fixed over the anatomical area corresponding to the surgical topography. The coil was positioned so that its surface was parallel to the operated region, 1cm away. For the EG, 5 neuromodulation sessions were performed, with a frequency set at once daily, for 5 consecutive days, starting on the fifth postoperative day. An intermittent stimulation protocol consisted of 10 cycles of 5 seconds of stimulation at a frequency of 100 Hz, followed by 55 seconds of rest, with a minimum intensity of 20% up to maximum intensity. In the CG, the coil was applied transversely to the surgical wound, but there was no stimulation (Figure 1). Both groups heard the same clicking sound during sessions, with the



Source: Study author.

Figure 1. EMPr application area.

coil placed in contact for a similar sensation. Experienced physical therapists administered rMPS to both groups under the main surgeon's supervision.

Assessment instruments

Neuropathic Pain 4 (DN4)^{15,16}: Used to classify postoperative pain after foot and ankle surgery (nociceptive or neuropathic) and correlate it with the different anatomical areas of the foot and ankle (ankle, hindfoot, midfoot, and forefoot).

Visual Analog Scale (VAS)¹⁷, Brief Pain Inventory (BPI)¹⁸, American Orthopedic Foot and Ankle Score (AOFAS)¹⁹⁻²²: Used to determine whether rMPS alters analgesic perception after foot and ankle surgery. These instruments were applied on days 0 (before the first neuromodulation session), 5 (after the last neuromodulation session), 14, 30 and 90 after foot and ankle surgery.

Data analysis

The following tests were used for statistical analysis of the collected data: Kruskal-Wallis test, Mann-Whitney test, Friedman test, Wilcoxon test; Spearman correlation; confidence interval for the mean and p-value.

Ethics, funding, data sharing and disclosures

This study was approved by the Ethics Committee of the institution – protocol 73680223.3.0000.5142 and by the Brazilian Registry of Clinical Trials (REBEC) – Protocol RBR-8g8ckzm. All participants signed the Free and Informed Consent Form (FICF). The author guarantee that the data presented is accurate and transparent and that no important changes in study design or analyzes have been made after starting the analysis of the data. Data confidentiality was guaranteed in accordance with the General Data Protection Law (LGPD), Law No. 13,709/2018. There were no study sponsors or funding received for conducting the study.

RESULTS

Of the participants, 61.2% were female (n=41) and 38.8% male (n=26), with a mean age of 51.7 years (± 15.1). Most surgeries were bone interventions (74.6%, n=50); soft tissue procedures accounted for 25.4% (n=17). Forefoot surgery was the most prevalent (37.3%, n=25), followed by ankle (35.8%, n=24), hindfoot (19.4%, n=13), and midfoot (7.5%, n=5) (Table 1).

Arthroscopic reconstruction for lateral ankle instability was the most common surgery performed (14.9%, n=10), followed by Chevron/Akin hallux valgus correction (13.4%, n=9) and neurectomy for Morton's neuroma (10.4%, n=7). In evaluating postoperative pain following foot and ankle surgeries, the average DN4 score was 3.40 (± 1.54), ranging from 2 to 8. Applying the established threshold of 4 for identifying pain with a neuropathic component, the findings demonstrate that postoperative pain most frequently exhibited nociceptive characteristics. DN4 scores did not significantly differ between operated regions (forefoot, midfoot, hindfoot, ankle; p=0.794), indicating postoperative nociceptive pain was consistent across foot and ankle segments (Table 2).

Pain scores on the VAS dropped significantly faster in the EG compared to the CG. Although the EG started with higher pain (6.47 vs. 4.3), it showed a rapid decline from D5 onward, while the CG's reduction was slower. Statistically significant differences between the groups emerged from D5, as shown by the confidence intervals (Figure 2).

The BDI results followed a similar pattern to the VAS. On D0, the EG presented a higher score (4.44) than the CG (3.14). From D5 onwards, there was a reduction in the EG, while the CG maintained a slower decrease. The CIs show that the differences between the groups are significant (Figure 3).

Table 1. Characterization of the general study sample.

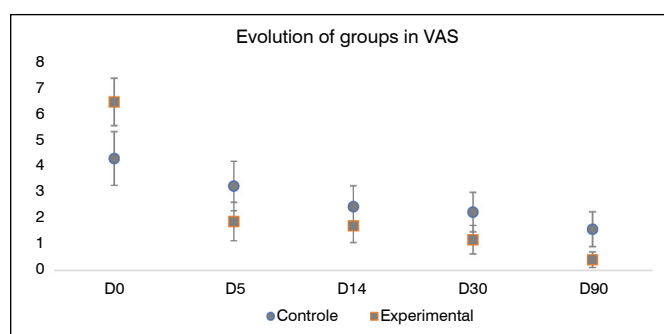
		N	%
Group	Control	33	49.3%
	Experimental	34	50.7%
Gender	Female	41	61.2%
	Male	26	38.8%
Surgery	Bone	50	74.6%
	Soft tissue	17	25.4%
Area	Forefoot	25	37.3%
	Midfoot	5	7.5%
	Hindfoot	13	19.4%
	Ankle	24	35.8%
Smoking	No	57	85.1%
	Yes	10	14.9%
Functionality	Active	21	31.3%
	Sedentary	46	68.7%
Surgery time	1h	31	46.3%
	2h	31	46.3%
	3h	4	6.0%
	4h	1	1.5%
Anesthesia	Block and sedation	7	10.4%
	Spinal and sedation	60	89.6%
Tourniquet	No	7	10.4%
	Yes	60	89.6%

Legend: N: Total number. Source: Study author.

Table 2. Comparison between the anatomical area of surgery and the DN4 score.

	Mean	Median	SD	N	IC	P-value
Forefoot	3.68	3	1.84	25	0.72	0.794
Midfoot	4.00	4	2.00	5	1.75	
Hindfoot	3.31	3	1.65	13	0.90	
Ankle	3.04	3	0.91	24	0.36	

Legend: CI: Confidence interval. N: Total number. SD: Standard Deviation. Source: Study author.



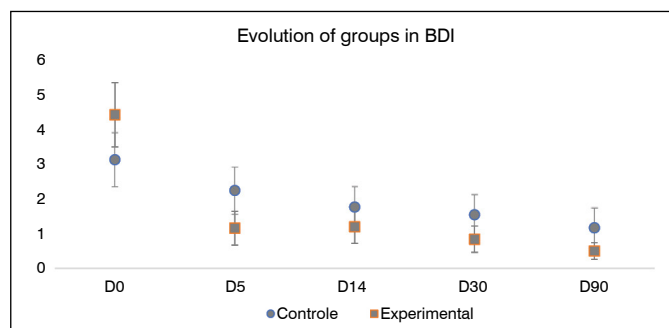
Legend: D: Day. Source: Study author.

Figure 2. Evolution of groups in VAS.

Regarding the AOFAS, on D0, the CG presented a higher score (86.7) than the EG (81.8), indicating a possible initial difference. However, from D5 onwards, the EG surpassed the CG, reaching significantly higher scores compared to the CG. The CIs demonstrate that these differences are statistically relevant (Figure 4).

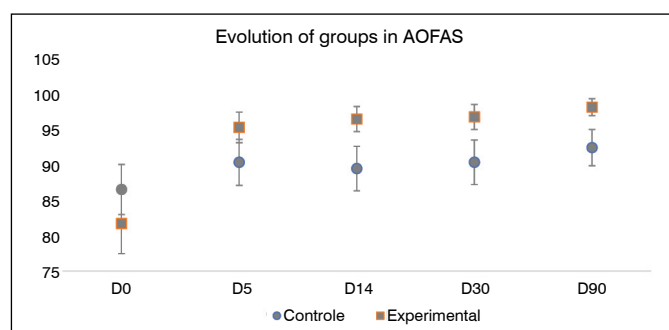
VAS, BDI and AOFAS scores between groups on postoperative days 0, 5, 14, 30, and 90 were compared (Table 3).

The comparison of opioid consumption between the CG and EG constitutes one of the main outcomes of this study, objectively reflecting the effectiveness of electromagnetic neuromodulation in



Legend: D: Day. Source: Study author.

Figure 3. Evolution of groups in BDI.



Legend: D: Day. Source: Study author.

Figure 4. Evolution of groups in AOFAS.

postoperative pain control. In the first postoperative week, mean opioid use was similar between groups (CG: 2.91 ± 2.38 tablets; EG: 3.62 ± 2.44 ; $p=0.217$). By the second week, opioid consumption remained notable in the CG (1.97 ± 2.16), while the EG had a significant reduction (0.50 ± 0.75 ; $p=0.002$). The IQR further highlights this, with just 1 tablet in the EG versus 3 in the CG, indicating more consistent lower opioid use among experimental group (Table 4).

DISCUSSION

Analysis of the total sample of study participants ($n=67$) showed that, based on the DN4 score, postoperative pain in foot and ankle surgeries was primarily nociceptive (3.40 ; ± 1.54), regardless of the affected region (ankle, hindfoot, midfoot, or forefoot). This finding highlights the importance of tailoring treatment to control acute pain and suggests a relevant inflammatory and mechanical profile for analgesic choice. Orthopedic surgeries generally result in more postoperative pain than other types of operations²³. Chung, Ritchie and Su²⁴ studied 10,008 patients and found orthopedic procedures led to the highest rates of reported pain. Factors such as body mass index, length of anesthesia, and specific surgery types can predict severe pain, though this study did not find anesthesia type to be influential. Similarly, McGrath et al.²⁵ examined 5,703 patients and noted that outpatient orthopedic procedures ranked among the most painful, with ankle surgeries accounting for two of the seven worst cases.

The clinical trial assessed whether rMPS impacts postoperative pain in foot and ankle surgeries. VAS scores dropped from 5.40 (Day 0) to 0.99 (Day 90), showing significant improvement. BPI scores also decreased from 3.80 to 0.83 over the same period, but variability among patients remained high. AOFAS scores rose from 84.2 (Day 0) to 95.7 (Day 90), also indicating better pain control. rEMP has proven to be a useful tool that can be used in postoperative pain control in foot and ankle surgeries^{10,12,26}. Regarding electromagnetic neuromodulation applied in foot and ankle surgeries, a study

Table 3. Intergroup comparison of VAS, BDI and AOFAS scores on days 0, 5, 14, 30 and 90 postoperatively.

		Mean	Median	SD	Q1	Q3	IQR	N	IC	P-value
VAS 0	Control	4.30	5	3.03	2	6	4	33	1.03	0.005
	Experimental	6.47	6.5	2.72	5	8	3	34	0.91	
VAS 5	Control	3.24	3	2.77	1	5	4	33	0.95	0.034
	Experimental	1.88	1	2.20	0	3	3	34	0.74	
VAS 14	Control	2.45	2	2.35	0	5	5	33	0.80	0.225
	Experimental	1.71	1	1.92	0	3	3	34	0.64	
VAS 30	Control	2.24	2	2.22	0	5	5	33	0.76	0.049
	Experimental	1.18	0	1.64	0	2	2	34	0.55	
VAS 90	Control	1.58	0	1.97	0	3	3	33	0.67	0.006
	Experimental	0.41	0	0.89	0	0	0	34	0.30	
BDI 0	Control	3.14	3	2.28	1.36	4.27	2.91	33	0.78	0.035
	Experimental	4.44	5	2.76	2.79	7	4.21	34	0.93	
BDI 5	Control	2.25	2	1.99	0.9	3	2.1	33	0.68	0.013
	Experimental	1.16	0.36	1.45	0	2.07	2.07	34	0.49	
BDI 14	Control	1.77	1.63	1.72	0	3	3	33	0.59	0.138
	Experimental	1.20	0.95	1.43	0	2	2	34	0.48	
BDI 30	Control	1.55	1.18	1.71	0	2	2	33	0.58	0.135
	Experimental	0.84	0	1.12	0	1.27	1.27	33	0.38	
BDI 90	Control	1.17	0.63	1.67	0	1.63	1.63	33	0.57	0.129
	Experimental	0.50	0	0.71	0	1	1	34	0.24	
AOFAS 0	Control	86.7	90	10.5	80	90	10	33	3.6	0.142
	Experimental	81.8	85	12.9	72.5	90	17.5	34	4.3	
AOFAS 5	Control	90.6	90	9.7	90	100	10	33	3.3	0.017
	Experimental	95.6	100	6.6	90	100	10	34	2.2	
AOFAS 14	Control	89.7	90	9.5	80	100	20	33	3.2	0.001
	Experimental	96.8	100	5.3	90	100	10	34	1.8	
AOFAS 30	Control	90.6	90	9.3	90	100	10	33	3.2	0.001
	Experimental	97.1	100	5.2	92.5	100	7.5	34	1.8	
AOFAS 90	Control	92.7	90	7.6	90	100	10	33	2.6	<0.001
	Experimental	98.5	100	3.6	100	100	0	34	1.2	

Legend: AOFAS: American Orthopaedic Foot and Ankle Society. VAS: Visual Analog Scale. BDI: Brief Pain Inventory. CI: Confidence Interval. CV: Coefficient of Variation. IQR: Interquartile Range. N: Total number. Q1: 1st Quartile. Q3: 3rd Quartile. SD: Standard Deviation. Source: Study author.

Table 4. Comparison between groups for opioid consumption.

		Mean	Median	SD	Q1	Q3	IQR	N	IC	P-value
Opioid 1st week	Control	2.91	2	2.38	1	4	3	33	0.81	0.217
	Experimental	3.62	3	2.44	2	5.75	3.75	34	0.82	
Opioid 2nd week	Control	1.97	2	2.16	0	3	3	33	0.74	0.002
	Experimental	0.50	0	0.75	0	1	1	34	0.25	

Legend: CI: Confidence Interval. IQR: Interquartile Range. N: Total Number. Q1: 1st Quartile. Q3: 3rd Quartile. SD: Standard Deviation. Source: Study author.

by Gerdesmeyer et al.²⁷ evaluated electromagnetic neuromodulation in 53 patients with chronic Achilles tendinopathy, comparing a treated group (80 mT, 3 Hz, 8 sessions) and another using elevation insoles. Both groups showed significant pain reduction, with a greater reduction in the group undergoing neuromodulation (VAS from 6.9 ± 1.3 to 3.6 ± 2.0 ; $p < 0.01$), especially from the 5th day onward. Despite focusing on a chronic condition, the study highlights the effectiveness of neuromodulation in foot and ankle pathologies, reinforcing its potential, even with differences in the clinical contexts analyzed.

Saltzman et al.²⁸ evaluated peripheral electromagnetic neuromodulation as an adjunctive treatment for delayed union in 19 foot and

ankle arthrodeses. Using a protocol with immobilization, limited weight-bearing, and electromagnetic stimulation, they observed low effectiveness of the technique alone, with only 26% success rate (5/19 cases). Although the objective of the current study was different, analyzing postoperative pain, this is one of the few studies in the foot and ankle field.

Tassone et al.²⁹ conducted a randomized, double-blind trial of peripheral electromagnetic neuromodulation in 182 diabetic neuropathy patients, dividing them into experimental (n=92) and control (n=90) groups. The experimental group had a 30% pain reduction, with 48% responding to treatment vs. 28% in control (p<0.05), though opioid use did not differ significantly between groups (p>0.05). Neuromodulation led to quicker and greater pain relief; differences in drug response were attributed to varying conditions analyzed. While the study by Tassone et al. confirmed neuromodulation's effectiveness for chronic peripheral neuropathy, the results of this clinical trial showed its value as an adjuvant in multimodal postoperative analgesia for foot and ankle surgeries involving acute pain. Neuromodulation has thus demonstrated analgesic potential in multimodal analgesia.

Another relevant point to this study concerned the use of opioids. In the total sample (n=67), mean opioid consumption was similar between the CG (2.91±2.38) and EG (3.62±2.44) in the first postoperative week (p=0.217). In the second week, there was a significant reduction in the EG (0.50±0.75) compared to the CG (1.97±2.16), with p=0.002. Electromagnetic neuromodulation contributed to reduced postoperative opioid use, highlighting its role in multimodal analgesia. From a clinical perspective, the reduced need for opioids corroborates

the benefit of neuromodulation, the subject of this study. Opioids are considered an alternative treatment and potentially harmful to health, especially when used for long periods. In this way, EMPr contributes to postoperative safety, in addition to aligning with current guidelines for rationalizing the use of opioids³⁰.

Among the study's limitations are: the scarcity of specific literature investigating the combination of peripheral electromagnetic neuromodulation with postoperative pain control in patients undergoing foot and ankle surgery; the grouping of different types of foot and ankle surgeries into a single group, without differentiating between major and minor procedures, bone versus soft tissue surgeries, or more complex versus simpler interventions; the heterogeneity of peripheral electromagnetic neuromodulation protocols used in the literature represents a significant limitation for the comparative analysis and discussion of the results.

CONCLUSION

Peripheral electromagnetic neuromodulation applied in the postoperative period of foot and ankle surgeries demonstrated efficacy in reducing pain and opioid consumption compared with the control group. The three assessment scores used — VAS, IBD, and AOFAS — showed consistent improvement throughout follow-up, indicating progressive pain relief. The DN4 questionnaire analysis showed that the predominant pain pattern was nociceptive, reinforcing the role of neuromodulation in peripheral modulation of postoperative pain. These findings support the use of this technique as a safe and effective adjuvant strategy for pain management in orthopedic foot and ankle surgeries.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. SJEA: contributed to the study conception, methodological design, execution of the experimental protocol, surgical procedures, data analysis, and final manuscript writing. GLP: contributed to the execution of the experimental protocol and patient follow-up. PGS: contributed to the execution of the experimental protocol and patient follow-up. LSM: contributed to patient recruitment, protocol standardization, and discussion of results. CJA: contributed to project supervision, methodological analysis, and critical revision of the final manuscript.

DATA AVAILABILITY DECLARATION

The underlying contents of the research text are contained in the manuscript.

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EPIDEMIOLOGICAL PROFILE OF CONGENITAL FOOT ANOMALIES IN THE STATE OF BAHIA FROM 2014 TO 2022

PERFIL EPIDEMIOLÓGICO DE ANOMALIAS CONGÊNTAS DO PÉ NO ESTADO DA BAHIA DE 2014 A 2022

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ABSTRACT

Objective: To investigate the epidemiological profile of births of children with congenital foot abnormalities and their associated factors within the Unified Health System (SUS). **Methods:** This study adopts a quantitative, descriptive, and cross-sectional approach, using secondary data from the Live Birth Information System (SINASC), provided by the SUS Department of Informatics (DATASUS). Data from the years 2014 to 2022, related to the State of Bahia, were analyzed. Births with congenital foot malformations were identified through specific ICD-10 codes designating the main diagnosis. **Results:** During the period from 2014 to 2022, Bahia recorded a total of 13,347 cases of congenital anomalies, of which 1,364 were related to congenital foot deformities, among a total of 1,765,439 births, representing a rate of 0.77 cases per 1,000 live births. **Conclusion:** The presented results indicate that male live births, children of mothers with less than 8 years of education, with a gestational age between 22 and 27 weeks, born by cesarean section, and with Apgar scores of less than 6 in the 1st and 5th minutes, are significantly associated with congenital foot malformations. **Level of evidence II; Retrospective study.**

Keywords: Defects, Congenital; Epidemiology; Unified Health System.

RESUMO

Objetivo: Investigar o perfil epidemiológico de nascimentos de crianças com Anormalidades Congêntas do Pé e seus fatores associados no âmbito do Sistema Único de Saúde (SUS). **Métodos:** Este estudo adota uma abordagem quantitativa, descritiva e transversal, utilizando dados secundários provenientes do Sistema de Informação sobre Nascidos Vivos (SINASC), disponibilizados pelo Departamento de Informática do SUS (DATASUS). Foram analisados os dados referentes aos anos de 2014 a 2022, referentes ao Estado da Bahia. Os nascimentos com Malformações Congêntas do pé foram identificados através de códigos específicos da CID-10 que designam o diagnóstico principal. **Resultados:** Durante o período de 2014 a 2022, a Bahia registrou um total de 13.347 casos de anomalias congêntas, dos quais 1.364 foram relacionados a deformidades congêntas nos pés, em meio a um universo de 1.765.439 nascimentos, representando uma taxa de 0,77 casos por cada 1.000 nascidos vivos. **Conclusão:** Os resultados apresentados indicam que nascidos vivos do sexo masculino, filhos de mães com escolaridade inferior a 8 anos, com idade gestacional entre 22 e 27 semanas, nascidos por cesariana e com Apgar no 1º e 5º minutos menor que 6 estão significativamente associados a malformações congêntas do pé. **Nível de evidência II; Estudo retrospectivo.**

Descritores: Anormalidades Congêntas; Epidemiologia; Sistema Único de Saúde.

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INTRODUCTION

Congenital malformations are morphological defects present at birth that can affect the structure of organs or systems, varying widely in severity and complexity. Such defects can significantly impact the functionality and quality of life of the affected individual¹. Among the etiologies of congenital foot deformities are inadequate movement during the gestational period, idiopathic, neurogenic, syndromic, intrinsic, and extrinsic causes, the latter being the most common². The gestational period most vulnerable for limb development, due

to its complexity and exposure to the uterine wall, lies between the 24th and 36th day post-fertilization, this interval being critical for the influence of environmental factors. The diagnosis of these conditions can be made during prenatal care, at birth, or through physical examination of the newborn³.

In the country, data on the prevalence and incidence of Congenital Foot Anomalies in their different types are still underestimated. Currently, it is known that these defects, together with congenital malformations of the musculoskeletal system, account for

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

The study was conducted at the Hospital Regional de Santo Antonio de Jesus.

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<< SUMÁRIO

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approximately 50% of all congenital deformities, since they are more easily detected during physical examination at birth⁴. There is greater emphasis on information about congenital clubfoot or talipes equinovarus, characterized by a deformity of the foot and ankle region, which may include cavus, varus, equinus, and adduction⁵, which is one of the most common congenital deformities, affecting 1 case per 1,000 live births⁶.

On the other hand, the Live Birth Information System (SINASC) provides high-quality data with national coverage^{7,8}, enabling the development of various investigations into perinatal care.

In the state of Bahia, which presents significant disparities in socioeconomic, demographic, and health indicators⁹, there is a favorable setting for conducting relevant studies on congenital foot deformities. Understanding the epidemiological profile of these deformities is essential to improve prenatal diagnosis and implement early and effective therapeutic interventions, aiming at improving children's quality of life.

Therefore, this study aims to investigate the epidemiological profile of births of children with Congenital Foot Anomalies and their associated factors within the Unified Health System (SUS).

METHODS

Study design and context

This is a quantitative epidemiological, cross-sectional study with individual secondary data from SINASC through DATASUS, extracted in 2024. The data refer to the prevalence of births with Congenital Foot Anomalies among live births in the State of Bahia between 2014 and 2022. This period was chosen because, at the time of extraction, no information was available for dates after 2022. This state has a territorial area of 567,295 km² divided into 417 municipalities with 9 health macro-regions. In 2022, the estimated number of live births was 171,272.

Study population

The study population consisted of individuals born alive between January 2014 and December 2022 who were registered in SINASC. The following congenital foot deformities were included in the study, classified according to codes within the range (Q660–Q669) of the Live Birth Declaration form, which contains the list of congenital malformation or anomaly codes, coded using the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10). Cases with incomplete or inconclusive data were excluded.

Data collection instrument

The database used is publicly available; data are collected and processed by the Ministry of Health, therefore personal identification data were not included. The information repository has a high coverage of live birth information, representing more than 90% of births occurring in the country⁷. The Live Birth Declaration form (DNV) is the basic data collection instrument, which must be mandatorily completed by healthcare professionals responsible for attending the newborn during the birth period. Data are extracted from hospital maternity medical records and entered into the electronic system by trained staff.

Other covariates investigated

Among the variables applied, sociodemographic, economic, and clinical history characteristics of probable factors associated with congenital foot deformities were included, as reported through the DNV. The following variables were considered: place of birth occurrence (hospital, home, other establishment); maternal age (in years), marital status (with partner/without partner), level of education (none, primary school, higher education, unknown),

mother's health region of residence, type of delivery (vaginal or cesarean), sex (male or female), Apgar score at the first and fifth minute, race/color (Black and non-Black), weeks of gestation, type of pregnancy.

Statistical analysis

The prevalence of Congenital Foot Anomaly cases among live births was determined through descriptive statistics, obtaining simple and relative frequencies, as well as the chi-square test χ^2 to assess the association of categorical variables of interest, with a statistically significant level set at p-values less than 0.05. The prevalence ratio (PR) and its respective 95% confidence interval (95% CI) were also obtained for comparisons between the described variables of interest and Congenital Foot Anomaly cases. For this purpose, the statistical software STATA (Data Analysis and Statistical Software) was used.

RESULTS

During the period from 2018 to 2022, Bahia recorded a total of 13,347 cases of congenital anomalies, of which 1,364 were related to congenital foot deformities, among a total of 1,765,439 births, representing a rate of 0.77 cases per 1,000 live births.

When examining the socioeconomic-demographic characteristics of live births in the bivariate analysis, the highest prevalences of congenital foot anomalies were observed among male individuals, with 1,006 cases (1.11/1,000 live births) PR 1.42, 95% CI (1.29; 1.47); non-Black individuals in terms of race/color, with 161 cases (1.08/1,000 live births) PR 1.10, 95% CI (0.93; 1.29); those born in other establishments (neither hospitals nor other healthcare facilities), with 6 cases (1.34/1,000 live births) PR 1.40, 95% CI (0.62; 3.11); those born by cesarean section, with 872 cases (1.10/1,000 live births) PR 1.30, 95% CI (1.19; 1.44); those with 1st-minute Apgar < 06, with 281 cases (3.95/1,000 live births) PR 4.48, 95% CI (1.12; 5.33); and 5th-minute Apgar also < 06, with 108 cases (6.92/1,000 live births) PR 7.52, 95% CI (6.19; 9.14), as shown in Table 1.

Furthermore, when examining the prevalence of congenital foot deformities according to maternal and gestational characteristics, the highest records were noted among individuals whose mothers had no partner, with 830 cases (1.00/1,000 live births) PR 1.08, 95% CI (0.98; 1.19); with less than 08 years of schooling, with 1,225 cases (2.91/1,000 live births) PR 8.64, 95% CI (7.44; 9.64); with gestational age of 22 to 27 weeks, with 30 cases (3.11/1,000 live births) PR 2.04, 95% CI (2.14; 4.39); and with twin pregnancy, with 45 cases (1.26/1,000 live births) PR 1.33, 95% CI (0.99; 1.78), as illustrated in Table 1.

Among congenital foot anomalies, the most prevalent were other deformities, totaling 687 cases (40.5/1,000 live births), followed by unspecified deformities, with 259 cases (15.3/1,000 live births). Subsequently, 217 cases (12.8/1,000 live births) of clubfoot calcaneovalgus and 215 cases (12.7/1,000 live births) of clubfoot equinovarus were observed, as indicated in Table 2.

DISCUSSION

The prevalence of congenital foot deformities found in the present study was 0.77 cases per 1,000 live births, a coefficient slightly lower than that obtained in the investigation of Congenital Clubfoot in a population-based study in European countries, which was 0.92 cases per 1,000 live births¹⁰. Furthermore, it is lower than the prevalence of 2 cases per 1,000 live births observed in research covering the entire national territory¹¹. These data do not rule out the hypothesis of persistent underreporting in the Live Birth Declaration (DNV) field, even after comparing the validity of congenital defect

Table 1. Prevalence of congenital foot malformations according to sociodemographic and obstetric characteristics. Bahia, January 2014 to December 2022. (n=1364)

Variables	n (prevalence/1,000 live births)	PR (95% CI)	P-Value
Sex			
Male	1,006 (1.11)	1.42 (1.29;1.57)	<0.05
Female	675 (0.78)		
Race/color			
Black	1,475 (0.98)		
Non-Black	161 (1.08)	1.10 (0.93; 1.29)	>0.05
Mother's race/color			
Black	1,455 (0.98)		
Non-Black	161 (1.10)	1.12 (0.95;1.32)	>0.05
Place of birth occurrence			
Hospital	1,627 (0.96)	0.98 (0.70;1.14)	>0.05
Other healthcare facility	51 (1.04)	1.09 (0.82; 1.44)	>0.05
Home	9 (1.03)	1.07 (0.56; 2.06)	>0.05
Other	6 (1.34)	1.40 (0.62; 3.11)	>0.05
Mother's marital status			
With partner	820 (0.92)		
Without partner	830 (1.00)	1.08 (0.98; 1.19)	>0.05
Mother's education (years)*			
≥8	430 (0.34)		
<8	1,225 (2.91)	8.64 (7.44; 9.64)	< 0.05
Weeks of gestation			
< 22 weeks	4 (2.86)	2.78 (1.04;7.41)	< 0.05
22 to 27 weeks	30 (3.11)	3.04 (2.14; 4.39)	< 0.05
28 to 31 weeks	49 (2.63)	2.60 (1.96; 3.50)	< 0.05
32 to 36 weeks	270 (1.70)	1.77 (1.55;2.01)	< 0.05
37 to 41 weeks	1,332 (0.92)	0.57 (0.51;0.64)	< 0.05
≥42 weeks	58 (0.97)	0.84 (0.65; 1.09)	
Type of pregnancy			
Single	1,639 (0.95)		
Twin	45 (1.26)	1.33 (0.99; 1.78)	>0.05
Type of delivery			
Vaginal	815 (0.84)		
Cesarean	872 (1.10)	1.30 (1.19;1.44)	<0.05
Apgar 1			
< 6	281 (3.95)	4.48 (1.12; 5.33)	<0.05
≥ 6	1,362 (0.84)		
Apgar 5			
< 6	108 (6.92)	7.52 (6.19;9.14)	<0.05
≥ 6	1,535 (0.92)		

Source: Live Birth Information System (SINASC), 2022.

cases reported in the Live Birth Information System in Brazil and the observed improvement in SINASC data quality, as rates still fall below the actual figures^{7,12}.

In this study, higher prevalences of congenital foot malformations were found among male individuals, with a rate of 1.11 per 1,000 live births. These results corroborate findings from previous research on all congenital malformations, highlighting the need for a more in-depth examination of the intrinsic (genetic) factors that influence this population¹³. The association between congenital foot deformities and cesarean deliveries, evidenced in other studies, suggests a preferential medical indication for cesarean section following a diagnosis of congenital malformation. This scenario is heightened by the high rate of cesarean deliveries performed in

Table 2. Distribution of the prevalence of Congenital Foot Deformities, according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10). Bahia, January 2014 to December 2022.

Congenital foot anomaly	n(%)
Q660 - Clubfoot equinovarus	215 (12.7)
Q661 - Clubfoot calcaneovalgus	103 (6.1)
Q662 - Metatarsus varus	-
Q663 - Other congenital varus deformities of the feet	45 (2.7)
Q664 - Clubfoot calcaneovalgus	217 (12.8)
Q665 - Congenital flat foot	106 (6.3)
Q666 - Other congenital valgus deformities of the feet	45 (2.7)
Q667 - Pes cavus	5 (0.3)
Q668 - Other congenital deformities of the foot	687 (40.5)
Q669 - Congenital deformity of the foot, unspecified	259 (15.3)

Source: Live Birth Information System (SINASC), 2022.

the state capital, which exceeds the averages of the other states in the country^{14,15,16}.

Among adverse birth outcomes, a significant association was observed between congenital foot anomaly and unsatisfactory Apgar scores at the first and fifth minute, as well as prematurity, as demonstrated in studies using different methodological approaches conducted in the country¹⁷. Another hypothesis for this finding is based on the condition that individuals subjected to this exposure are allocated to higher-complexity care units, such as the Intensive Care Unit, where they receive more detailed investigation and, consequently, are less underdiagnosed¹⁸.

The slight increase in congenital foot defect coefficients among children of mothers without partners and the high prevalence among children of mothers with low levels of education point to a possible association between socioeconomic factors and the outcome in question. This is because mothers with less social and educational support may be exposed to additional adversities during the gestational period, such as reduced access to health services and inadequate, low-quality prenatal care^{19,20}, which have been considered factors associated with congenital deformities²¹.

In contrast, Black live births and children of Black mothers had a lower prevalence of the outcome in question, but this was not a conclusive association. This does not rule out the aforementioned hypothesis, as Black pregnant women also face vulnerabilities regarding access to health services²².

Furthermore, the higher coefficients among twin pregnancies and congenital foot deformities, and among those born in establishments other than home or healthcare facilities, suggest a risk factor, though not a significant one.

Despite the limitations of this study, such as the cross-sectional design and the use of publicly available secondary data, which restrict the generalization of the results, this investigation is relevant for highlighting the epidemiological distribution of congenital foot malformation cases and their associated factors, a context that is little explored in countries such as Brazil. Furthermore, for interpreting the results, it is unnecessary to consider the aggregate effect known as the ecological fallacy, since the statistical analyses were performed on individual-level data, reducing distortions in the findings.

Therefore, it is suggested that more robust investigations on the subject be conducted, especially regarding sociodemographic, gestational, neonatal, and modifiable predictive factors. Such studies could identify preventable factors that deserve greater attention from healthcare professionals, management teams, and the families of affected individuals.

CONCLUSION

The presented results indicate that male live births, children of mothers with less than 8 years of education, with a gestational age between 22 and 27 weeks, born by cesarean section, and with Apgar scores of less than 6 in the 1st and 5th minutes, are significantly associated with congenital foot malformations. However, these data should be interpreted with caution, as they come from publicly available secondary sources and reflect the resource limitations typical of regions in northeastern Brazil. Although this study is specific to the State of Bahia and has its respective limitations,

it is believed that the conclusions may be applicable to states with similar population profiles.

These data highlight the importance of interventions directed at specific risk groups for the prevention and early detection of congenital malformations. Furthermore, they underscore the need for public policies aimed at improving maternal education and ensuring adequate prenatal follow-up, especially in high-risk pregnancies, in order to mitigate the extrinsic factors associated with the development of these conditions.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. PFSJ: writing of the article, review, and data collection; AAM: data analysis, writing of the article, and preparation of the entire research project; JPFPA: statistical analysis, review of the article, and also the entire intellectual concept of the article; JNS: spelling analysis and data review; RPB: writing and review of the article.

DATA AVAILABILITY DECLARATION

The contents underlying the research text are available upon reviewers' request.

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CLINICAL OUTCOMES OF ACL RECONSTRUCTION WITH THREE DIFFERENT AUTOGRAFTS

RESULTADOS CLÍNICOS DA RECONSTRUÇÃO DO LCA COM TRÊS DIFERENTES AUTOENXERTOS

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ABSTRACT

Objective: To compare short-term clinical and functional outcomes (0–6 months) of Anterior Cruciate Ligament (ACL) reconstruction using rectus femoris autograft versus established graft options. **Methods:** Prospective cohort study (Level II) including 35 patients who underwent ACL reconstruction between 2024 and 2025. Pain, Lysholm score, and range of motion (ROM) were assessed preoperatively, on post-operative day (POD) 1, POD 15, and at six months. Statistical analysis included ANOVA, Kruskal–Wallis tests, and linear mixed-effects models ($\alpha = 0.05$). **Results:** The sample (15 hamstring, 11 rectus femoris, and 9 patellar tendon grafts) was homogeneous ($p > 0.05$). Significant improvements over time were observed in Lysholm scores ($p < 0.001$) and knee flexion ROM ($p < 0.001$), with no influence of graft type ($p = 0.167$ and $p = 0.177$, respectively). On POD 1, pain scores were similar among groups ($p = 0.701$), with mean Visual Analog Scale (VAS) values of 2.20 (hamstrings), 2.18 (rectus femoris), and 1.78 (patellar tendon). On POD 15, mean pain scores were 1.27, 1.73, and 3.00, respectively, remaining statistically comparable ($p = 0.149$). **Conclusion:** ACL reconstruction using the rectus femoris autograft demonstrates clinical and functional outcomes equivalent to patellar tendon and hamstring grafts within the first six months postoperatively. **Level of Evidence II; Prospective cohort study.**

Keywords: Anterior Cruciate Ligament; Anterior Cruciate Ligament Reconstruction; Knee; Patellar Ligament; Tendons; Quadriceps Muscle.

RESUMO

Objetivo: Comparar resultados clínico-funcionais (0–6 meses) da reconstrução do Ligamento Cruzado Anterior (LCA) utilizando autoenxerto do reto femoral em relação aos enxertos já consagrados. **Métodos:** Estudo de coorte prospectivo (Nível II) com 35 pacientes operados entre 2024–2025. Avaliaram-se dor, escala de Lysholm e amplitude de movimento (ADM) no pré-operatório, 1º e 15º dias pós-operatórios (DPO) e após seis meses. A análise incluiu testes ANOVA, Kruskal–Wallis e modelos lineares mistos ($\alpha = 0,05$). **Resultados:** A amostra (15 flexores, 11 reto femoral, 9 patelar) foi homogênea ($p > 0,05$). Observou-se melhora significativa na Lysholm ($p < 0,001$) e ADM de flexão ($p < 0,001$) ao longo do tempo, sem influência do tipo de enxerto ($p = 0,167$ e $p = 0,177$, respectivamente). No 1º DPO, a dor foi semelhante entre grupos ($p = 0,701$), com médias de 2,20 (flexores), 2,18 (reto femoral) e 1,78 (patelar) segundo Escala Visual Analógica (EVA). No 15º DPO, as médias foram 1,27, 1,73 e 3,00, respectivamente, mantendo a semelhança estatística ($p = 0,149$). **Conclusão:** O emprego do enxerto de reto femoral apresenta resultado clínico-funcional equivalente aos de tendão patelar e flexores nos primeiros seis meses. **Nível de Evidência II; Coorte prospectivo.**

Descritores: Ligamento Cruzado Anterior; Reconstrução do Ligamento Cruzado Anterior; Joelho; Ligamento Patelar; Tendões; Músculo Quadríceps.

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INTRODUCTION

Rupture of the anterior cruciate ligament (ACL) is one of the most frequent and clinically relevant ligamentous injuries of the knee, particularly in young and physically active individuals, being associated with joint instability, functional limitation, and inability to engage in sports.^{1,2} In such cases, surgical reconstruction has been established as the treatment of choice to restore stability, allow a

safe return to functional and sports activities, and reduce the risk of early joint degeneration.^{3,4}

Traditionally, the most commonly used autografts include the patellar tendon and the hamstring tendons, widely validated techniques that are, however, associated with donor-site morbidity, such as anterior knee pain, discomfort when kneeling, and possible specific strength deficits.^{3,5,6} In recent years, the use of the rectus femoris tendon graft,

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<< SUMÁRIO

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as a variation of the quadriceps tendon graft, has attracted growing interest owing to its favorable biomechanical properties, adequate tensile strength, satisfactory diameter, and potential for lower functional impact on the donor region, with increasing application in combined reconstructions and surgical revisions.^{1,4,7,8}

However, despite the expansion of graft options, there is still no definitive consensus regarding the superiority of one graft type over the others in terms of functional outcomes, pain, and stability, and the literature remains divergent when comparing the patellar tendon, hamstring tendons, and quadriceps grafts.^{2,5,6} While some studies associate the patellar graft with a higher incidence of anterior knee pain, others suggest specific strength deficits related to the hamstring tendons, without consistent demonstration of functional superiority among the techniques.^{3,6,9} In this context, it becomes relevant to compare, within the same cohort, the clinical and functional outcomes of ACL reconstruction with rectus femoris tendon, patellar tendon, and hamstring tendon autografts, in order to support a more individualized and evidence-based surgical choice.

MATERIALS AND METHODS

Study design

This is a prospective, observational cohort study conducted at a referral university hospital between 2024 and 2025.

Participants

Patients of both sexes, aged between 18 and 50 years, with complete primary ACL rupture and an indication for surgical reconstruction were included. All procedures were performed by surgeons from the same team, following a standardized technique. Patients with ACL re-rupture, multiligamentous injuries, the need to use more than one graft type, and those who did not complete the planned postoperative follow-up were excluded.

Study groups

Patients were allocated into three groups according to the graft type used in the reconstruction, namely: rectus femoris tendon graft; patellar tendon graft; and hamstring tendon graft. The graft choice was defined by individualized clinical criteria, integrating the surgeon's experience and shared decision-making with the patient, while respecting the anatomical and functional particularities of each individual.

Clinical and functional assessment

The assessments were performed preoperatively and at standardized postoperative follow-up at one day, 15 days, and 6 months after the procedure. Accordingly, criteria such as pain, measured using the VAS,¹⁰ knee function, assessed by the Lysholm score,¹¹ range of motion, measured by goniometry,¹² and joint stability, assessed by the Lachman, anterior drawer, and pivot shift tests, were analyzed.

Statistical analysis

Continuous variables were described as mean and standard deviation or median and interquartile range, according to their distribution. Categorical variables were presented as absolute and percentage frequencies. Normality was verified using the Shapiro–Wilk test. For comparison of baseline characteristics among the graft groups, Pearson's chi-square or Fisher's exact tests were used for categorical variables, and one-way ANOVA or Kruskal–Wallis for continuous variables, according to normality. The evolution of active flexion and extension range of motion of the operated knee was assessed using linear mixed-effects models, considering time and graft type as fixed effects and the patient as a random effect, with analysis of the interaction between graft and time.

When pertinent, pairwise comparisons between grafts were performed at each assessment time point, based on the estimated marginal means, using t-tests with Bonferroni adjustment. The Lysholm score (preoperative and six months) was also analyzed using a linear mixed-effects model with the same effects. Postoperative pain intensity, given its non-normal distribution, was compared between groups using the Kruskal–Wallis test. A 95% confidence interval (CI) was adopted, with a significance level of 5% ($\alpha = 0.05$). Analyses were performed using R software.

Ethical aspects

The study was approved by the Research Ethics Committee (opinion No. 7,053,125; CAAE: 82397724.0.0000.5134), and all participants signed the Free and Informed Consent Form.

RESULTS

A total of 35 patients who underwent anterior cruciate ligament (ACL) reconstruction were evaluated, of whom 15 (42.9%) received a hamstring tendon graft, 11 (31.4%) a rectus femoris graft, and 9 (25.7%) a patellar graft. The mean age of the sample was 31.0 ± 10.9 years, with no statistically significant difference among groups ($p = 0.981$). A predominance of males was observed (80.0%), with a similar distribution among graft types ($p = 0.220$).

No statistically significant differences were identified among groups regarding self-reported skin color ($p = 0.187$), smoking ($p = 0.699$), alcohol consumption ($p = 0.860$), or body mass index class ($p = 0.715$), demonstrating comparability among the demographic, clinical, and anthropometric characteristics of the sample.

In the preoperative period, the active extension range of motion (ROM) of the operated knee showed medians equal to 0° in all groups, with no statistically significant difference ($p = 0.262$). Similarly, the preoperative scores of the Lysholm functional scale were similar among groups ($p = 0.527$), indicating a comparable initial functional condition (Figure 1).

On the first postoperative day (POD 1), the active flexion ROM showed medians of 70° (interquartile range - IQR: 45° – 85°) in the hamstring group, 90° (IQR: 55° – 100°) in the rectus femoris group, and 90° (IQR: 85° – 90°) in the patellar group. Although the hamstring group presented numerically lower values, the inferential analysis did not demonstrate statistically significant differences among the graft types ($p = 0.301$). The estimated mean differences were -12.97° ($p = 0.164$) between hamstring and rectus femoris, and -15.00° ($p = 0.110$) between hamstring and patellar (Figures 2 and 3).

Regarding active extension on POD 1, all groups maintained medians of 0° , full extension, with no evidence of statistical disparity

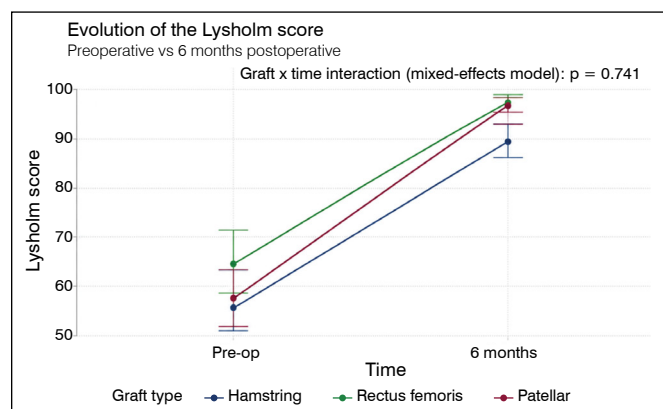


Figure 1. Evolution of the Lysholm functional score from the preoperative period to six months after anterior cruciate ligament reconstruction, according to graft type.

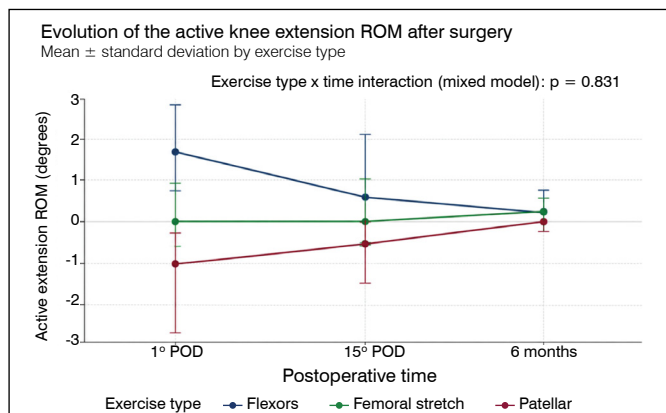


Figure 2. Evolution of the active extension range of motion of the operated knee throughout the postoperative period, according to graft type.

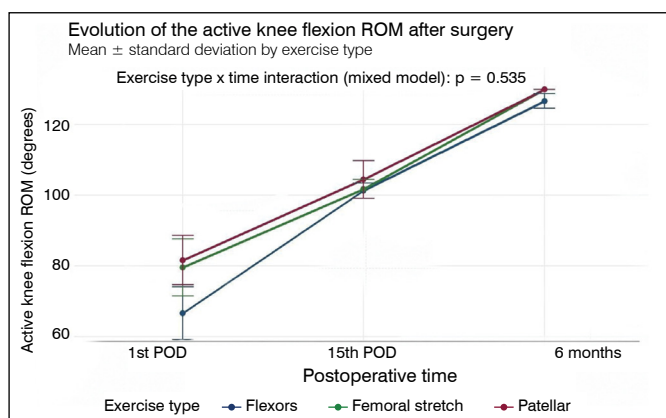


Figure 3. Evolution of the active flexion range of motion of the operated knee throughout the postoperative period, according to graft type.

($p = 0.217$). Pairwise comparisons confirmed this similarity, with estimated differences ranging from 1.11° to 2.78° , encompassing the null value in all comparisons. Longitudinal analysis using linear mixed-effects models revealed a progressive and significant recovery of ROM throughout follow-up (time effect: $p < 0.001$). However, the clinical trajectory was not influenced by the graft type used, as indicated by the absence of a significant graft-by-time interaction for flexion ($p = 0.535$) and extension ($p = 0.831$) (Figures 2 and 3). Analysis of the Lysholm functional scale demonstrated a significant improvement in scores at six months postoperatively in all groups compared with the preoperative period ($p < 0.001$). However, no statistically significant differences were observed among groups, either in the main effect of the graft ($p = 0.167$) or in the graft-by-time interaction ($p = 0.742$).

Postoperative pain intensity, assessed by the VAS (1 to 10), remained low throughout the entire follow-up. On the first postoperative day, mean pain scores were similar among groups ($p = 0.701$), with values of 2.20 (SD = 1.74) for the hamstring group, 2.18 (SD = 1.40) for the rectus femoris group, and 1.78 (SD = 1.30) for the patellar group. At 15 days postoperatively, a global reduction in pain was observed, with means of 1.27 (SD = 0.59), 1.73 (SD = 1.27), and 3.00 (SD = 3.08), respectively, with no statistically significant differences among groups ($p = 0.149$). At six months, pain scores remained low and comparable among groups ($p = 0.102$). Overall, all groups showed satisfactory clinical and functional progression, with progressive recovery of mobility, significant functional improvement, and low pain intensity, without statistically significant differences related to the graft type used.

DISCUSSION

Historically, the patellar graft was considered the gold standard for ACL reconstruction, especially in athletes with high functional demand, owing to its high biomechanical strength and the favorable bone integration provided by the bone–tendon–bone model.¹ However, despite good results in terms of joint stability, its use is associated with a higher incidence of anterior knee pain, discomfort when kneeling, and greater donor-site morbidity, factors that may negatively impact patient satisfaction.⁴

Hamstring tendon grafts came to be widely used as an alternative to the patellar graft precisely because of the lower incidence of anterior knee pain; nevertheless, studies indicate a possible association with specific muscle strength deficits and, in some cases, subtle differences in rotational control, especially in patients with high sports demand.⁹ Thus, although they offer advantages regarding donor-site morbidity, the functional superiority of hamstring tendons over other grafts remains controversial.⁹

The results of the present study, referring to the evaluated period of 0 to 6 months, demonstrate that anterior cruciate ligament (ACL) reconstruction with the rectus femoris tendon graft provides clinical and functional outcomes comparable to those obtained with patellar tendon and hamstring tendon grafts. Consistently, all groups showed significant improvement in knee function and adequate recovery of range of motion, without statistically significant differences among graft types throughout follow-up. These findings reinforce the hypothesis that, from a functional standpoint, the main autografts currently used in ACL reconstruction show similar performance, as suggested by recent literature reviews.³

In this scenario, the rectus femoris tendon graft has stood out as a viable alternative, presenting adequate biomechanical properties, good diameter and tensile strength, in addition to good surgical reproducibility.⁶ Studies also indicate lower donor-site morbidity, especially regarding anterior knee pain and difficulty kneeling, when compared with the patellar graft, without compromising joint stability or increasing failure rates.¹³ The findings of the present study are consistent with this perspective, since no significant differences were observed in functional outcomes, recovery of mobility, or postoperative pain intensity among the three graft types evaluated. The absence of statistically significant differences among groups regarding postoperative pain suggests that, although the literature describes distinct patterns of donor-site morbidity among grafts, these differences do not always translate into relevant clinical impact in the short and medium term.^{2,11} In addition, the similar evolution of range of motion, measured by goniometry, and of functional scores indicates that the rehabilitation process was effective regardless of the graft used, corroborating the idea that functional recovery depends not only on the graft type but also on the surgical technique, the rehabilitation protocol, and patient adherence.^{14,15}

Among the limitations of this study, the relatively small sample size and the follow-up time limited to six months stand out, which precludes assessing long-term outcomes such as return to sport at the pre-injury level, graft failure, and the development of degenerative knee changes. Previous studies demonstrate that a significant proportion of patients undergoing ACL reconstruction do not return to the same sports level after a few years, regardless of the graft used, which reinforces the importance of investigations with larger samples and prolonged follow-up.¹⁶

CONCLUSIONS

The results of this study show that anterior cruciate ligament reconstruction with the rectus femoris tendon graft presents clinical and functional progression similar to that observed with patellar

tendon and hamstring tendon grafts. Regardless of the graft type used, patients showed satisfactory functional improvement, adequate recovery of range of motion, and low pain levels during the evaluated period.

Therefore, the choice of graft for ACL reconstruction should be individualized, considering the patient's characteristics, their functional

demands, and the surgeon's experience. In light of the findings of this study, the patellar tendon, hamstring tendons, and rectus femoris tendon constitute safe and effective options in the short and medium term. Studies with larger samples and prolonged follow-up are necessary to assess the durability of the results, the return to sports activities, and the long-term safety of the different grafts.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. TCC: data curation, investigation. MOC: data curation, investigation. LFMS: data curation, investigation, writing – original draft. MTV: data curation, investigation, writing – original draft. LGFF: supervision, project administration, validation, writing – review and editing. GBM: supervision, project administration, validation, writing – review and editing.

DATA AVAILABILITY DECLARATION

The contents underlying the research text are available upon reviewers' demand/request.

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COMPARATIVE EVALUATION OF FIRST- AND ADAPTED SECOND-GENERATION BONE CEMENTATION IN POST-CURETTAGE BONE DEFECT FILLING IN AN ANIMAL MODEL

COMPARAÇÃO ENTRE CIMENTAÇÃO DE PRIMEIRA E DE SEGUNDA GERAÇÃO ADAPTADA PARA PREENCHIMENTO DE FALHAS ÓSSEAS PÓS-CURETAGEM EM MODELO ANIMAL

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ABSTRACT

Introduction: Bone cementation is fundamental for orthopedic stability, and different techniques have been proposed to optimize the bone–cement interface. **Objective:** To evaluate whether adapted second-generation cementation improves osteointegration compared with the first-generation technique. **Methods:** Bone defects created in the femora and tibiae of goats were filled with polymethylmethacrylate using either the first-generation technique (Group 1) or an adaptation of the second-generation technique (Group 2). Cementation quality and the bone–cement interface were assessed by radiography, CT, and photographic analysis, evaluated by orthopedic examiners. Statistical analyses employed the chi-square and Mann–Whitney U tests. **Results:** No statistical differences were observed between the groups regarding cementation quality (radiography and CT) or osteointegration (photographic analysis) ($p > 0.05$). On CT, the mean number of bubbles was higher in the second-generation (6.05 vs. 3.95), whereas the proportion of samples with ≥ 5 bubbles was higher in the first-generation (50% vs. 30%). Photographic analysis showed that the second-generation group had a higher mean number of interdigitations (2.4 vs. 1.6) and a greater frequency of rough interfaces (50% vs. 25%). However, the first-generation group presented greater interdigitation depth (0.40 mm vs. 0.35 mm). **Conclusion:** Adapted second-generation cementation showed no clear advantage over the first-generation technique. **Level of evidence II; Investigation of treatment outcomes in an animal model.**

Keywords: Bone Cements; Curettage; Polymethyl Methacrylate; Bone Neoplasms.

RESUMO

Introdução: A cimentação óssea é fundamental para a estabilidade ortopédica, e diferentes técnicas têm sido propostas para otimizar a interface osso-cimento. **Objetivo:** Avaliar se a cimentação de segunda geração adaptada promove melhor osteointegração que a técnica de primeira geração. **Métodos:** Falhas ósseas produzidas em fêmures e tíbias de caprinos foram preenchidas com polimetilmetacrilato por técnica de primeira geração (Grupo 1) ou por adaptação da segunda geração (Grupo 2). A interface osso-cimento foi analisada por radiografia, TC e fotografias por ortopedistas. As análises estatísticas empregaram os testes qui-quadrado e Mann-Whitney U. **Resultados:** Não houve diferenças estatísticas entre os grupos quanto à qualidade da cimentação (RX e TC) ou à osteointegração (análise fotográfica) ($p > 0,05$). Na TC, a média de bolhas foi maior na segunda geração (6,05 vs. 3,95), mas a proporção de amostras com ≥ 5 bolhas foi superior na primeira (50% vs. 30%). Nas fotografias, a segunda geração apresentou maior número médio de interdigitações (2,4 vs. 1,6) e maior frequência de interfaces rugosas (50% vs. 25%); no entanto, a profundidade média das saliências foi maior no grupo da primeira geração (0,40 mm vs. 0,35 mm). **Conclusão:** A cimentação de segunda geração adaptada não demonstrou vantagens sobre a de primeira geração. **Nível de evidência II; Investigação dos resultados de tratamento em modelo animal.**

Descritores: Cimentos Ósseos; Curetagem; Polimetil Metacrilato; Neoplasias Ósseas.

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The study was conducted at the Department of Orthopedics and Anesthesiology, Hospital das Clínicas, Ribeirão Preto Medical School (HCFMRP), Universidade de São Paulo (USP), Ribeirão Preto, SP, Brazil.

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<< SUMÁRIO

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INTRODUCTION

Benign bone tumors exhibit variable histological aspects and biological behaviors. Although rarely lethal, they can result in significant changes to bone architecture with potential mechanical weakening^{1,2}. Among the various therapeutic possibilities, curettage, associated with adjuvant techniques that extend the necrosis of neoplastic cells beyond the curetted margins, is the most frequent treatment option, as it reduces the local recurrence rate and offers good functional results³⁻⁷. Orthopedic cement or polymethylmethacrylate (PMMA) is used both for filling and mechanically stabilizing bone defects created by curettage, as well as for its adjuvant action⁴⁻⁷.

Cementation in orthopedics was introduced by Sir John Charnley in 1958 for the fixation of the femoral and acetabular components in total hip arthroplasty⁸⁻¹⁰. The first-generation cementation technique, known as “finger packing”, involved the manual mixing of the cement and its insertion into the medullary canal by finger pressure⁸. During the 1980s, the technique was refined to provide greater pressure during its insertion. Low-viscosity cement began to be introduced retrogradely, after careful cleaning and occlusion of the medullary canal, with the aid of a syringe and gun^{9,11}. These adaptations and improvements defined the second-generation cementation, reducing the presence of blood at the bone-cement interface and improving the penetration of the cement into the bone pores⁸. Pressurization during application resulted in greater integration of the materials and better mechanical stability, with lower rates of loosening of the prosthetic components and a reduced need for surgical revisions¹². In the field of orthopedic oncology, the use of PMMA for filling cavities after curettage was first described in 1969, in the treatment of giant cell tumors (GCT)^{13,14}. With successful application, the technique has been expanded to treat other benign tumors¹⁵. In addition to being an accessible and low-cost material, with a simple application technique for filling irregular bone defects, cementation provides mechanical stability, and in subchondral lesions, it preserves joint mobility^{16,17}. The cement completely fills the cavity without leaving dead space, offers immediate support, preventing collapse, and also penetrates the bone, forming interdigitation that provides better coupling at the bone-cement interface^{14,18,19}. The adjuvant action of PMMA results from polymerization, which is an exothermic reaction and causes tissue necrosis up to 2–3 mm deep, providing better control of recurrences^{18,20,21}.

Despite advances in cementation techniques, the first generation is still universally used for filling irregular cavities after curettage. However, loosening of the cement block is a frequent complication, resulting in the formation of a fibrous tissue membrane between the bone and the cement, radiographically characterized by a radiolucent halo²²⁻²⁵. Several causes are related to this loosening, such as cementation technique, preparation of the receiving bed, thermal necrosis, and mechanical incompatibility²⁶. Therefore, it is possible that the application of cement in a lower viscosity state and under high pressure, with benefits already well established in the context of arthroplasties, may replicate good results in oncology^{9,27}. The objective of this study is to evaluate, in an animal model, whether adapting the second-generation technique for post-curettage defects can improve the initial quality of cementation, increasing integration at the bone-cement interface.

MATERIALS AND METHODS

In this experimental animal study, with approval from the Animal Ethics Committee (CEAU) of the *Campus* of Ribeirão Preto-USP (Protocol No. 06.1.254.53.0), defects were created in the femurs and tibias of sheep to simulate the curettage of bone tumors. These defects were then filled with bone cement, using the first-generation technique in group 1 and an adapted second-generation technique in group 2. The quality of cementation was evaluated based on

parameters such as interdigitation between the cement and the bone, the presence of spaces between both, and the amount of air bubbles in the cement, analyzed through radiographs, computed tomography, and photographs of the specimens.

Each group consisted of 10 young sheep of the same sex of the Santa Inês breed²² that, after intravenous anesthesia with ketamine and xylazine, asepsis, and lateral incision of the knee, underwent the creation of cubic bone defects of 15 mm on each side (3.375 cm³) in the metaepiphyseal regions of the femur and tibia, followed by abundant washing with 0.9% saline solution and 0.1% heparin until the macroscopic elimination of clots.

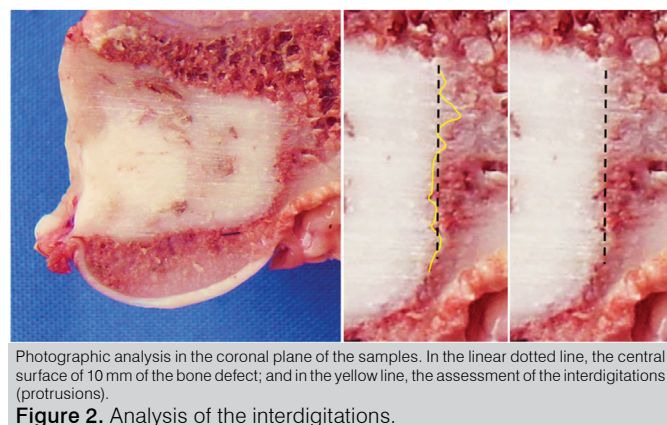
In group 1, the cavities were filled using the first-generation cementation technique, with the application of orthopedic cement (PMMA) (C-MAXXX®, Cimtech®, Rio Claro, Brazil) in a higher viscosity state – after the setting time – inserted manually and compacted with fingers. In group 2, an adaptation of the second-generation cementation was used. PMMA was applied in a lower viscosity state – before the setting time, still in the liquid phase – followed by pressurization using two surgical gloves (one inside the other) filled with water that occluded the bone window and transmitted the pressure applied in the glove to the cement. In this way, an attempt was made to occlude the bone window while simultaneously increasing the pressure inside the cavity, pushing the cement into the pores of the bone. The pressure of the glove against the opening was maintained until the cement fully cured.

After the procedure, the animals were euthanized, and the bone segments containing the cemented cavities were resected. These segments underwent simple radiographic examination (X-ray) and computed tomography (CT) (Figure 1A). Subsequently, the segments were sectioned in the coronal plane, cleaned, and photographed with a high-resolution digital camera.

The quality of the bone-cement interface was evaluated based on two parameters in the radiographs and tomographies: the presence of space between the bone and the cement, referred to as a “lacuna,” and the appearance of the interface between the materials, called “transition.” The transition was classified as abrupt, with a clear distinction between the bone and the cement, or smooth, indicating better interdigitation of the cement into the bone (Figure 1B). Additionally, the presence and appearance of the interdigitation (penetration of the cement into the pores of the trabecular bone) were analyzed in photographs. To standardize the evaluation, the central 10 mm of the deep face of the cubic bone defect was examined. With the aid of the ImageJ program (version 1.49, U.S. National Institutes of Health, Bethesda, Maryland, USA), a mean line was drawn along the perimeter of the cement and another line parallel to the initial one, outlining the interdigitation perpendicular to the initial line. Each deviation from the mean line was considered a prominence. The number of prominences and their size in mm were quantified (Figure 2). The penetration of the interdigitation in the piece was also considered as “deep” (average size of the prominences ≥ 0.5 mm) or “superficial.” Finally, a parameter was created for the classification of the interface in the CT and in the photograph, as “rough” (many prominences, ≥ 3) or “smooth.” To assess the quality of the cement production, the number of bubbles present in the cement block was measured.

All images were analyzed blindly and independently by two to three experienced orthopedic examiners.

For data evaluation, Microsoft Excel Corporation software (2023) and Jamovi (version 1.6) were used. Qualitative variables were analyzed using the chi-square test, and quantitative variables were analyzed using the Mann-Whitney U test, considering that they presented a non-parametric distribution. The OpenAI tool, ChatGPT version GPT-4, was used exclusively for language corrections during the writing process of the article.



RESULTS

Simple Radiography

The radiographic analysis did not reveal a statistical difference between the groups for the evaluated parameters ($p > 0.05$). The gaps were identified in 75% of the first-generation samples and in 90% of the second-generation. The transition was considered abrupt in 50% and in 30% of the cases, respectively. In all samples of group 2, bubbles were identified (100%), while in the other group, in 90% of the cases (Table 1).

Computed Tomography

The gaps were present in 45% of the first-generation samples and 55% of the second ($p > 0.05$). Regarding the transition at the

Table 1. Lacuna, transition, and bubbles in simple X-rays according to the type of cementation.

Parameter	1st generation	2nd generation	N(t)	N(a)	p
Gaps (Yes, %)	75	90	10	60	0.15*
Transition (Abrupt, %)	50	30	10	40	0.19*
Bubbles (Yes, %)	90	100	10	40	0.14*

N(t), total number of samples analyzed in each group. N(a), total number of evaluations conducted by different examiners. *chi-square.

bone-cement interface, 23.33% of the first-generation samples were rough, compared with 55% of the second generation ($p = 0.014$). The average number of bubbles was higher in group 2 (6.05) than in group 1 (3.95). When grouped into many (≥ 5) and few bubbles, 50% of the samples in group 1 had many bubbles, in contrast to 30% in group 2. For these two analyzed parameters, there was no statistical difference ($p > 0.05$) (Table 2).

Table 2. Gap, transition, and bubbles in computed tomography according to the type of cementation.

Parameter	1st generation	2nd generation	N(t)	N(a)	p
Gaps (Yes, %)	45	55	10	40	0.52*
Transition (Rough, %)	23.33	55	10	60	0.014*
Bubbles (average, number)	3.95	6.05	10	40	0.17**
Bubbles (many, %)	50	30	10	40	0.33*

N(t), total number of samples analyzed in each group. N(a), total number of evaluations conducted by different examiners. *chi-square. **Mann-Whitney U.

Photographs

The average number of protrusions per sample in group 1 was 1.6, while in group 2 it was 2.4. As with the other parameters, this difference was not significant ($p > 0.05$). The average size of the protrusions was 0.40 mm and 0.35 mm, respectively in groups 1 and 2. In the first generation, 25% of the samples showed many protrusions and 50% in the second generation. The penetration was deep in 30% of the samples in group 1 and 15% in group 2 (Table 3).

Table 3. Analysis of protrusions in photographic images according to the type of cementation.

Parameter	1st generation	2nd generation	N(t)	N(a)	p
Average (number)	1.6	2.4	10	40	0.07**
Average (mm)	0.40	0.35	10	40	0.69**
Quantity (many, %)	25	50	10	40	0.10*
Penetration (deep, %)	30	15	10	40	0.25*

N(t), total number of samples analyzed in each group. N(a), total number of evaluations conducted by different examiners. *chi-square. **Mann-Whitney U.

DISCUSSION

The results suggest that the adapted second-generation cementation technique does not present significant advantages compared to the first-generation technique. Despite the trend towards more protrusions/interdigitation in the second-generation cementation group, more gaps were also found in this group, indicating that the adaptation of the second-generation technique did not provide more efficient interdigitation of the cement in the bone cavity, although there were no significant differences in these parameters. Regarding the quality of the cement, analyzed from the quantity and size of the bubbles, there was no difference between the techniques; therefore, no interference in the strength or adhesion of the cementation.

The second-generation cementation presupposes the creation of a closed compartment in which low-viscosity cement is injected in a liquid state under high pressure. In the medullary canal for implanting prostheses, these conditions are achieved by obstructing

the canal with a plastic pin (*stop*), and the opening of the medullary canal is blocked with a plastic and *rubbery* device that surrounds the syringe tube²⁸. In the defects created after curettage of bone tumors, the opening is a cortical window that is usually large and of variable shape, making it difficult to develop specific equipment. The double-glove filled with water should occlude the cortical window and transmit the applied pressure to the cement, pushing it into the pores of the trabecular bone. The study data show that this did not occur, and the likely cause is that the pressure applied to the glove was neither sufficient nor comparable to the pressure achieved with the use of a gun. It is possible that developing a technique that allows greater pressure to be applied to the cement will improve the quality of integration. This is, therefore, an open field for development.

The adoption of more modern cementation techniques for treating cavities after curettage remains a challenge. Developing

mechanisms that increase pressure in irregular cavities requires technical sophistication to adapt to different bone windows, which may increase procedural cost and cause additional damage to the bone structure if the cavity must be molded beyond the limits of curettage. In light of this, the results obtained indicate that maintaining digitopressure (first generation) is an efficient method for the proposed end, and is accessible, technically easier, and lower in cost.

CONCLUSION

In an animal model, a comparison of first-generation cementation methods and a second-generation adaptation in bone defects simulating curettage of bone tumors showed no differences, leading to the conclusion that the first-generation technique (digitopressure), with the introduction of cement after the setting phase using fingers, remains the method of choice.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. CMVM: Analysis, interpretation of data, and writing of the article; GNF: Design of the work, development and experimental execution, and data analysis; FV: Analysis and interpretation of data; MCI: Analysis and interpretation of data; EEE: Design of the work, critical review of the intellectual content, and final approval of the manuscript version to be published; DSMA: writing and final revision of the article.

DATA AVAILABILITY DECLARATION

The underlying contents of the research text are contained in the manuscript.

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MORTALITY PROFILE FROM PEDIATRIC BONE NEOPLASIA IN MINAS GERAIS (2015–2024)

PERFIL DOS ÓBITOS POR NEOPLASIA ÓSSEA PEDIÁTRICA EM MINAS GERAIS (2015–2024)

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ABSTRACT

Objectives: To analyze the profile of deaths from malignant neoplasms of bones and articular cartilage in the pediatric population of Minas Gerais (2015–2024), considering sociodemographic, clinical, epidemiological, and regional aspects. **Methods:** Epidemiological, documentary, descriptive, and retrospective study with a census design, including deaths of individuals aged 0–19 years residing in Minas Gerais (ICD-10 C40–C41) registered in SIM/DATASUS. Variables analyzed included sex, age, race/color, municipality, place of death, length of hospital stay, and hospital costs. Descriptive statistics were used with frequencies, percentages, and mortality rates. **Results:** There were 3,883 hospitalizations and 79 deaths, predominating male patients (57.7% of hospitalizations; 59.5% of deaths), adolescents aged 10–19 years, and individuals of mixed race/color (pardo). Belo Horizonte accounted for most hospitalizations and deaths, while Juiz de Fora had high hospitalization rates but low mortality. Longer hospital stays were observed in female patients and those under 1 year; the highest costs were among adolescents aged 10–14 years. Hospitalizations decreased over time, but mortality remained stable. **Conclusions:** Findings highlight the need for early detection, access to specialized therapies, and reduction of regional inequalities to improve clinical outcomes and equity in pediatric oncology care. **Level of Evidence IV; Retrospective cohort study.**

Keywords: Bone neoplasms; Pediatrics; Mortality; Epidemiology.

RESUMO

Objetivos: Analisar o perfil dos óbitos por neoplasias malignas dos ossos e cartilagens articulares na população pediátrica de Minas Gerais (2015–2024), considerando aspectos sociodemográficos, clínicos, epidemiológicos e regionais. **Métodos:** Estudo epidemiológico, documental, descritivo e retrospectivo, com delineamento censitário, incluindo óbitos de 0 a 19 anos residentes em Minas Gerais (CID-10 C40–C41) registrados no SIM/DATASUS. Variáveis analisadas: sexo, idade, cor/raça, município, local de óbito, tempo de internação e custos hospitalares. A análise foi descritiva, com frequências, percentuais e taxas de mortalidade. **Resultados:** Foram registradas 3.883 internações e 79 óbitos, predominando pacientes masculinos (57,7% das internações; 59,5% dos óbitos), adolescentes de 10 a 19 anos e pardos. Belo Horizonte concentrou mais internações e óbitos; Juiz de Fora apresentou alta hospitalização com baixa mortalidade. Maior permanência hospitalar entre pacientes do sexo feminino e menores de 1 ano; custos mais elevados entre 10 e 14 anos. As internações reduziram ao longo do período, mas a mortalidade manteve-se estável. **Conclusão:** Evidencia-se a necessidade de detecção precoce, de acesso a terapias especializadas e de redução das desigualdades regionais para melhorar os desfechos clínicos e a equidade no cuidado oncológico pediátrico. **Nível de Evidência IV; Estudo de coorte retrospectivo.**

Descritores: Neoplasias ósseas; Pediatria; Mortalidade; Epidemiologia.

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INTRODUCTION

Neoplasia is characterized by abnormal and uncontrolled cell growth. When it exceeds the limits of the site of origin and invades neighboring tissues or spreads to other regions of the body, it is classified as malignant. Unlike normal cells, neoplastic cells do not follow the expected life cycle: they continue to proliferate and can spread both locally and through the bloodstream¹. In bones and articular cartilages, malignant tumors can arise primarily, when they originate in the tissue itself, or secondarily,

through metastases from other organs. These cancers present with heterogeneous clinical manifestations that directly influence prognosis. Although infrequent, they occur more frequently in children and adolescents².

The musculoskeletal system is composed of specialized tissues with complementary functions. Bone, rigid, vascularized, and metabolically active, serves in body support, organ protection, locomotion, and mineral storage, in addition to having a great capacity for remodeling³. In contrast, cartilage, flexible and poorly

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regenerative, covers joints to reduce friction and absorb impacts⁴. Both can be affected by neoplasms, such as chondrosarcoma in cartilage and, especially in young people, osteosarcoma and Ewing's sarcoma³⁻⁴.

Malignant bone neoplasms in childhood are rare, accounting for 3%–5% of cancers in individuals under 15 years old. Among them, osteosarcoma stands out as the most prevalent (3.8/million), preferentially affecting the metaphyses of long bones, and Ewing's sarcoma (3.5/million), characteristic of adolescence, often located in the pelvis and diaphyses⁵⁻⁷.

The initial recognition of the disease usually occurs after consultation with a pediatrician, general practitioner, or orthopedic surgeon. Warning signs include progressive pain, with variable intensity depending on the tumor stage, and an increase in volume in the affected area, noticeable as the disease progresses⁸.

The definitive diagnosis is based on imaging tests. X-ray is the initial method due to its wide availability, but it has limitations. CT and MRI allow for detailing the extent and tumor invasion, while advanced techniques, such as PET-CT, contribute to metabolic assessment and therapeutic planning⁹.

The treatment is necessarily multimodal. It involves chemotherapy to reduce the tumor and control micrometastases, surgery for resection with limb preservation whenever possible, and, in specific situations, radiation therapy, especially in Ewing's sarcoma. Thanks to advances in surgical techniques and chemotherapy protocols, patients' survival and quality of life have improved significantly. Still, the prognosis continues to depend on the tumor type, disease stage, and initial response to therapy¹⁰.

In this context, it is observed that deaths from malignant neoplasms of bones and articular cartilages in the pediatric population pose a significant challenge for public health, both due to clinical and social impact. These diseases, although infrequent, present high aggressiveness, potentially progressing rapidly to severe outcomes, including fatal ones. Factors such as age group, presence of comorbidities, and advanced stage at diagnosis increase patients' vulnerability to worse outcomes. In this context, analyzing the profile of deaths is essential to support strategies for early detection, expand access to specialized therapies, and improve the quality of care, thereby contributing to reduced mortality and the sustainability of the healthcare system.

OBJECTIVES

The general objective of this study is to analyze the profile of deaths from malignant neoplasms of the bones and articular cartilages among the pediatric population in the state of Minas Gerais, from 2015 to 2024. Specifically, the aim is to describe the distribution of deaths according to sociodemographic variables such as age, sex, and municipality of residence; characterize the deaths concerning clinical and epidemiological variables, including length of hospitalization, location of occurrence, and presence of associated comorbidities; evaluate the temporal trend of mortality due to malignant neoplasms of the bones and articular cartilages during the studied period; compare the profile of deaths according to age groups of the pediatric population (0–4 years, 5–9 years, 10–14 years, and 15–19 years); and identify possible differences in outcomes according to the health region of the state, aiming to understand inequalities in pediatric oncological care.

METHODOLOGY

This was an epidemiological, documentary, quantitative, descriptive, and retrospective study, with a census design that encompassed all deaths among children and adolescents resulting from malignant neoplasms of the bones and articular cartilages recorded in the

state of Minas Gerais from January 1, 2015, to December 31, 2024. The data were obtained through the Mortality Information System (SIM) and the public databases of the Department of Informatics of the Unified Health System (DATASUS).

All cases of death in individuals aged 0 to 19 years, residing in Minas Gerais, whose underlying cause was classified under codes C40 and C41 of the International Classification of Diseases, 10th revision (ICD-10), were included. Records concerning non-residents of Minas Gerais, fetal deaths, and those with inconsistent or incomplete information that hindered analysis were excluded.

Data collection was conducted by consulting the public databases of SIM/DATASUS, using the TabNet tool to extract the available information. The variables analyzed included year of death, sex, age group, race/color, municipality of residence, location of death, and ICD-10 subcategories.

The data were organized and tabulated in electronic spreadsheets using Microsoft Excel 2020. The analysis was conducted using descriptive statistics, presenting absolute numbers, relative frequencies, percentages, and mortality rates, and preparing tables and graphs to facilitate visualization of the results. The temporal and geographical distribution of deaths was evaluated, as well as the sociodemographic profile of the affected pediatric population in the state throughout the studied period.

RESULTS

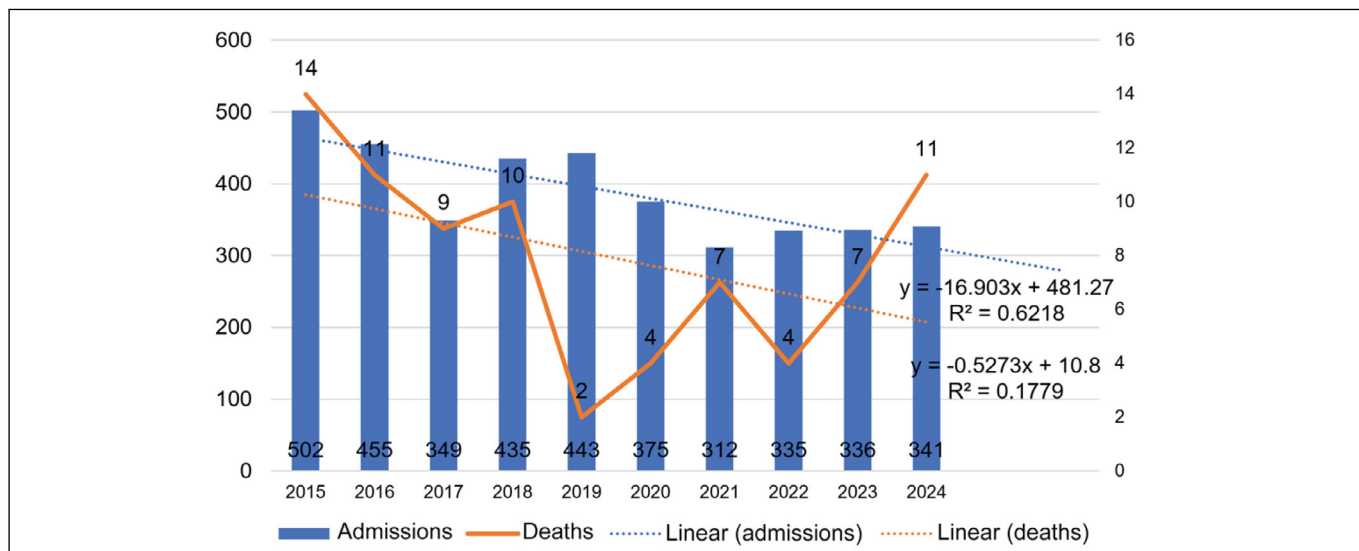
The analysis of hospitalizations for malignant neoplasms of the bones and articular cartilage among the pediatric population of the state of Minas Gerais from 2015 to 2024 revealed a total of 3,883 records.

The joint analysis of hospitalizations and deaths due to malignant neoplasms of the bones shows annual variations, but with a general trend of reduction in the number of hospitalizations over the historical series. In 2015, 502 hospitalizations were recorded, a number that fell to 341 in 2024, representing a decrease of approximately 32.1%. Despite this reduction, no linear pattern is observed, as some years, such as 2018 and 2019, showed peaks in hospitalizations (435 and 443 cases, respectively). Regarding deaths, the annual number fluctuated between 2 (2019) and 14 (2015), totaling 79 cases during the period. When comparing the proportion of deaths to hospitalizations, it is noted that years like 2017 (9 deaths for 349 hospitalizations) and 2024 (11 deaths for 341 hospitalizations) had higher rates, suggesting variations in lethality over time, as shown in Figure 1.

From 2015 to 2024, the municipality of Belo Horizonte concentrated the highest absolute number of hospitalizations for malignant neoplasms of the bones and articular cartilage in the pediatric population of Minas Gerais, with 2,154 records, followed by Juiz de Fora (339 hospitalizations) and Muriaé (296 hospitalizations). Regarding deaths, Belo Horizonte also had the highest absolute number, with 39 records, followed by Montes Claros (8), Muriaé (7), and Ipatinga (6). It is noteworthy that Juiz de Fora, despite having a high number of hospitalizations, recorded only one death during the period, as shown in Figure 2.

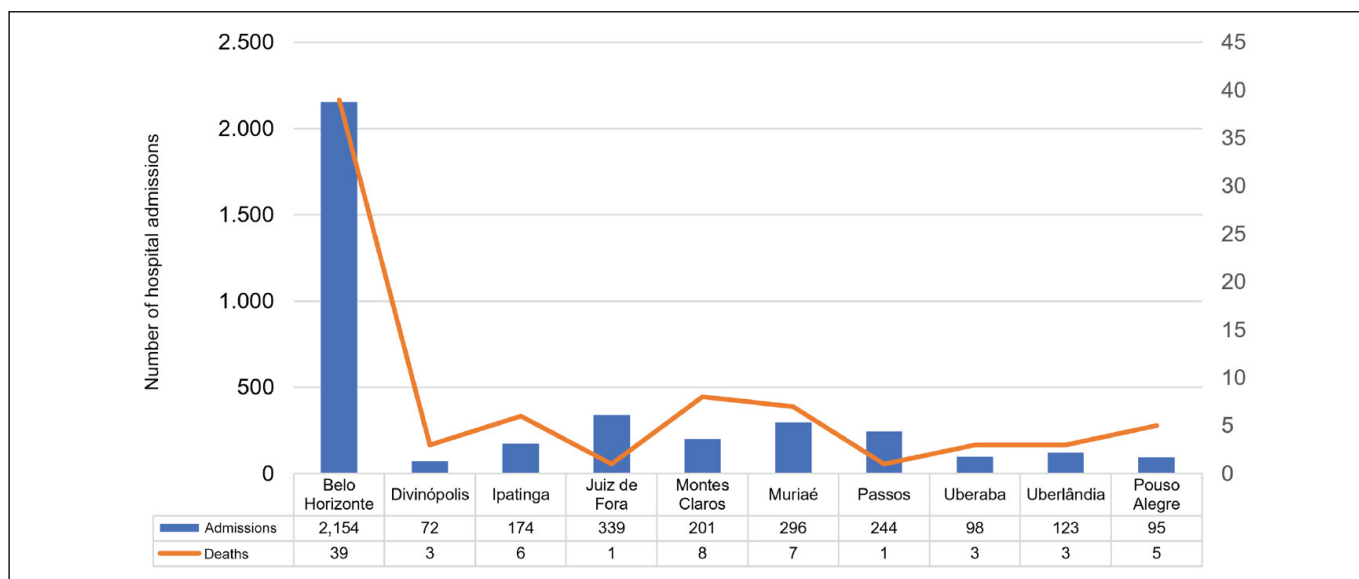
Table 1 shows the distribution of the profile (gender, age group, and race) of hospitalizations for malignant neoplasms of the bones and cartilage.

There is a predominance of the male sex, with 2,242 hospitalizations (57.7%), compared to 1,641 for the female sex (42.3%). When evaluating the distribution by age group, it is noted that the highest concentration of hospitalizations occurred among adolescents aged 10 to 14 years, totaling 1,682 cases (43.3%), followed by the group aged 15 to 19 years, with 1,433 hospitalizations (36.9%). The analysis by color/race indicates a predominance of hospitalizations among brown patients, with 2,155 notifications (55.5%), as shown in Table 1.



Source: DATASUS-SIH.

Figure 1. Distribution of the profile of hospitalizations/deaths of patients with malignant neoplasms of the bones and articular cartilage in the pediatric population of the state of Minas Gerais, 2015 to 2024. (hospitalizations=3,883; deaths=79).



Source: DATASUS-SIH.

Figure 2. Distribution of the profile of hospitalizations/deaths by municipalities of patients with malignant neoplasms of the bones and articular cartilage in the pediatric population of the State of Minas Gerais, 2015 to 2024.

Table 2 shows the profile (sex, age group, and race) of deaths due to malignant neoplasms of the bones and articular cartilage in the pediatric population.

From 2015 to 2024, there were 79 deaths due to malignant neoplasms of the bones and articular cartilage in the pediatric population of the State of Minas Gerais. The distribution of deaths by sex revealed a higher frequency among male patients, with 47 cases (59.5%), compared to 32 deaths in female patients (40.5%). This male predominance persisted throughout much of the historical series, with average mortality rates of 2.09% for males and 2.34% for females, values that are close but indicate a slight proportional increase in female patients, despite the lower absolute number of cases. The analysis by age group showed that most deaths occurred among adolescents aged 15 to 19 years (58.2%), followed by the group aged 10 to 14 years (30.4%). Regarding the distribution by

color/race, there was a predominance of deaths among brown patients (59.5%), as shown in Table 2.

In financial terms, the average total cost of hospitalizations was R\$ 310,272.64 for males and R\$ 236,174.59 for females, suggesting higher average costs for male patients. Regarding the average cost by age group, the highest value was observed among adolescents aged 10 to 14 years (R\$ 225,912.43), closely followed by the group of 15 to 19 years (R\$ 225,851.22), which may be associated with the complexity of treatment in this age range. As for the average hospital stay by gender, female patients stayed hospitalized longer (6.39 days) than male patients (5.27 days). Considering the age group, the highest average was recorded among children under 1 year old (9.25 days), possibly related to greater clinical fragility and the need for intensive care. The other age groups showed averages ranging from 5.39 days (5 to 9 years) to 5.98 days (15 to 19 years), as shown in Table 3.

Table 1. Profile of pediatric hospitalizations for malignant neoplasms of the bones and articular cartilage in the State of Minas Gerais, 2015 to 2024. (n=3,883).

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total	%
Hospitalizations by Gender												
Male	254	250	196	228	228	232	219	207	207	221	2242	57.7
Female	248	205	153	207	215	143	93	128	129	120	1641	42.3
Total	502	455	349	435	443	375	312	335	336	341	3883	100
Hospitalizations by Age Group												
Under 1 year	0	1	2	4	19	5	4	0	4	1	40	1.0
1 to 4 years	18	14	2	7	12	9	18	36	20	16	152	3.9
5 to 9 years	98	72	66	36	41	68	24	28	64	79	576	14.8
10 to 14 years	212	188	121	224	204	171	157	153	129	123	1682	43.3
15 to 19 years	174	180	158	164	167	122	109	118	119	122	1433	36.9
Total	502	455	349	435	443	375	312	335	336	341	3883	100
Hospitalizations by Color/Race												
White	140	158	113	108	104	109	99	101	101	108	1141	29.4
Black	27	19	20	62	56	28	18	8	29	36	303	7.8
Brown	290	247	184	247	268	165	171	198	191	194	2155	55.5
Yellow	3	2	0	0	0	19	0	0	9	3	36	0.9
Indigenous	14	13	5	1	0	0	1	7	0	0	41	1.1
No Information	28	16	27	17	15	54	23	21	6	0	207	5.3
Total	502	455	349	435	443	375	312	335	336	341	3883	100

Source: DATASUS-SIH.

Table 2. Distribution of the profile of deaths of patients with malignant neoplasms of the bones and articular cartilage in the pediatric population of the State of Minas Gerais, 2015 to 2024. (n=79).

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total	%
Deaths by Sex												
Male	7	8	6	5	2	2	2	3	5	7	47	59.5
Female	7	3	3	5	-	2	5	1	2	4	32	40.5
Total	14	11	9	10	2	4	7	4	7	11	79	100
Deaths by Age Group												
1 to 4 years	1	1	0	0	0	0	0	0	0	0	2	2.5
5 to 9 years	1	0	0	1	0	1	0	2	1	1	7	8.9
10 to 14 years	4	4	3	2	0	1	2	2	3	3	24	30.4
15 to 19 years	8	6	6	7	2	2	5	0	3	7	46	58.2
Total	14	11	9	10	2	4	7	4	7	11	79	100
Deaths by Color/Race												
White	6	3	4	1	1	0	2	2	1	3	23	29.1
Black	2	1	0	1	0	0	0	0	1	0	5	6.3
Brown	6	7	3	7	1	4	4	2	5	8	47	59.5
Indigenous	0	0	1	0	0	0	0	0	0	0	1	1.3
No Information	0	0	1	1	0	0	1	0	0	0	3	3.8
Total	14	11	9	10	2	4	7	4	7	11	79	100

Source: DATASUS-SIH.

DISCUSSION

The analysis of hospitalizations for malignant neoplasms of the bones and articular cartilages in Minas Gerais between 2015 and 2024 revealed a general trend of declining hospitalizations, though with annual fluctuations. This pattern finds partial parallels in national and international findings.

In Brazil, Rinaldi da Cruz et al.¹¹, analyzing 70,322 pediatric hospitalizations between 2018 and 2023, observed similar annual fluctuations, attributing them to regional inequalities in access, weaknesses in the oncological network, and the impact of the COVID-19 pandemic.

Table 3. Distribution of the average value of expenses and the average length of hospital stay by sex and age group of hospitalizations of patients with malignant neoplasms of the bones and articular cartilage in the pediatric population of the State of Minas Gerais, 2015 to 2024.

Year	Average
Total Value by Sex	
Male	310,272.64
Female	236,174.59
Total	546,447.23
Total Value by Age Group	
Under 1 year	10,964.634
1 to 4 years	1,816,383.8
5 to 9 years	655,551.14
10 to 14 years	225,912,429
15 to 19 years	225,851,216
Total	546,447.23
Average Length of Stay by Gender	
Male	5.27
Female	6.39
Total	5.75
Average Length of Stay by Age Group	
Under 1 year	9.25
1 to 4 years	5.52
5 to 9 years	5.39
10 to 14 years	5.56
15 to 19 years	5.98
Total	5.75

Source: DATASUS-SIH.

However, unlike the context in Minas Gerais, at the national level, an increase in hospitalizations was observed until 2022, highlighting the heterogeneity among states and suggesting that the reduction observed in Minas may be related to local factors, such as regional health policies, greater centralization of oncological care, or even underreporting during certain periods¹¹.

Additionally, Moreira et al.¹², in the Southeast region, identified annual fluctuations, but with maintenance of clinical severity, as reflected in the relatively stable mortality rate, reinforcing that diagnostic delays and unequal access to specialized therapies remain structural barriers to the proportional reduction of deaths.

In the international context, Helenius and Krieg¹³, when analyzing trends in European countries, highlighted that reductions in hospitalizations do not necessarily imply lower clinical severity, as delays in diagnosis and difficulty in early recognition of symptoms contribute to some patients reaching specialized services at advanced stages of the disease. These findings directly relate to the results from Minas Gerais, where the decline in hospitalizations was not accompanied by a significant reduction in deaths, suggesting the persistence of structural challenges in pediatric oncological care.

Accurate diagnostic evaluation is central to the management of these patients. In this context, Gassert et al.¹⁴ demonstrated that specific characteristics in computed tomography (CT) and magnetic resonance imaging (MRI), such as intraosseous edema, extraosseous component, endosteal contour, cortical penetration, bone expansion, and presence of limited calcifications, significantly increase the likelihood of atypical cartilaginous tumors (ACTs), reinforcing the need for biopsy or surgical intervention in selected cases.

The identification of these characteristics in long bones allows differentiation between benign tumors, such as enchondromas, and ACTs, contributing to more targeted management and avoiding unnecessary procedures. In Minas Gerais, the centralization of cases in large centers, such as Belo Horizonte and Juiz de Fora, may facilitate the application of these advanced imaging criteria,

helping to explain the higher hospital costs and prolonged stays observed in certain groups.

In parallel, in the management of soft tissue tumors containing fat in children and adolescents, Cardoen et al.¹⁵ showed that the vast majority of lesions are benign and that the indication for biopsy should be guided by factors such as age ≥ 10 years, genetic predisposition, low fat content, and the presence of myxoid areas. This approach minimizes invasive procedures and general anesthesia, promoting safer, more appropriate management for the pediatric population. These findings complement the discussion on the centralization of care and resource optimization, reinforcing the need for differentiated protocols for children and adolescents, especially in reference centers, and aligning with observations of longer hospital stays and higher costs in complex cases.

The study of the geographic profile of hospitalizations in Minas Gerais shows that Belo Horizonte concentrated the highest absolute number of hospitalizations and deaths, confirming the central role of large reference centers. A similar pattern was described by Moreira et al.¹² in São Paulo and by Rinaldi da Cruz et al.¹¹ in Brazil, with a concentration of cases in the Southeast Region. In Minas Gerais, the case of Juiz de Fora stands out: it had a high volume of hospitalizations but only one death in the historical series, possibly reflecting earlier diagnosis or greater therapeutic efficacy, in contrast to Belo Horizonte, where a higher concentration of cases coincided with higher mortality.

Centralization is also reflected in hospital costs, with Belo Horizonte having the highest total hospitalization costs, followed by Ipatinga and Divinópolis, a pattern consistent with the complexity of services offered in the state. National comparisons, such as those by Moura et al.¹⁶ in Piauí, show lower average costs, while international studies, such as Fang et al.¹⁷, indicate that resource limitations in low- and middle-income countries impact both costs and survival, widening inequalities in oncological care.

The demographic profile of hospitalizations in Minas Gerais reveals a male predominance, stable throughout the historical series, consistent with Moreira et al.¹² and Petca et al.¹⁸ in Romania, as well as in multicenter cohorts like Kadhim et al.¹⁹. However, Moura et al.¹⁶ observed a female predominance in Piauí, indicating that regional, cultural, and social factors may alter the clinical trajectory. Regarding age, adolescents aged 10 to 14 years represented the largest share of hospitalizations in Minas Gerais, aligning with the findings of Rinaldi da Cruz et al.¹¹ in Brazil and Moreira et al.¹² in the Southeast, as well as international studies like Breden et al.²⁰, which confirm the disease's preference for the second decade of life.

In relation to race/color, brown patients predominated, reflecting the state's demographic composition, contrasting with the white predominance in the Southeast and approaching the pattern in Piauí; access barriers and socioeconomic vulnerabilities may contribute to this heterogeneity, in line with Helenius and Krieg¹³.

Regarding mortality, Minas Gerais recorded 79 pediatric deaths, with an absolute male predominance and slightly higher average rates among girls, a pattern similar to the national one described by Rinaldi da Cruz et al.¹¹ and the regional one by Moreira et al.¹², but divergent from Piauí, where Moura et al.¹⁶ recorded a higher female participation. In terms of age, deaths concentrated between

15 and 19 years, with an increase also in children aged 1 to 4 years, aligning with the bimodal pattern described by Moreira et al.¹² and the international literature of Breden et al.²⁰. Regarding race/color, a predominance of deaths among brown individuals was observed, approaching that of Piauí and contrasting with the Southeast, while high rates among indigenous and black individuals indicate the impact of socioeconomic vulnerabilities on clinical outcomes.

The analysis of costs and hospital stays reinforces the influence of sex, age group, and treatment complexity on hospital outcomes. In Minas Gerais, female patients stayed hospitalized longer than males, and those under one year had a higher average length of stay, reflecting greater clinical fragility and the need for intensive care. The 10-14 age group had the highest average costs, possibly due to therapeutic complexity. These findings partially converge with Rinaldi da Cruz et al.¹¹ and Moreira et al.¹² but diverge from Moura et al.¹⁶, who observed lower costs and less difference between sexes, highlighting the influence of the availability of therapeutic resources. International studies, such as Helenius and Krieg¹³ and Fang et al.¹⁷, corroborate the relationship between age, clinical complexity, and prolonged hospital stay, while Petca et al.¹⁸ indicate that complications and diagnostic delays contribute to longer hospitalization times in girls, consistent with the situation in Minas Gerais.

In summary, the findings from Minas Gerais align with patterns observed nationally and internationally regarding the centralization of cases in large centers, male predominance, greater vulnerability of adolescents, and high hospital costs. The integration of findings from Gassert et al.¹⁴ and Cardoen et al.¹⁵ reinforces the need for accurate diagnostic evaluation and management based on specific criteria for each tumor type, whether bone or soft tissue, thereby promoting safer therapeutic decisions, avoiding unnecessary biopsies, and enabling more efficient allocation of hospital resources.

However, local divergences in the state of Minas Gerais regarding sex, race/color, and costs highlight the relevance of regional, demographic, and structural factors. The body of evidence reinforces that timely screening policies, shorter time to specialized care, and increased access to high-complexity therapies are essential to reduce lethality among the most vulnerable groups, improve hospital outcomes, and promote equity in pediatric oncological care.

CONCLUSION

The study allowed for the characterization of the profile of deaths due to malignant neoplasms of bones and articular cartilage in the pediatric population of Minas Gerais between 2015 and 2024. A trend toward reduced hospitalizations was observed, but mortality remained stable, reflecting challenges in early detection and access to specialized therapies. Belo Horizonte concentrated the highest number of cases and deaths, while other municipalities, such as Juiz de Fora, showed a high frequency of hospitalizations but low mortality. Male patients predominated, particularly adolescents aged 10 to 19 years and of mixed race. Younger patients and females had longer hospital stays, and costs were higher among adolescents aged 10 to 14 years. The findings reinforce the need for early detection policies, increased access to specialized oncological care, and the reduction of regional inequalities, aiming to improve clinical outcomes and promote equity in pediatric care.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. MAI: Conceptualization, Data curation, Investigation, Methodology, Writing – Original Draft; CRM: Conceptualization, Data curation, Investigation, Methodology, Writing – Original Draft; SFHC: Conceptualization, Data curation, Methodology, Writing – Review and Editing.

DATA AVAILABILITY DECLARATION

The underlying contents of the research text are contained in the manuscript.

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DISTAL TRICEPS TENDON RUPTURE DUE TO OLECRANON OSTEOPHYTE AVULSION: A CASE SERIES

RUPTURA DO TENDÃO DISTAL DO TRÍCEPS POR AVULSÃO DE OSTEÓFITO DO OLÉCRANO: SÉRIE DE CASOS

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ABSTRACT

Objective: To report a case series of distal triceps tendon rupture associated with olecranon osteophyte avulsion, a rare condition with few reports in the literature. **Methods:** This study analyzed patients who underwent surgical treatment between 2011 and 2022 for distal triceps tendon rupture associated with olecranon osteophyte avulsion. Clinical and radiographic characteristics, pain levels, and functional outcomes were assessed using the Q-DASH and MEPS scores. **Results:** There was a significant reduction in pain between the 1st and 12th weeks (mean VAS from 5.8 to 0.8; $p < 0.001$). The mean Q-DASH score improved from 1.9 to 0.2 between the 6th and 12th months ($p = 0.003$). The MEPS remained high throughout the follow-up period (final mean: 100). Patients operated on within 7 days from trauma had less residual pain ($p = 0.02$). Smokers had worse functional scores at 6 months ($p = 0.04$). Previous elbow pain was associated with worse pain score in the first week post op ($p = 0.048$), but no difference in final outcomes. **Conclusion:** Surgery for triceps tendon rupture with olecranon osteophyte avulsion led to significant improvements in pain and function. Factors such as time to treatment, smoking, and age influence recovery. **Level of Evidence IV; Case Series.**

Keywords: Tendons; Tendon Injuries; Osteophyte; Elbow; Orthopedic Procedures; Case Reports.

RESUMO

Objetivo: Relatar uma série de casos de ruptura do tendão distal do tríceps associada à avulsão de osteófitos do olécrano, condição rara, com poucos relatos na literatura. **Métodos:** Esse estudo analisou pacientes submetidos a tratamento cirúrgico entre 2011 e 2022 por ruptura do tendão distal do tríceps associada à avulsão osteofitária do olécrano. Foram avaliadas características clínicas, radiográficas, dor e desfechos funcionais por meio dos escores Q-DASH e MEPS. **Resultados:** Houve redução significativa da dor entre a 1ª e a 12ª semana (EVA média de 5,8 para 0,8; $p < 0,001$). O escore Q-DASH melhorou de 1,9 para 0,2 entre o 6º e o 12º mês ($p = 0,003$). O MEPS manteve-se elevado ao longo do seguimento (média final: 100). Pacientes operados há menos de 7 dias do trauma apresentaram menor dor residual ($p = 0,02$). Tabagistas apresentaram piores escores funcionais no 6º mês ($p = 0,04$). Dor prévia no cotovelo associou-se a pior escore de dor na primeira semana pós-operatória ($p = 0,048$), mas não houve diferença no desfecho final. **Conclusão:** A cirurgia para ruptura do tríceps com avulsão de osteófito do olécrano resultou em melhora significativa da dor e da função. Fatores como o tempo até o tratamento, o tabagismo e a idade influenciam a recuperação. **Nível de Evidência IV; Série de casos.**

Descritores: Tendões; Traumatismos dos Tendões; Osteófito; Cotovelo; Cirurgia Ortopédica; Relatos de Casos.

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INTRODUCTION

The rupture of the distal triceps tendon is a rare injury, accounting for less than 1% of all upper-limb tendon ruptures¹. This condition predominantly affects middle-aged men and is usually associated with direct trauma to the elbow or vigorous eccentric contraction, as occurs in falls onto an outstretched hand or during

weightlifting^{2,3}. In many cases, the initial diagnosis is overlooked, as the extension of the elbow may be partially preserved due to the integrity of the lateral expansion of the tendon, masking the complete functional deficit^{4,5}.

The distal insertion of the triceps at the olecranon has complex anatomical features and is subject to degenerative changes from

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The study was conducted at the Sports Trauma-Orthopedics Center of the Sports Medicine and Physical Activity Discipline, Department of Orthopedics and Traumatology, Paulista School of Medicine, Universidade Federal de São Paulo.

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chronic use and repetitive overload⁶. In these cases, the formation of enthesophytes, also known as olecranon spurs, is common; these are bony projections arising from chronic traction at the tendon enthesis^{7,8}. Although often asymptomatic, these spurs can predispose to tendon avulsion in traumatic events, especially when associated with degeneration of the tendon tissue⁹.

Despite reports of triceps rupture in patients with olecranon osteophytes, the direct association between these two conditions is rarely described in the literature. Additionally, isolated fracture of the spur as a mechanism of tendon avulsion is rarely recognized on initial diagnosis^{10,11}. Confusion with other elbow pathologies, such as bursitis or epicondylitis, contributes to delays in appropriate treatment^{5,12}.

This study aims to describe a series of cases of distal triceps rupture associated with avulsion of olecranon osteophytes and to characterize the clinical, radiographic, and surgical aspects of this poorly documented entity. The analysis aims to provide relevant clinical and anatomical data to support early diagnosis and appropriate management of these cases.

MATERIALS AND METHODS

This is a series of cases of patients diagnosed with distal triceps tendon rupture with avulsion of the olecranon osteophyte, treated by the shoulder and elbow surgery team at the Sports Trauma-Orthopedics Center of the Federal University of São Paulo between 2011 and 2022. The study was approved by the institutional ethics committee under registration CAAE 55501222.2.0000.5505. All patients signed the informed consent form.

After reviewing electronic medical records, cases of traumatic rupture of the distal triceps tendon associated with avulsion of the insertional osteophyte were identified. Cases of purely tendon injuries, ruptures with olecranon fracture, chronic injuries (>14 days), and cases with other concomitant elbow injuries were excluded. All patients had the diagnosis of the injury made through clinical evaluation (local pain, bruising, and palpable gap) and confirmed by ultrasound or magnetic resonance imaging. For complete tendon injuries, surgical treatment was indicated. For partial injuries, the patient was given the option to choose between conservative or surgical treatment, depending on work and sports demands.

Demographic characteristics of the patients were evaluated, such as sex, age, body mass index (BMI), dominant limb, physical activity, comorbidities, and habits (smoking, alcoholism, use of anabolic steroids). Data related to the injury were also analyzed, including the type of injury (partial or complete), the mechanism of trauma, the presence of prior symptoms, the treatment (surgical or conservative), the time to surgery, the complications, and the time to return to work and sports activities. The evolution of pain complaints was assessed using the Visual Analog Scale (VAS). Elbow function was evaluated using the Quick-Disabilities of the Arm, Shoulder and Hand (Q-DASH) scores and the Mayo Elbow Performance Score (MEPS). At the end of treatment, patients rated their satisfaction with the treatment on a scale from 0 to 10 (0 = dissatisfied, 10 = completely satisfied).

Surgical Technique

Under general anesthesia, in a prone position, the injured limb was supported on a brace, with the forearm hanging down. A distal posterior incision of about 6 centimeters was made on the arm. The tendon stump was identified and its mobility tested by moving it to its insertion on the olecranon. The avulsed bone fragment, as well as the remaining part still attached to the olecranon, were resected. The tendon repair was performed with two bioabsorbable SwiveLock anchors (Arthrex, Naples, Florida, USA), fixed to the olecranon and spaced 2 centimeters apart. The range of motion

of the elbow was assessed to confirm appropriate repair tension, and the incision was sutured.

Post-operative

After surgery, patients kept their elbows immobilized in slings at 90 degrees for 3 weeks. Starting from the fourth week, under physiotherapeutic supervision, passive exercises were initiated to recover elbow flexion and extension. Patients were encouraged to achieve a full range of motion by the 8th week post-operatively. From weeks 9 to 12, the focus was on isometric and isotonic exercises. Starting in the 12th week, concentric and eccentric exercises with progressively increasing loads were initiated to achieve gradual strengthening. Work and sports activities that did not require load on the upper limbs were permitted starting from the 2nd month post-operation. Return to sports for more strenuous activities was allowed when the patient achieved a range of motion and strength clinically similar to the contralateral side, and when it was deemed safe for sports practice.

Statistical Analysis

Descriptive analysis of the data was performed using Stata software version 17.0 (StataCorp LLC, College Station, TX, USA), and tables were created in Excel software version 365 (Microsoft Corporation, Redmond, WA, USA). Continuous variables were represented by mean and standard deviation, while categorical variables were represented by absolute numbers and relative frequency. The normality of continuous variables was verified using the Shapiro-Wilk test. Given the small sample size ($n = 12$), all comparisons between independent groups were performed using the Mann-Whitney U test. For paired comparisons in longitudinal measures, the Wilcoxon test was used. The assessment of pain over time was conducted using the Friedman test, complemented by pairwise comparisons with the Wilcoxon test. To investigate associations between age and clinical outcomes, the Spearman correlation coefficient was used. The level of statistical significance was set at 5% ($p < 0.05$).

RESULTS

Twelve elbows in nine patients were analyzed with a mean age of 51.5 years (± 7.4) and a mean BMI of 26.5 kg/m² (± 1.0). All patients engaged in regular physical activity, with weightlifting, running, and CrossFit being the most prevalent. The rupture was complete in nine cases and partial in three. Three patients presented with bilateral injury. The average time between trauma and surgery was four days. Two patients with partial injury were treated conservatively. Most injuries occurred in the dominant limb. Previous pain was reported in six cases, comorbidities in three, use of anabolic steroids in four, and smoking in two patients. The main characteristics of the sample are presented in Table 1, and the individual characteristics of each patient are in Table 2. Figures 1 to 4 illustrate clinical and radiographic images of the lesions.

Throughout the follow-up, progressive clinical improvement was observed (Table 3). Pain showed a statistically significant reduction between the first and the 48th week ($p < 0.001$). Comparisons between consecutive weeks showed continuous improvement through the 12th week, followed by stabilization between the 12th and 24th weeks, with further reduction through the 48th week. The Q-DASH score showed a significant improvement between 6 and 12 months ($p = 0.039$), whereas the MEPS score remained high throughout the follow-up period, with no statistically significant difference between the same periods ($p = 0.157$). The average patient satisfaction was 9.9 on a scale from 0 to 10.

In comparisons between subgroups, no significant differences were observed in functional outcomes, pain, or satisfaction between

patients with total and partial injuries (Table 4). Similarly, patients with bilateral injuries and those treated conservatively did not differ statistically compared to others. However, it was observed that patients who underwent surgery early, within seven days after the trauma, had lower residual pain scores at 12 months (VAS 48S), with statistical significance ($p = 0.031$). Smoking patients showed worse functional performance at six months (MEPS6, $p = 0.0016$) and greater dysfunction at 12 months (Q-DASH12, $p = 0.044$). The use of anabolic steroids, the presence of previous pain, and the dominance of the injured limb did not significantly influence the functional outcomes. The presence of comorbidities was associated with a trend towards worse functional performance on the MEPS

Table 1. Clinical and demographic characteristics of the study participants.

Characteristic	Value/Number
Sex (Male/Female)	12 / 0
Age (years)	51.5 ± 7.4
BMI (kg/m)	26.5 ± 1.0
BMI > 25	12 (100%)
Physical activity	
- Weightlifting	10 (83.3%)
- Running	4 (33.3%)
- CrossFit	1 (8.3%)
- Kite-surf	1 (8.3%)
- Jiu-jitsu	1 (8.3%)
Smoking	2 (16.7%)
Use of anabolic steroids	4 (33.3%)
Injury to dominant limb	7 (58.3%)
Bilateral injury	3 (33.3%)
Type of injury	
- Complete rupture	9 (75%)
- Partial rupture	3 (25%)
Previous pain	6 (50%)
Time until surgery (days)	3.9 ± 4.7
Treatment	
- Surgical	10 (83.3%)
- Conservative	2 (16.7%)
Complications	1 (8.3%)
Time to return to sport (months)	4.6 ± 1.6

It refers to the percentage of individuals with bilateral injury among those with some type of injury.

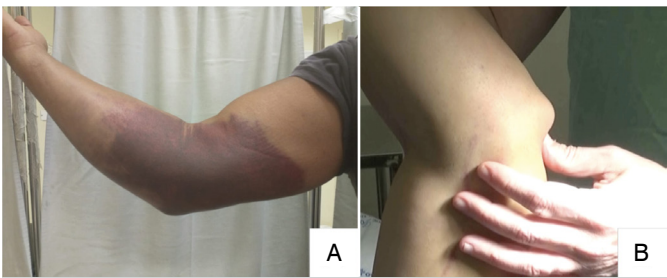


Figure 1. Clinical images from the physical examination of two patients. A) Bruising on the elbow around the injury. B) Palpable gap at the site of the tendon rupture.

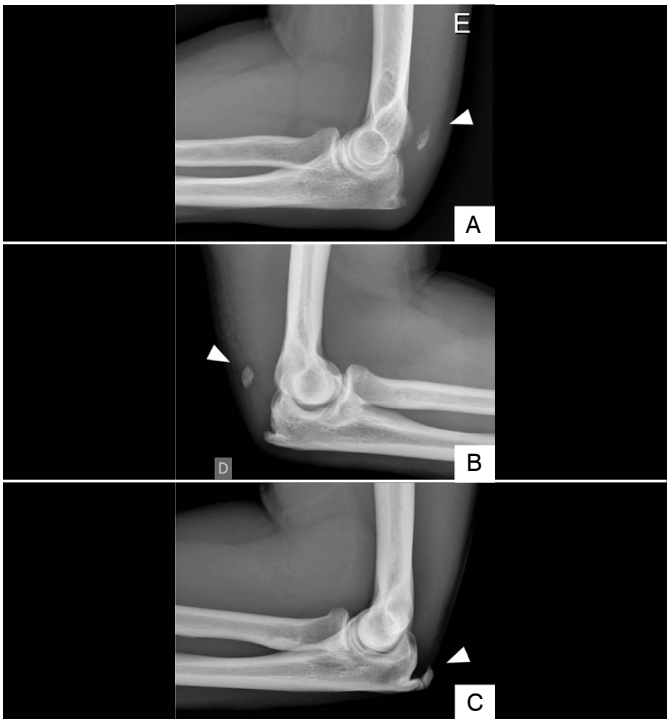


Figure 2. Lateral radiographs of the elbow showing the injury. A and B) The arrows point to the avulsed bone fragment from the osteophyte. C) The arrow points to the olecranon osteophyte, already showing signs of incomplete fracture, on the verge of rupture.

Table 2. Individual clinical characteristics of the study participants.

Case	Gender	Age (years)	BMI (kg/m)	Dominant limb	Type of injury	Time to surgery (days)	Physical activity	Comorbidities	Habits	Trauma mechanism	Previous pain
1	M	52	25,6	Yes	Total	2	Weight training	—	—	Weight training	Yes
2	M	60	25,2	Yes	Total	7	Running	SAH, melanoma, lung cancer	Smoking	Getting out of bed	No
3	M	60	25,2	No	Partial	Conservative	Running	SAH, melanoma, lung cancer	Smoking	Getting out of bed	No
4	M	44	27,4	Yes	Total	1	Weightlifting, Cross-Fit	—	Anabolic	Weight training	Yes
5	M	46	26,9	Yes	Total	14	Weightlifting, Cross-Fit, Kite-surfing	—	—	Kite-surfing training	Yes
6	M	66	28,1	Yes	Total	1	Weight training	SAH, DM	Anabolic	Fall from one's own height	No
7	M	40	25,4	No	Partial	10	Weight training, Jiu-jitsu	—	Anabolic	Jiu-jitsu	No
8	M	51	27,0	Yes	Total	1	Weight training	—	—	Fight	Yes
9	M	51	27,0	No	Total	1	Weight training	—	—	Fight	Yes
10	M	48	27,2	Yes	Total	1	Weightlifting, Running	SAH, DM	—	Motorcycle fall	No
11	M	48	27,2	No	Total	1	Weightlifting, Running	SAH, DM	—	Motorcycle fall	No
12	M	52	25,8	No	Partial	Conservative	Weight training	—	Anabolic	Weight training	Yes

at six months ($p = 0.103$), without a statistically significant impact on other outcomes.

There was a negative correlation between age and MEPS at six months ($p = 0.082$) and a positive correlation between age and Q-DASH at the same time point ($p = 0.087$), suggesting that older patients had slightly inferior functional recovery in the early stage of

follow-up, although this was not statistically significant. No relevant correlations were observed between age and pain or satisfaction.

DISCUSSION

The results of this study demonstrated a favorable clinical evolution in patients with distal triceps tendon rupture associated with olecranon osteophyte avulsion. Progressive improvement in pain was observed throughout the follow-up period, with clinical stabilization beginning in the 12th week. Upper limb function, assessed by the Q-DASH, showed consistent improvement between the sixth and twelfth months, while MEPS scores remained high throughout the follow-up. Most patients reported high satisfaction with functional outcomes. Among the subgroups, early surgery was associated with less residual pain, and smoking patients showed worse functional outcomes in intermediate assessments. Age also showed a tendency for slightly inferior initial functional performance. These findings reinforce the relevance of clinical and behavioral factors in the functional prognosis of this rare injury.

The good functional results observed corroborate previous findings in case series and systematic reviews, which show significant improvement in pain and function after surgical repair of the triceps, especially when performed early^{1,2}. In contrast, delays in diagnosis, common in injuries with preserved extension, are associated with worse outcomes, as reported by Sharma et al. and Downey et al.^{4,5}. This emphasizes the importance of early diagnosis, especially in patients with persistent pain and a history of eccentric effort.

The association with avulsion of osteophytes from the olecranon, present in all cases in this series, is rarely described in the literature but has been reported in anatomical studies and isolated cases⁷⁻⁹. These spurs may represent mechanical weak points at the triceps insertion, predisposing to rupture even with low-energy trauma. The fracture of the spur can be subtle or mistaken for benign calcifications, delaying recognition of the condition¹⁰.

Surgical treatment proved effective, regardless of the technique used. Techniques with anchors, transosseous methods, or suture bridges are widely used, and the results of the present series are consistent with the good outcomes described by Furuhashi et al. and Bernardi et al.^{11,12}. The failure reported by Neumann et al. with isolated anchors highlights the importance of assessing bone quality and adapting the technique as needed³.



Figure 3. Ultrasound image of the elbow. The left arrow points to the avulsed bone fragment and the right arrow points to the remaining osteophyte that is still attached to the olecranon.

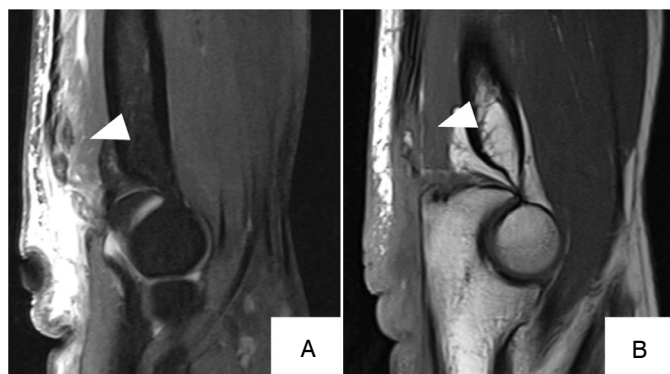


Figure 4. Sagittal cuts from magnetic resonance imaging highlighting the injury with arrows pointing to the bone fragment avulsed by the triceps tendon. A) T2 weighting. B) T1 weighting.

Table 3. Functional results, pain intensity, and patient satisfaction over the follow-up period.

Case	Return to sport (months)	Q-DASH (6M)	Q-DASH (12M)	MEPS (6M)	MEPS (12M)	VAS (1W)	VAS (2W)	VAS (4W)	VAS (8W)	VAS (12W)	VAS (6M)	VAS (1Y)	Satisfaction
1	4	0.0	0.0	100	100	6	5	2	1	1	1	0	10
2	2	10.0	2.5	85	100	7	5	2	1	1	1	1	10
3	2	2.5	0.0	85	100	5	3	2	1	1	1	0	10
4	4	0.0	0.0	100	100	3	2	1	1	0	1	0	10
5	6	5.0	0.0	100	100	7	6	3	2	2	1	1	9
6	6	2.5	0.0	100	100	8	7	5	1	0	0	0	10
7	4	0.0	0.0	100	100	8	7	5	1	1	1	1	10
8	6	0.0	0.0	100	100	4	4	3	1	0	1	1	10
9	6	0.0	0.0	100	100	4	4	3	1	0	1	1	10
10	6	0.0	0.0	100	100	7	7	5	2	2	1	0	10
11	6	0.0	0.0	100	100	7	7	5	2	2	1	0	10
12	3	2.5	0.0	100	100	4	3	3	1	0	0	0	10
Average	4.6	1.9	0.2	97.5	100.0	5.8	5.0	3.3	1.3	0.8	0.8	0.4	9.9
Minimum	2.0	0.0	0.0	85.0	100.0	3.0	2.0	1.0	1.0	0.0	0.0	0.0	9.0
Maximum	6.0	10.0	2.5	100.0	100.0	8.0	7.0	5.0	2.0	2.0	1.0	1.0	10.0
Standard deviation	1.6	3.0	0.7	5.8	0.0	1.7	1.8	1.4	0.5	0.8	0.4	0.5	0.3

Table 4. Subgroup analysis: p-values for functional scores, pain (VAS), and satisfaction.

Subgroups	MEPS (6M)	MEPS (12M)	Q-DASH (6M)	Q-DASH (12M)	VAS (1W)	VAS (2W)	VAS (4W)	VAS (8W)	VAS (12W)	VAS (24W)	VAS (48W)	Satisfaction
Partial vs. total injury	0.48	1.00	0.68	0.70	1.00	0.51	1.00	0.33	0.84	0.48	0.83	0.70
Early vs. late surgery	0.48	1.00	0.15	0.12	0.11	0.34	1.00	0.81	0.24	0.48	<0.05*	0.12
Unilateral vs. bilateral injury	0.17	1.00	0.79	0.40	0.74	1.00	0.93	0.59	0.55	0.17	0.64	0.40
Smoking	<0.05*	1.00	0.07	<0.05*	1.00	0.44	0.14	0.48	0.73	0.62	0.90	0.82
Anabolic steroids	0.36	1.00	1.00	0.60	0.93	0.86	0.72	0.21	0.10	<0.05*	0.49	0.60
Comorbidities	0.10	1.00	0.36	0.31	0.13	0.21	0.45	0.39	0.23	0.90	0.26	0.50
Previous pain	0.17	1.00	0.65	0.40	<0.05*	0.06	0.16	0.59	0.17	1.00	0.64	0.40
Dominant limb	0.90	1.00	0.71	0.50	0.87	0.80	0.50	0.83	1.00	0.90	1.00	0.50
Age	0.08	0.09	0.09	0.93	0.65	0.55	0.17	0.35	0.11	0.44	0.33	0.33

Values with asterisk indicate $p < 0.05$ (statistically significant difference). MEPS: Mayo Elbow Performance Score. Q-DASH: Quick Disabilities of the Arm, Shoulder and Hand. VAS: Visual Analog Scale for Pain. W: weeks; M: months

Clinical variables, such as smoking and age, influenced the outcomes, reflecting patterns already observed in other orthopedic conditions. Although not always directly addressed in studies on the triceps, factors such as compromised vascularization and reduced tendon healing capacity help explain these differences¹³⁻¹⁶. Thus, the findings of this series reinforce the importance of individualized approaches and early attention to clinical signs suggestive of this rare entity.

Limitations

This study presents methodological limitations that must be considered. The small number of patients limits the statistical power to detect differences between subgroups and compromises the generalization of the findings. However, since it is a rare clinical condition, this series represents one of the largest ever published, providing descriptive relevance to the work.

The retrospective design may introduce selection bias and limitations in the standardization of data collection. Nevertheless, all patients were treated at a single specialized center, under homogeneous clinical protocols, which favors the consistency of the data. The absence of a control group limits causal inference, particularly regarding the effectiveness of conservative treatment. However, the prospective collection of functional data at multiple time points over 12 months enabled a robust evolutionary analysis of patients' clinical and functional recovery.

CONCLUSION

The rupture of the distal triceps tendon associated with the avulsion of an olecranon osteophyte is a rare condition, but with an excellent functional prognosis when diagnosed early and treated appropriately.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this manuscript. EBSL: project development, data collection and analysis, manuscript writing; TSV: project development and manuscript writing; EBC: project development and manuscript writing; PSB: data collection and manuscript writing; ACP: data collection and manuscript writing; BE: study coordination, data collection and manuscript writing. All authors reviewed the manuscript and agreed to submit the final version of the article for publication.

DATA AVAILABILITY DECLARATION

The underlying contents of the research text are contained in the manuscript.

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NATIONAL INSTITUTE OF TRAUMATOLOGY AND ORTHOPEDICS: A BIBLIOMETRIC STUDY

INSTITUTO NACIONAL DE TRAUMATOLOGIA E ORTOPEDIA: ESTUDO BIBLIOMÉTRICO

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ABSTRACT

Objective: This study aimed to map the scientific production of the National Institute of Traumatology and Orthopedics (INTO) over its 50 years of history. **Methods:** We conducted a descriptive bibliometric study in the PubMed, Scopus, and BVS databases, retrieving 522 articles published between 2007 and 2024. We identified the co-citation networks of INTO-affiliated authors, the keyword networks with the main topics addressed in the publications, and the institution's interaction network with other research and teaching entities. **Results:** There was a progressive growth in publications linked to INTO. In the last six years (2019–2024), the annual average number of publications increased by 44.83% compared with the previous period. The keywords with the highest co-occurrence were related to applied research, mainly with an epidemiological profile, but also to different study designs in basic and translational research. **Conclusions:** The analysis revealed a higher frequency of collaboration with public universities (UFRJ, UFF, UERJ, and USP). The institution's scientific production presented a well-articulated scientific collaboration network. Part of INTO's mission was evidenced through its work in public health research for health promotion in orthopedics and its contribution to the production of data for the formulation of public policies. **Level of Evidence V; Descriptive Studies with Qualitative Approach.**

Keywords: Bibliometrics; Scientific Publication Indicators; Orthopedics; Unified Health System.

RESUMO

Objetivo: O objetivo deste artigo foi mapear a produção científica do Instituto Nacional de Traumatologia e Ortopedia (INTO) nos seus 50 anos de história. **Métodos:** Realizamos estudo bibliométrico descritivo nas bases de dados Pubmed, Scopus e BVS, sendo obtidos 522 artigos, de 2007 a 2024. Identificamos as redes de co-citação dos autores filiados ao INTO, de palavras-chave, com os principais temas abordados nas publicações, e de interação da instituição com outras entidades de pesquisa e ensino. **Resultados:** Houve um crescimento progressivo nas publicações ligadas ao INTO. Nos últimos seis anos (2019-2024), a média anual de publicações aumentou 44,83% em relação ao período anterior. As palavras-chave de maior coocorrência estavam relacionadas à pesquisa aplicada, principalmente de perfil epidemiológico, mas também a diferentes desenhos de estudos em pesquisa básica e translacional. **Conclusões:** A análise revelou maior frequência de colaboração com as universidades públicas (UFRJ, UFF, UERJ e USP). A produção científica da instituição apresentou uma rede de colaboração científica articulada. Evidenciou-se parte da missão do INTO com a atuação em pesquisa em saúde pública para a promoção de saúde em ortopedia e sua contribuição na produção de dados para elaboração de políticas públicas. **Nível de Evidência V; Estudos Descritivos com Abordagem Qualitativa.**

Descritores: Bibliometria; Indicadores de Produção Científica; Ortopedia; Sistema Único de Saúde.

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INTRODUCTION

The Instituto Nacional de Traumatologia e Ortopedia (INTO), affiliated with Brazil's Ministry of Health, is a national reference for the high-complexity treatment of the musculoskeletal system within the Unified Health System (SUS). It also stands out in research and innovation in orthopedics and traumatology, contributing to the formulation of guidelines, clinical protocols, and new surgical techniques in Brazil.

Created in 1973 as the Hospital de Traumatologia-Ortopedia, following the acquisition of the Hospital Central de Acidentados by the National Institute of Social Security, the institution's trajectory has been marked by pioneering work in several areas of orthopedics. Notably, it performed the first hip arthroplasty with a ceramic prosthesis in 1975. In 1994, it was recognized as a National Institute affiliated with the Health Care Secretariat of the Ministry of Health. Currently, INTO is the only Brazilian hospital to be part of the International Society

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

The study was conducted at the Instituto Nacional de Traumatologia e Ortopedia (INTO), Rio de Janeiro, RJ, Brazil.

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<< SUMÁRIO

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of Orthopaedic Centers (ISOC), a society that brings together the 19 leading orthopedic hospitals in the world and disseminates best practices and innovations in orthopedic patient care. Musculoskeletal diseases (MSDs) represent a growing challenge for health systems, affecting the population's quality of life and increasing the demand for specialized care. According to global estimates, in 2017 and 2019 MSDs were among the leading diseases affecting the health of the world's population, being the leading cause of disability¹. Individuals with MSD are twice as likely to develop other chronic systemic diseases compared with those without these conditions². Although prevalent across all age groups, these conditions represent a substantial demand for rehabilitation services, including in children. In this context, specialized hospitals such as INTO are decisive for structuring the care network and optimizing the resources of the SUS³, ensuring greater functional, economic, and social independence for the population throughout life. Considering INTO's institutional relevance and its scientific production in consolidating health policies and practices, the objective of this study is to map the institution's scientific production over its 50 years of history. Specifically, it will quantify works whose affiliation is attributed to INTO, identify the main topics addressed in the publications, and analyze the institution's interaction network with other research and teaching entities.

MATERIALS AND METHODS

In September 2024, we used the PubMed, Scopus, and BVS databases to identify articles, with the following inclusion criteria: original scientific articles, reviews, case reports, observational or clinical

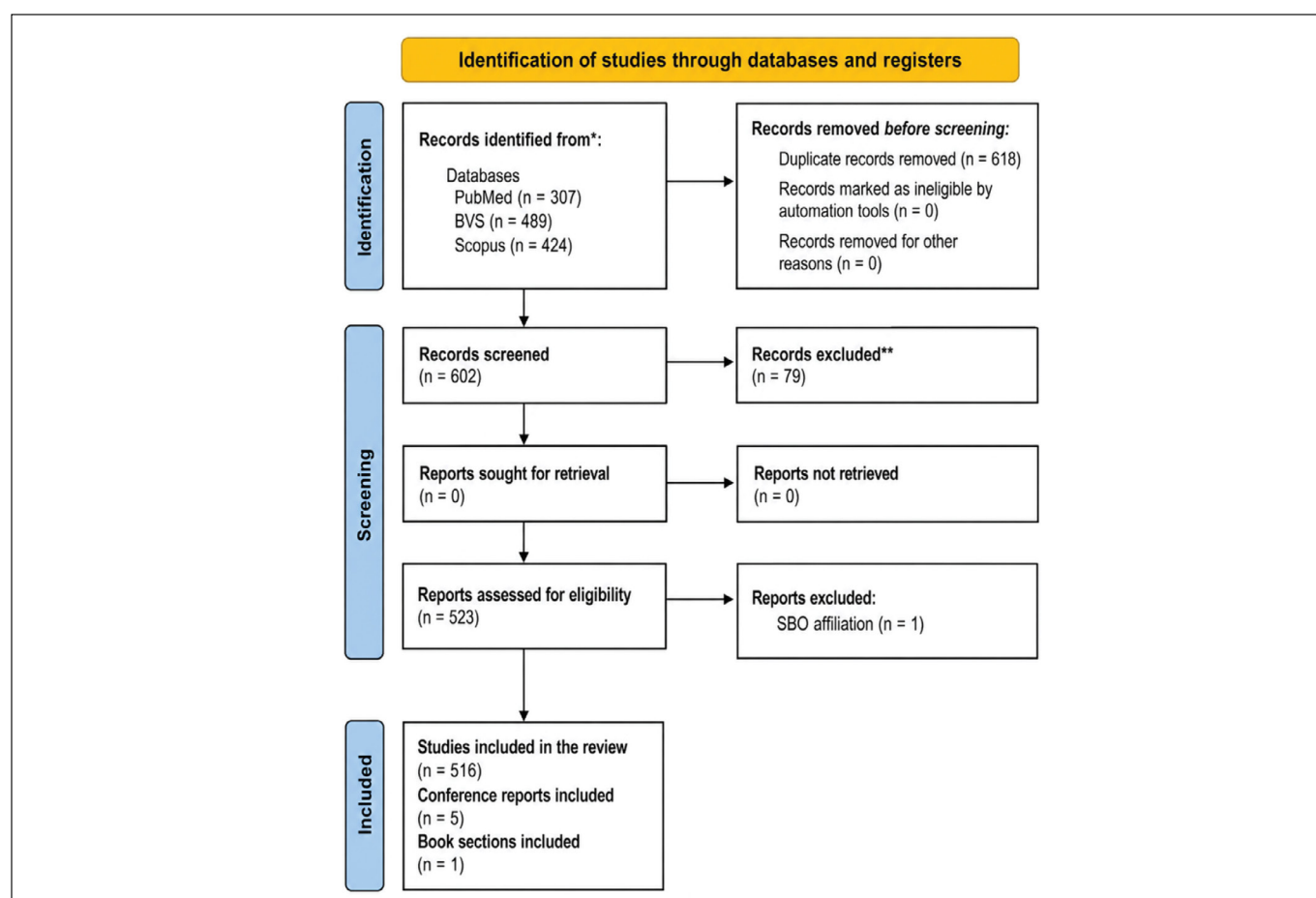
studies, with no time restriction on the searches. The keywords used were "Instituto Nacional de Traumatologia" and "INTO", combined with the Boolean operators AND and OR. Additionally, in the PubMed database, a specific search was performed using the selection of the institution in the "Affiliation" field. The search strategy used, which retrieved 307 publications, is shown below.

1. (((("Instituto Nacional de Traumatologia e Ortopedia"[Affiliation]) OR ("INTO"[Affiliation])) OR ("National Institute of Traumatology and Orthopedics" AND Brazil)) OR (("National Institute of Traumatology and Orthopaedics"[Affiliation]) AND ("INTO"[Affiliation]))) OR ("Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad (INTO)"[Affiliation])

The same strategy was applied to the BVS and Scopus databases, retrieving 489 and 424 publications, respectively.

The Rayyan software was used to remove duplicates and select the articles according to the criteria. Thus, 1,220 publications were identified. After analysis, 617 publications were confirmed as duplicates and discarded.

Next, the adherence of each publication's affiliation to INTO was verified in 603 publications by two independent reviewers, and disagreements were resolved by discussion. Of these, 79 articles were excluded for being affiliated with the "Instituto Nacional de Traumatologia e Ortopedia" of other countries; one article was excluded because it was conducted at the "Hosp. de Traumatologia-Ortop. RJ (INTO)" but its affiliation was attributed to the Brazilian Society of Orthopedics; and another article was excluded for being a duplicate. Finally, we obtained 522 articles attributed to INTO that were published between 2007 and 2024 (Figure 1).



Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

Figure 1. Publication selection flowchart.

The bibliometric analysis examined collaboration networks and keyword occurrences with the aid of the VOSviewer software. The evaluation of keywords, authorship, and organizations was preceded by data processing with the Thesaurus tool in order to normalize terms from different languages into English.

RESULTS

The annual publication of the 522 articles shows three periods of growth: an initial range up to 2012, followed by a period up to 2018, and finally a new plateau up to 2024 (Figure 2).

The average frequency of scientific publications between 2007 and 2012 was 16 articles per year, increasing to 29 per year from 2013 to 2018. In the last six years (2019–2024), the average rose to 42, a growth of 44.83% compared with the previous period and of 162.5% compared with the first interval analyzed (2007–2012). This significant growth in scientific production reflects a strengthening of institutional research.

Regarding author productivity, the analysis of the co-author network can reveal which authors contributed most to research at INTO. Among the 8,982 co-authors who contributed to this research, 58 authors were co-cited more than 95 times. All authors showed a positive co-citation relationship with the other authors. Among the 5 main co-cited authors, the author Guimarães stands out with 980 documents, collaborating with authors present in all 7 clusters generated by VOSviewer (Figure 3A).

It can be observed in Figure 3A that the 5 main authors belong to two distinct clusters, namely: cluster 2 (Guimarães and Duarte) and cluster 5 (Mozella, De Souza, and Rocha de Faria), indicating groups of authors who frequently collaborate with one another (co-authorship) with high interrelation. Among them, only two establish connections with all 7 clusters identified in VOSviewer, including the author with the highest number of publications and De Souza (fourth place). This indicates that they play a central role in the collaboration network, functioning as links between different research groups, which may reflect interdisciplinary activity or a strong impact within INTO's scientific community. It is interesting to note, when visualizing the publication timeline (Figure 3B), that 4 of the main authors had publications in the last 5 years. Analyzing cluster 1 of the co-authorship network visualization, its separation from the others is evident, indicating that the authors of this group have a more internal collaboration network that is less connected to the other clusters. However, the author Salles-Neto plays a bridging role between this cluster and the others. His proximity to the other nodes suggests that he maintains collaborations both within his own group and with other researchers. This strategic

position of Salles-Neto ensures that cluster 1 is not isolated from the other groups.

The co-occurrence analysis of the keywords in the articles published by INTO between 2007 and 2024 identified the main prominent themes within the institution's scientific production. In total, 4,200 keywords were found in 522 articles, with 49 words cited more than 70 times. The VOSviewer analysis allowed these words to be organized into a visual map, in which the proximity between terms indicates their correlation within the field of study. Terms frequently used together form clusters, highlighting specific subareas of research and their thematic connections.

Figure 4 presents the keywords with the highest co-occurrence. Of these, the five most frequent are related to applied research in humans ("humans", "male", "female", "adult", "middle aged"), reflecting the diversity of the population served at the institution, from children to adults.

A deeper analysis reveals the predominance of terms associated with different observational study designs, highlighting the term "retrospective studies" but also "cross-sectional studies", "prospective studies", "case-control studies", and "cohort studies", suggesting a broad methodological diversity, encompassing cross-sectional and cohort studies with both retrospective and prospective temporal follow-up analyses.

In addition, the formation of a specific cluster related to research with animal models stands out (cluster 4). Figure 4 shows the proximity between the terms "animals" and "mice" and the key terms "mesenchymal stem cells", "osteogenesis", and "osteoporosis", indicating the relevance of developing basic research studies for the implementation of translational research at the institution, and clinical applicability in humans. Interestingly, the terms "animals" and "mice" are connected by the term "bone" as a linking element to the other terms.

In the context of orthopedics, the keywords reflect the activity of the institution's CAAEs, encompassing areas such as Knee ("knee", "knee arthroplasty", "osteotomy", "tibia"), Hip ("hip arthroplasty", "osteotomy"), Spine ("spine", "scoliosis", "kyphosis"), and Shoulder and Elbow ("shoulder"), evidencing the breadth and high complexity of the research developed at the institution.

The analysis highlights the relative disconnection of cluster 6, formed by the terms "nursing", "pain", and "quality of life". The keyword "nursing" appears isolated, without direct connections to others; its link is made through the term "pain", which connects to 12 keywords.

Finally, a set of words related to the assessment of risk factors ("risk factors"), prevalence ("epidemiology"), outcomes and complications ("treatment outcome", "postoperative complications"), as well as prosthesis and implant interventions ("arthroplasty"), is observed. In addition, terms associated with diagnostic and prognostic assessment examinations ("magnetic resonance image", "radiography", "muscle strength") also stand out, reinforcing the interdisciplinarity of the research developed at the institution, given its eight Research Laboratories registered, such as those for Neuromuscular Research and Exercise Physiology.

Additionally, 34 institutions cited at least 5 times were identified, represented by 305 of the 522 documents retrieved from the databases. Thus, the VOSviewer tool organized these 34 institutions into 10 clusters. Here too, the network map shows (Figure 5) that, in terms of research relationships, despite being within cluster 2, there is strong collaboration between INTO and cluster 1, composed of the National Cancer Institute (INCA), the National Institute of Metrology, Quality and Technology (Inmetro), Hospital Santa Teresa, and the Federal University of Rio de Janeiro (UFRJ). The strong relationship between INTO and cluster 1 is based on the short distance between their nodes⁴.

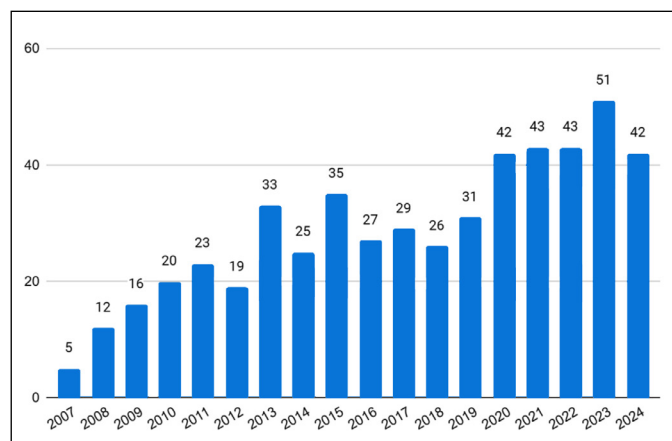
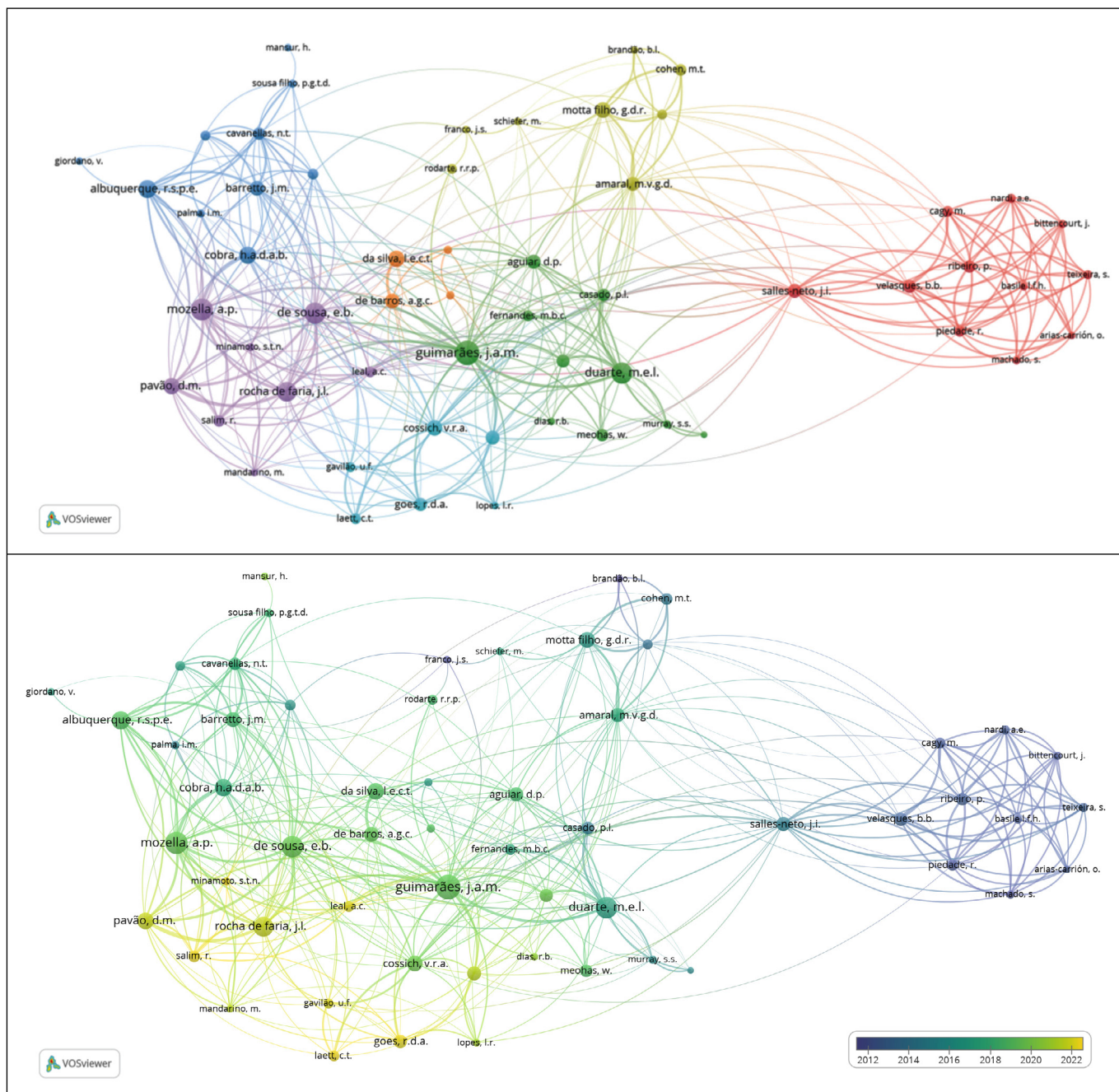


Figure 2. Absolute frequency of the evolution of the scientific production of articles affiliated with INTO from 2007 to 2024.



*The size of the nodes represents the number of publications of each author in the network, while the thickness of the connections indicates the frequency of collaboration between researchers. More connected authors form clusters, evidencing research groups with greater scientific interaction.

Figure 3. Co-authorship network of authors affiliated with INTO. A: Co-authorship network; B: Temporal co-authorship network.

There is a certain frequency, represented by the lines, with which INTO relates and collaborates in the production of knowledge, with those among the Federal Universities standing out, namely, the Universidade Federal do Rio de Janeiro (UFRJ), the Universidade Federal Fluminense (UFF), and the Universidade Federal do Estado do Rio de Janeiro (UNIRIO); Federal Institutions, such as the Instituto Nacional de Câncer (INCA), the Fundação Oswaldo Cruz (Fiocruz), the Instituto Nacional de Metrologia, Qualidade e Tecnologia (Inmetro), and the Instituto Nacional de Cardiologia (INC); State Universities, such as the Universidade do Estado do Rio de Janeiro (UERJ) and the Universidade de São Paulo (USP); and, finally, among International Institutions and Universities, such as the University of California, the University of Marburg,

and the Medical Center for Veterans Affairs, evidencing international insertion through this interaction network. They point to a higher frequency of collaboration with public universities (UFRJ, UFF, UERJ, and USP), especially UFRJ, indicated by the size of the nodes, the short distance between them, and the large thickness of its line (Figure 5).

It can be observed that the relationships between authors for the production of knowledge occurred predominantly between INTO and UFRJ, demonstrating the strong and frequent collaboration between them. Furthermore, it denotes research partnerships among peers in the context of internationalization (University of California, Institute of Applied Neurosciences, and Medical Center for Veterans Affairs) (Figure 5).

indicating a well-established scientific collaboration structure. This organization suggests the existence of common goals among the researchers, aligned with the orthopedic subspecialties, favoring the exchange of knowledge and the development of more robust research. Moreover, this structuring of collaboration tends to maximize both productivity and scientific impact⁸, and, when combined, they enhance knowledge creation.

It is also possible to observe, in these networks, the correlation between the clusters of researchers and INTO's orthopedic subspecialties. The main authors are currently affiliated with two units at the institution: Guimarães, Duarte, and Rocha de Faria with the Research Division, and Mozella, De Souza, and Rocha de Faria are associated with the Knee Surgery Center. The academic background of these researchers, with experience at UNIRIO, the University of California, UFF, UFRJ, and USP, demonstrates how institutional networks contribute to building collaborative networks, connecting INTO to national and international research centers. In addition, the existence of Graduate Programs, such as the Specialization Course in Nursing, in a Residency format developed in partnership with UNIRIO, may influence interinstitutional collaboration and consequent scientific production.

Although geographic proximity between institutions facilitates the exchange of knowledge and the sharing of resources, scientific collaboration also depends on political and institutional factors, such as regulations, agreements, and cooperation. At INTO, the interaction between specialized groups strengthens scientific production in orthopedics and traumatology, allowing the rapid incorporation of advances across subareas.

Regarding the predominant themes, the keyword with the most appearances is related to applied research in humans. This finding is expected, considering that the institution is a national reference unit of the SUS and is part of the direct administration of the Ministry of Health. This activity is aligned with its vision of being recognized nationally and internationally as a center of excellence in care, teaching, research, and management in the areas of orthopedics, traumatology, and rehabilitation, where scientific findings are directly transposed into clinical practice and into the formulation of health policies.

Furthermore, the results reveal a broad methodological spectrum, with emphasis on translational studies in the health field aimed at overcoming the limitations of conventional bone and cartilage regeneration therapies. Despite advances in the use of biomaterials and mesenchymal stem cells⁹, the clinical application of these approaches still faces challenges related to the standardization of protocols for cell expansion, the low rate of graft integration, and the heterogeneity of the mesenchymal stem cells used⁹. From a public health perspective, understanding how new therapies are integrated into the health system and what barriers exist to their adoption is essential for building evidence-based guidelines.

Another aspect that deserves consideration in the incorporation of new orthopedic therapeutic approaches is the epidemiological profile of the Brazilian population. Between the years 2000 and 2023, the country underwent an accelerated process of population aging; the proportion of older adults jumped from 8.7% to 15.6%, and projections indicate that about 37.8% of Brazilians will be older adults by 2070¹⁰. With aging, the incidence and prevalence of degenerative processes of the musculoskeletal system¹¹ also increase¹¹, affecting the quality of life and functional mobility of this segment of the population.

In the global scenario, data indicate that 40% of older patients undergo orthopedic surgery and, among them, 24% present with

sarcopenia, impacting recovery and rehabilitation¹². In Brazil, hospitalizations due to falls among older adults have been increasing, with a projected economic impact of approximately R\$260 million on the Brazilian health system in 2025¹³, reinforcing the need for multidisciplinary and technological approaches to reduce morbidity and improve outcomes¹⁴.

The distribution of these surgeries across Brazilian territory evidences the concentration of specialized care in a few reference centers, such as INTO. The institution accounts for 58.7% of high-complexity orthopedic surgeries in the city of Rio de Janeiro and 39.3% in the state¹⁵. Regarding the institution's most common surgeries, they are concentrated in the Spine, Knee, and Hip subspecialties, corroborating the global scenario in which hip and knee arthroplasties are among the most frequently performed elective orthopedic procedures¹⁶, mainly due to the high prevalence of osteoarthritis and population aging. This care pattern points to the impact of degenerative musculoskeletal diseases and the need for reference centers in the management of these complex conditions.

However, although the SUS provides high-complexity services, demand exceeds its response capacity, resulting in delays in care and worsening of clinical conditions. The importance of strengthening primary health care, capable of acting preventively and diagnostically, therefore stands out³.

Another relevant topic for the management of orthopedic patients concerns interdisciplinary discussions. When analyzing the keyword network, a disconnection is observed, especially with the isolation of the term "nursing", revealing a gap regarding the themes of pain and quality of life. In the literature, the role of nursing in pain management and the promotion of self-care is central, especially through educational interventions. For example, preoperative education about pain reduces postoperative opioid consumption and improves patient satisfaction¹⁷. Continuity of care, especially in chronic conditions^{18,19}, and multidisciplinary integration are associated with reduced mortality and long-term sequelae²⁰.

These aspects are aligned with the findings of this analysis, which evidenced the strong presence of terms associated with the assessment of risk factors, prevalence, and postoperative complications, in addition to surgical interventions such as arthroplasty.

CONCLUSION

There was an increase in INTO's scientific production in the period between 2007 and 2024, especially in the last six years (2019–2024). The institution presented a well-articulated scientific collaboration network and highlighted the importance of strategic partnerships in promoting evidence-based practices and in training qualified professionals, reflected in the productivity of its collaborators. INTO's commitment to public health research, especially in the epidemiological area, and its multidisciplinary approaches were evidenced. In this way, its integration with primary care strengthens the SUS, ensuring more efficient and effective care for the population, which reaffirms INTO's role as a center of excellence in orthopedic care and as an active agent in the promotion of public health in Brazil.

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CONTRIBUTIONS OF THE AUTHORS

Each author made a personal and significant contribution to the development of this article. RFON: Data collection, Data analysis, Design of data presentation, Data interpretation, Writing of the original manuscript. JAMG: Supervision, Writing – review and editing. PCSC: Conceptualization, Data collection, Data analysis, Data curation, Data interpretation, Writing of the original manuscript and review. All authors approved the final version submitted.

DATA AVAILABILITY DECLARATION

The data underlying the research text are available upon the reviewers' demand/request.

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ARE POSTS ABOUT TRIGGER FINGER ON THE SOCIAL NETWORK INSTAGRAM OF ADEQUATE QUALITY AND RELIABILITY?

AS PUBLICAÇÕES SOBRE DEDO EM GATILHO NA REDE SOCIAL INSTAGRAM TÊM QUALIDADE E CONFIABILIDADE ADEQUADAS?

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ABSTRACT

Introduction: Trigger finger (stenosing tenosynovitis of the flexors) is a common hand condition, causing pain and functional limitation. With the increasing use of social media as a source of information, especially Instagram, it becomes necessary to evaluate the quality and reliability of content related to the topic made available to the public. **Objective:** To evaluate the quality and reliability of information about trigger finger published on Instagram, using the validated instruments modified DISCERN and Global Quality Score (GQS). **Methods:** Observational, cross-sectional study based on the analysis of the hashtags #triggerfinger and #stenosingtenosynovitis. 118 eligible posts were analyzed. Two independent evaluators (orthopedic residents in hand surgery) classified the content. **Results:** There was excellent inter-rater agreement, and a positive correlation was observed between longer content duration and better quality. There was a significant difference between professionals: hand surgeons presented higher quality scores. **Conclusion:** The quality of the information is very low to moderate. Content produced by hand surgeons presents greater technical rigor, and the Reels format offers better informational quality. **Level of evidence V; Descriptive observational study.**

Keywords: Social Media; Messaging; Social Media; Trigger Finger Disorder; Stenosing Tenosynovitis; Internet.

RESUMO

Introdução: O dedo em gatilho (tenossinovite estenosante dos flexores) é uma condição comum da mão, causando dor e limitação funcional. Com o crescente uso de redes sociais como fonte de informação, especialmente o Instagram, torna-se necessário avaliar a qualidade e confiabilidade dos conteúdos relacionados ao tema disponibilizados ao público. **Objetivo:** Avaliar a qualidade e a confiabilidade das informações sobre dedo em gatilho publicadas no Instagram, utilizando os instrumentos validados DISCERN modificado e Global Quality Score (GQS). **Métodos:** Estudo observacional, transversal, baseado na análise com as hashtags #dedoemgatilho e #tenossinoviteestenosante. Foram analisados 118 posts elegíveis. Dois avaliadores independentes (ortopedistas residentes em cirurgia da mão) classificaram os conteúdos. **Resultados:** Houve excelente concordância interavaliadores e observou-se correlação positiva entre maior duração do conteúdo e melhor qualidade. Houve diferença significativa entre profissionais: cirurgiões de mão apresentaram maiores escores de qualidade. **Conclusão:** A qualidade das informações é muito baixa a moderada. Conteúdos produzidos por cirurgiões de mão apresentam maior rigor técnico, e o formato Reels apresenta melhor qualidade informacional. **Nível de evidência V; Estudo observacional descritivo.**

Descritores: Mídias Sociais; Meios de Comunicação Sociais; Dedo em Gatilho; Tenossinovite Estenosante; Internet.

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INTRODUCTION

Trigger finger (stenosing tenosynovitis of the flexor tendon at the A1 pulley) was a term first proposed by Notta in 1850.¹ This condition is one of the most common causes of pain and disability in the hand, leading to varying degrees of limitation of daily activities.² It presents with hand pain, edema, discomfort, and disability, with a “triggering” sensation.

Trigger finger is characterized by blocked gliding movements of the flexor tendon during finger flexion and extension at the topography of the A1 pulley.³ These pathological changes lead to an increase in the size of the flexor tendon and its tendon sheath, resulting in the inability to flex or extend the finger without discomfort.⁴ It has an annual incidence in the general population of 28 per 100,000 people.⁵ Among adults, women in the 5th and 6th decades

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of life are the most affected by trigger finger.⁴ In addition, trigger finger may be associated with other conditions, including carpal tunnel syndrome, gout, rheumatoid arthritis, De Quervain's disease, and diabetes mellitus.⁴

In general, the diagnosis is clinical, with a classic presentation of "clicking" and locking of the finger. However, ultrasonography or magnetic resonance imaging (MRI) may aid in the differential diagnosis with other conditions.³

Currently, several treatment options are available for trigger finger, including noninvasive and surgical procedures.² Conservative treatment is initially chosen, with the use of splints, physiotherapy, nonsteroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injection. Despite the good results of steroid treatment, many patients with trigger finger still require surgical therapy, with open or percutaneous release of the A1 pulley.³

Although the diagnosis of trigger finger is clinical and relatively simple, many patients turn to the internet to better understand this condition, its symptoms, and forms of treatment. Studies show that interest in online information about trigger finger has increased in recent years, reflecting the growing search for self-diagnosis and understanding of the disease by patients.⁶

Access to medical information through the internet has become a common practice among patients seeking to understand symptoms, diagnoses, and treatment options before consulting a health professional. However, the quality and accuracy of this information vary considerably, which can lead to misinterpretations and inappropriate clinical decisions.

An analysis of medical images related to common hand conditions revealed that 55% of the images about trigger finger contained errors, most of them originating from the websites of private and academic medical institutions.⁷

Furthermore, the way information is presented significantly influences patient understanding. A randomized clinical trial demonstrated that educational videos provide better understanding and greater satisfaction among patients with trigger finger compared with printed leaflets.⁸

In view of this scenario, it becomes essential to critically evaluate the quality, reliability, and accuracy of the information about trigger finger available on the internet, especially Instagram, one of the most common social media platforms, which presents itself as a fast and widely disseminated tool today, with Brazil being the third country with the largest number of users, totaling 134 million.⁹

However, the quality of the information provided by this platform appears questionable, as already evidenced by previous studies conducted on other topics, such as prostate cancer,¹⁰ oral cavity cancer,¹¹ and hypothyroidism.¹²

By identifying the reliability and quality of this information, it becomes possible to confirm the accuracy of the data conveyed to patients, as well as to prevent misunderstandings and to preemptively address any doubts that may arise.

The hypothesis of this study is that the content available on Instagram about trigger finger/flexor stenosing tenosynovitis is of low quality and reliability.

Therefore, this study proposed a systematic analysis of Instagram posts with the hashtags #dedoemgatilho and #tenossinoviteestenose, using the modified DISCERN score (Figure 1), translated into Portuguese,¹³ and the Global Quality Score.¹⁴ (Figure 2)

GQS Scoring System	
Score	Global score description
1	Poor quality, poor flow of site, most information missing, not at all useful for patients
2	Generally poor quality and poor flow, some information listed but missing many important points, very limited use for patients
3	Moderate quality, suboptimal flow, some important information is adequately discussed but others poorly discussed, somewhat useful for patients
4	Good quality and generally good flow, most of the relevant information is listed but some issues not covered, useful for
5	Excellent quality and excellent flow, very useful for patients

Figure 2. GQS Scoring System.

1. Os objetivos da publicação estão claros? Não Parcialmente Sim 0 1 2 3 4 5 2. A publicação atinge seus objetivos? Não Parcialmente Sim 0 1 2 3 4 5 3. A publicação é relevante para o leitor? Não Parcialmente Sim 0 1 2 3 4 5 4. As fontes de informação usadas são claras e confiáveis? Não Parcialmente Sim 0 1 2 3 4 5 5. A data das informações é claramente apresentada? Não Parcialmente Sim 0 1 2 3 4 5 6. As informações são equilibradas e imparciais? Não Parcialmente Sim 0 1 2 3 4 5 7. São apresentadas fontes adicionais de apoio e informação? Não Parcialmente Sim 0 1 2 3 4 5 8. São descritas áreas de incerteza? Não Parcialmente Sim 0 1 2 3 4 5	9. É descrito como cada tratamento funciona? Não Parcialmente Sim 0 1 2 3 4 5 10. São descritos os benefícios de cada tratamento? Não Parcialmente Sim 0 1 2 3 4 5 11. São descritos os riscos de cada tratamento? Não Parcialmente Sim 0 1 2 3 4 5 12. É descrito o que pode acontecer se nenhum tratamento for utilizado? Não Parcialmente Sim 0 1 2 3 4 5 13. A publicação descreve como as opções de tratamento afetam a qualidade de vida? Não Parcialmente Sim 0 1 2 3 4 5 14. Está claro que existem múltiplas opções de tratamento? Não Parcialmente Sim 0 1 2 3 4 5 15. A publicação apoia a tomada de decisão compartilhada? Não Parcialmente Sim 0 1 2 3 4 5 16. Avaliação global da qualidade da publicação. Não Parcialmente Sim 0 1 2 3 4 5
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Figure 1. DISCERN questionnaire translated into Portuguese.

OBJECTIVE

To evaluate the quality of posts about trigger finger on the social media platform Instagram, using two different objective scores: modified DISCERN and GQS, in addition to inter-observer reliability.

MATERIALS AND METHODS

Ethical approval was not required, as this study does not involve any human or animal participants.

A scientifically based, exploratory, cross-sectional study that analyzed, on a single day, the 118 most relevant posts with the hashtags #dedoemgatilho (68 posts) and #tenossinoviteestenose (50 posts), from a newly created Instagram account, configured as Brazilian and belonging to a fictitious female user, approximately 50 years of age.

Content that was not in Portuguese, was not publicly open, or was unrelated to trigger finger was excluded by two of the evaluators (LFAB and HYS); in case of disagreement, a third evaluator (VYM) would decide on inclusion. The included posts were independently evaluated by two different evaluators, second-year orthopedic residents in hand surgery.

The scores used to evaluate the content were the modified DISCERN and the GQS. DISCERN¹⁵ was jointly developed by the University of Oxford and the British Library team (adapted from DISCERN, a tool created to evaluate written health content); it assesses the reliability, quality, and relevance of publications, and was translated into Portuguese by Logullo P. et al.¹³

The scoring system consists of 16 questions: the first 8 assess the reliability of the publication, the next 7 questions assess the quality of the details about the treatment of the condition, and the 16th question assesses the overall quality of the publication. Each question is scaled from 1 to 5 points; a score of 1 indicates a lack of information, a score between 2 and 3 indicates that some information is present, and a score of 5 indicated all information available. The total score ranges from 15 to 80, and the score results are rated as excellent (63–80), good (51–62), moderate (39–50), poor (28–38), and very poor (16–27).

The Global Quality Score (GQS) (14) assesses the quality of the content on a scale from 1 to 5, with 1 for content with low quality of information, missing information, and little usefulness for patients, and 5 points for content with excellent quality of information, being relevant and useful for the patient.

RESULTS

We set a significance level of 0.05 (5%). Thus, the results are statistically significant when they are lower than the adopted significance level. Nonparametric statistical tests were used, as we tested the normality of the quantitative primary outcome variables using the Shapiro-Wilk test ($N \geq 100$) and concluded that a normal distribution is not assured. We performed a descriptive analysis of the two scores for each evaluator, but considering the total sample. A total sample size of $N = 118$ publications was obtained, with results according to Table 1. Analyzing, for example, DISCERN Evaluator 1 (DISCERN 1), we obtained a mean of 24.02 ± 1.00 . Considering the same Evaluator 1, but now for GQS (GQS 1), the mean was 2.09 ± 0.15 . For the DISCERN score by Evaluator 2 (DISCERN 2), we obtained a mean of 22.25 ± 0.93 . Considering the same Evaluator 2, but now for GQS (GQS 2), the mean was 1.99 ± 0.15 .

In addition, the agreement between the two evaluators was assessed for the results of the DISCERN and GQS questionnaires. Table 2 demonstrates that there is statistically significant agreement between the evaluators, both for DISCERN and for GQS. The ICC (Intraclass Correlation Coefficient) values are quite high.

The posts show a statistically significant correlation of duration with both DISCERN and GQS. We note that all correlations are positive, demonstrating that the longer the duration, the higher the DISCERN or GQS result.

We categorized the number of views as Low (fewer than 3,000) and High (more than 3,000) in order to analyze the relationship with the Professional. Table 3 shows the joint distribution of the variables in absolute values and their percentages across all combinations of the levels of these two variables. To verify whether or not there is an association (difference), we should examine the percentage values, by row, comparing the columns.

No statistical correlation was identified between views and the professional; that is, the results are considered statistically independent. It is worth noting that we did not consider the professional groups that had only 2 cases.

The data in Table 4 provide information to compare the relationship between the number of views and the scores; the table demonstrates that there is no statistical difference between Views (Low/High) and the quality results of DISCERN and GQS.

Table 1. Complete Descriptive Statistics of DISCERN and GQS in the Total Sample.

			Mean	Median	Standard Deviation	Q1	Q3	N	CI
DISCERN	Evaluator 1	Trigger finger	24.02	24.0	5.56	21.0	26.8	118	1.00
	Evaluator 2	Trigger finger	22.25	21.0	5.13	19.0	25.0	118	0.93
GQS	Evaluator 1	Trigger finger	2.09	2.0	0.84	2.0	2.0	118	0.15
	Evaluator 2	Trigger finger	1.99	2.0	0.85	1.0	2.0	118	0.15

Table 2. Agreement between Evaluators.

		ICC	p-value
Trigger finger	DISCERN	0.890	<0.001
	GQS	0.937	<0.001

Table 3. Relationship of Views with the Professional.

		Low		High		p-value
		%	N	%	N	
Trigger finger	Hand surgeon	6	33.3%	10	27.8%	0.673
	Physiotherapist	5	27.8%	15	41.7%	0.319
	Physician	3	16.7%	3	8.3%	0.358
	Orthopedist	2	11.1%	2	5.6%	0.462
	Others	0	0.0%	2	5.6%	0.308
	Occupational therapist	2	11.1%	4	11.1%	1.000

Table 4. Relationship of Views (high vs. low) with the scores.

			Mean	Median	Standard Deviation	Q1	Q3	N	CI	p-value
DISCERN 1	Trigger finger	Low	25.56	25.5	5.73	23.0	28.8	18	2.65	0.769
		High	25.36	24.5	6.35	22.0	29.0	36	2.07	
DISCERN 2	Trigger finger	Low	23.61	21.0	5.63	20.0	27.5	18	2.60	0.733
		High	23.83	22.5	5.95	19.8	28.0	36	1.94	
GQS 1	Trigger finger	Low	2.44	2.0	0.86	2.0	3.0	18	0.40	0.797
		High	2.42	2.0	0.91	2.0	3.0	36	0.30	
GQS 2	Trigger finger	Low	2.33	2.0	0.84	2.0	3.0	18	0.39	0.968
		High	2.33	2.0	0.93	2.0	3.0	36	0.30	

The 5 professional groups were analyzed, with the data shown in Tables 5 and 6, in which it was possible to demonstrate that there is a statistically significant difference among them in the DISCERN 1 and 2 evaluations, as well as GQS 2 (p-values in Table 5). Let us take as an example the result for DISCERN 1, where the highest mean was for Hand Surgeon, with a mean of 26.49, which, based on the post-hoc p-values, is statistically different from the Physiotherapist, with a mean of 22.06 (p-value = 0.002), and from the Occupational Therapist, with a mean of 21.82 (p-value = 0.033). In addition to these data, the type of publication was analyzed and compared for the scores of each evaluator, which is shown in Tables 7 and 8. We divided the publications into 3 types: photo, Reels (short video), and carousel (a post with more than 1 photo). In the data

Table 5. Comparison of the Professional for DISCERN and GQS.

		Mean	Median	Standard Deviation	Q1	Q3	N	CI	p-value
DISCERN 1	Hand surgeon	26.49	26.0	6.35	22.0	30.0	41	1.94	0.017
	Physiotherapist	22.06	22.0	4.32	19.0	25.0	35	1.43	
	Physician	23.94	24.5	3.73	21.8	27.0	16	1.83	
	Orthopedist	23.31	24.0	5.85	22.0	26.0	13	3.18	
	Occupational therapist	21.82	23.0	5.34	18.5	23.5	11	3.16	
DISCERN 2	Hand surgeon	24.73	24.0	5.93	20.0	29.0	41	1.81	0.002
	Physiotherapist	20.49	20.0	3.81	18.0	22.0	35	1.26	
	Physician	22.38	22.0	4.27	20.8	23.5	16	2.09	
	Orthopedist	21.69	22.0	4.57	21.0	24.0	13	2.48	
	Occupational therapist	19.45	19.0	4.41	17.5	20.0	11	2.61	
GQS 1	Hand surgeon	2.39	2.0	1.00	2.0	3.0	41	0.31	0.071
	Physiotherapist	1.80	2.0	0.72	1.0	2.0	35	0.24	
	Physician	2.06	2.0	0.57	2.0	2.0	16	0.28	
	Orthopedist	2.00	2.0	0.71	2.0	2.0	13	0.38	
	Occupational therapist	2.00	2.0	0.77	2.0	2.0	11	0.46	
GQS 2	Hand surgeon	2.37	2.0	0.99	2.0	3.0	41	0.30	0.011
	Physiotherapist	1.69	2.0	0.68	1.0	2.0	35	0.22	
	Physician	2.00	2.0	0.63	2.0	2.0	16	0.31	
	Orthopedist	1.92	2.0	0.64	2.0	2.0	13	0.35	
	Occupational therapist	1.64	1.0	0.92	1.0	2.0	11	0.55	

Table 6. Post-hoc p-values among the professionals.

		Hand surgeon	Physiotherapist	Physician	Orthopedist
DISCERN 1	Physiotherapist	0.002			
	Physician	0.226	0.076		
	Orthopedist	0.239	0.300	0.895	
	Occupational therapist	0.033	0.806	0.144	0.383
DISCERN 2	Physiotherapist	0.001			
	Physician	0.293	0.048		
	Orthopedist	0.201	0.155	0.930	
	Occupational therapist	0.005	0.254	0.011	0.054
GQS 2	Physiotherapist	0.002			
	Physician	0.236	0.109		
	Orthopedist	0.171	0.249	0.742	
	Occupational therapist	0.021	0.560	0.092	0.170

analysis, it was evidenced that there are statistically significant differences among the types of publications (p-values in Table 8). Analyzing Table 8, we found that in the comparisons performed the difference is observed between Photo and Reels, with photo-type publications always yielding the lowest mean and Reels-type publications the highest, as evidenced in the DISCERN 1 analysis with means of 22.07 and 25.23 (p-value = 0.004), respectively.

Table 7. Comparison of Publication Type for DISCERN and GQS.

		Mean	Median	Standard Deviation	Q1	Q3	N	CI	p-value
DISCERN 1	Carousel	25.19	24.0	5.34	21.5	27.3	16	2.62	0.010
	Photo	22.07	22.0	4.46	19.0	25.0	45	1.30	
	Reels	25.23	25.0	6.03	22.0	29.0	57	1.56	
DISCERN 2	Carousel	22.44	21.5	3.69	19.0	25.0	16	1.81	0.014
	Photo	20.47	20.0	4.31	18.0	22.0	45	1.26	
	Reels	23.60	22.0	5.69	20.0	28.0	57	1.48	
GQS 1	Carousel	2.13	2.0	0.72	2.0	2.0	16	0.35	<0.001
	Photo	1.71	2.0	0.66	1.0	2.0	45	0.19	
	Reels	2.39	2.0	0.88	2.0	3.0	57	0.23	
GQS 2	Carousel	1.94	2.0	0.77	1.8	2.0	16	0.38	<0.001
	Photo	1.62	2.0	0.68	1.0	2.0	45	0.20	
	Reels	2.30	2.0	0.89	2.0	3.0	57	0.23	

Table 8. Post-hoc p-values among the publication types.

			Carousel	Photo
Trigger finger	DISCERN 1	Photo	0.062	
		Reels	0.718	0.004
	DISCERN 2	Photo	0.085	
		Reels	0.583	0.005
	GQS 1	Photo	0.051	
		Reels	0.274	<0.001
	GQS 2	Photo	0.141	
		Reels	0.124	<0.001

DISCUSSION

It is a fact that social media and digital platforms make available a great deal of information related to medical content. However, most of this information lacks technical and scientific validation, which can lead to mistaken guidance for patients.

Data on trigger finger available on YouTube have already been analyzed in other previous studies, and it was demonstrated that they are of low quality, unreliable, and not very instructive.^{16,17} As Instagram posts related to these subjects have not yet been evaluated, this work set out to determine the quality of this information using two different objective scores, the modified DISCERN and the GQS. In addition, we sought to evaluate inter-observer reliability, considering the results indicated by two orthopedic physicians who are residents in hand surgery.

It is worth noting that the social network Instagram was selected because it is one of the most widely used social media platforms in Brazil today.

To carry out the study, we chose to create on the network a profile of a 50-year-old woman, corresponding to the sex and age most commonly affected by trigger finger.^{5,18}

The results demonstrated high inter-rater reliability for both instruments used (DISCERN and GQS), reinforcing the robustness of the assessment applied to the analyzed posts. These data are consistent with data already existing in the literature, which evidence adequate inter-observer reliability for already-validated assessment methods, such as DISCERN.¹⁵

The positive, although weak, correlation between video duration and the quality measured by the scores suggests that longer content tends to present greater informational rigor, which may be related to the possibility of addressing the topic in greater depth. However, the magnitude of this correlation indicates that video length alone does not guarantee information quality.

The analysis between the number of views (low vs. high) and the quality of the posts showed no significant differences, suggesting that the popularity of a piece of content is not necessarily associated with its scientific quality. This finding is relevant, as it shows that engagement metrics, commonly valued on social media, should not be used as indicators of reliability for the lay or professional public. The comparison among the different professionals revealed statistically significant differences, especially in the DISCERN and GQS scores. Posts by hand surgeons obtained the best results, presenting higher quality than those produced by physiotherapists and occupational therapists. This difference may be attributed to the greater technical and scientific mastery of hand surgeons over the topics addressed, as well as to academic training oriented toward producing more structured content aligned with scientific evidence. On the other hand, the lower score observed among physiotherapists and occupational therapists should not be interpreted as an absence of relevance of these professionals in the rehabilitation process, but may indicate a need for greater training in the use of social media for disseminating evidence-based information.

These findings align with previous studies that point to heterogeneity in the quality of health information available on digital platforms.¹⁴ Moreover, they reinforce the importance of media education both for health professionals — in the sense of developing scientific communication skills adapted to the lay public — and for users, who need to be empowered to identify more reliable sources.

Other results demonstrated a statistically significant difference among the publication formats (carousel, photo, and Reels) for both evaluators and for both analysis instruments, DISCERN and GQS ($p < 0.05$).

Consistently, the Reels format presented the highest quality means, while the photo format presented the lowest values. This pattern was confirmed in the post-hoc analysis, which identified a significant difference specifically between photo and Reels in all comparisons (for example, DISCERN 1: 22.07 vs. 25.23; $p = 0.004$).

These findings suggest that the visual presentation format influences not only the reach of the posts — as already demonstrated in studies on digital engagement — but also the perceived and measurable quality of health information.

The Reels format allows greater exposure time, the use of verbal explanations, and the inclusion of dynamic visual elements,

which can contribute to greater detailing of the educational content. In contrast, the photo format depends almost exclusively on the text written in the caption, which is often simplified, superficial, or reduced to promotional messages.

The overall DISCERN means were 24.02 for evaluator 1 and 22.25 for evaluator 2, with GQS scores of 2.09 and 1.99 for evaluators 1 and 2, respectively.

Olcár¹⁶ and Uzel et al¹⁷ concluded in their studies that YouTube videos about trigger finger generally present low quality and low reliability as a source of information for patients. The analysis of the most-viewed videos, by means of scores, demonstrated low means across all instruments, classifying most of the content as inadequate or of little use for health education.

Considering that DISCERN can reach up to 80 points and that the GQS score ranges from 1 to 5, these results demonstrate that most of the publications do not meet minimum quality criteria to adequately guide patients, especially with regard to the explanation of treatment options, risks, benefits, and grounding in scientific evidence.

From the standpoint of health education, these results are concerning, especially considering that patients use social media as a primary source of information and decision-making when seeking medical care. Excessive simplification of content may contribute to the creation of unrealistic expectations, inappropriate self-diagnosis, or adherence to practices not validated by the scientific literature. Another relevant aspect is that, despite the growth in the use of social media by health professionals, the results indicate that not all content produced meets technical quality criteria — and that the chosen format can be decisive for this. This finding reinforces the importance of qualified professionals, including hand surgeons and orthopedic specialists, acting as content producers, applying principles of efficient scientific communication geared toward the digital environment.

CONCLUSION

The results of this study indicate that information about trigger finger (stenosing tenosynovitis) published on the Instagram platform is of unsatisfactory quality. A predominance of content with low quality and reliability, limited scientific basis, and restricted clinical usefulness for the lay public was observed, a fact corroborated by the low scores achieved on the assessment instruments used. Thus, this work demonstrates an important gap between the public's need for quality information and what is actually made available. This gap represents an opportunity for the work of specialists, the dissemination of evidence-based content, and the strategic use of the most effective formats for transmitting information.

CONTRIBUTIONS OF THE AUTHORS

Each author made significant individual contributions to the development of this manuscript. BLFA: study conception, data collection and analysis, and writing; SHYF: study conception, data collection and analysis, and writing; MVY: data collection, statistical analysis, and writing; TMJS: statistical interpretation of the data, methodological review, and critical review of the content; SJBG: partial writing and final review; BJC: statistical interpretation of the data, methodological review, critical review of the content, partial writing, and final review; NLR: partial writing and final review.

DATA AVAILABILITY DECLARATION

The data underlying the research text are contained in the manuscript.

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ECONOMIC STUDIES IN BRAZILIAN ORTHOPEDICS: A SCOPING REVIEW

AVALIAÇÃO DOS ESTUDOS ECONÔMICOS EM ORTOPEDIA NO BRASIL: REVISÃO DE ESCOPO

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ABSTRACT

Objective: To identify and analyze economic studies in orthopedics conducted in Brazil, classifying them according to the type and completeness of the analysis. **Methods:** Scoping review conducted according to PRISMA-ScR guidelines. Searches were performed in PubMed and BVS, including LILACS, using descriptors related to economic evaluation, orthopedics, and Brazil. Studies conducted exclusively in Brazil were included, with no year restriction. **Results:** Ninety-five records were identified, and 13 studies remained after application of the eligibility criteria. Of these, nine were complete economic evaluations and four were incomplete analyses. **Conclusion:** There is a scarcity of complete economic evaluations in orthopedics in Brazil. **Level of Evidence III; Review article.**

Keywords: Costs; Economics; Health; Orthopedics; Review; Brazil.

RESUMO

Objetivo: Identificar e analisar os estudos econômicos em ortopedia realizados no Brasil, classificando-os quanto ao tipo e completude da análise. **Métodos:** Revisão de escopo conduzida conforme o PRISMA-ScR, com busca nas bases PubMed e BVS (incluindo LILACS), utilizando descritores relacionados à avaliação econômica, ortopedia e Brasil. Foram incluídos estudos realizados exclusivamente no país, sem restrição de ano. **Resultados:** Foram identificados 95 registros, restando 13 estudos após aplicação dos critérios de elegibilidade. Desses, 9 foram análises econômicas completas e 4 análises incompletas. **Conclusão:** Observa-se escassez de avaliações econômicas completas em ortopedia no Brasil. **Nível de Evidência III; Artigo de revisão.**

Descritores: Custo; Economia; Saúde; Ortopedia; Revisão; Brasil.

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INTRODUCTION

In recent decades, there has been a global increase in health economic studies. Researchers, industry, and healthcare institutions are increasingly interested in making decisions about which clinical approaches to adopt, based on costs in relation to health outcomes. Given the growing availability of data and the greater ease of obtaining them, it increasingly makes sense to select the best treatment, procedure, or medication through economic analyses.¹ Within the healthcare setting, orthopedics is a specialty characterized by extensive use of what are known as OPMs (orthoses, prostheses, and special materials), owing to the surgical treatment of the musculoskeletal system, which requires durable and functional devices that support the maintenance of body structure with early rehabilitation of bones, muscles, tendons, ligaments, and joints. The use of OPMs in orthopedics drives the industry to produce various types of orthoses, prostheses, plates, and screws – a development that facilitates the emergence of new treatments but, in most cases, is more expensive, thereby increasing the costs of medical care. Consequently, institutional decisions regarding changes in treatment

methods and the incorporation of new technologies are challenging and require product-effectiveness analyses to ensure that increasingly limited resources are spent as efficiently as possible, whether in the public sector or in supplemental healthcare. In Brazil, the Unified Health System (SUS) incorporates new treatment methods through cost-effectiveness evaluations analyzed by the National Committee for Health Technology Incorporation (CONITEC), whose purpose is to advise the Ministry of Health on matters related to the incorporation, exclusion, or modification of health technologies in the SUS, as well as on the development or revision of clinical protocols or therapeutic guidelines. CONITEC incorporates new technologies according to the following workflow: the secretariat receives the incorporation request; evaluates the scientific studies submitted (and requests supplementary studies if necessary); reports on the technology, available SUS alternatives, and a critical appraisal of the studies are prepared; CONITEC assesses the reports, issues an opinion, and submits them for public consultation; contributions received are incorporated into the technical report; CONITEC receives the report and ratifies the recommendation.²

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

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In the United States (US), which produces one of the largest volumes of scientific articles worldwide, orthopedics still lags behind several other specialties in the production of economic analysis articles, despite the substantial consumption of OPMEs. Notwithstanding the limited number of studies in orthopedics, recent years have seen greater incentives toward production, with the emergence of new guidelines for the field.¹

In line with what is observed in various Western healthcare systems, the Brazilian healthcare system has been facing considerable impacts driven by high expenditures and limited resources, a situation made all the more serious given that a large share of the population relies exclusively on this public system. Countries with public health systems should be more concerned with economic analyses, which could help allocate these resources more efficiently.³ Healthcare managers need to obtain and interpret data that demonstrate the true benefits and risks of health technologies in order to support decision-making and better allocate resources toward the incorporation of technologies that can restructure services.⁴ Given that orthopedics is a surgical specialty that frequently requires the use of OPMEs, and considering the Brazilian context in which 80% of users rely exclusively on a public healthcare system, the objective of this study is to conduct a scoping review of economic studies in orthopedics already carried out in Brazil and indexed in the main databases, in order to analyze the number of articles produced in the country, their types, and the quality of the studies.

METHODS

The entire scoping review framework was guided by the PRISMA-ScR protocol, a validated checklist for systematic reviews with an extension for scoping reviews.⁵ Due to the scarcity of articles in the field, we determined that a systematic review would not achieve adequate quality or yield a meaningful analysis of the landscape. We opted for a scoping review because it is a study design that maps the gaps in a given area and describes the types of available evidence.⁶

The inclusion criteria required studies to have been conducted exclusively in Brazil, given that this was the setting under evaluation. Articles could be from any year and written in Portuguese, English, or Spanish, provided they assessed a health outcome related to orthopedics. The search aimed to identify all possible economic evaluation articles in orthopedics conducted in Brazil at any point in time, of any type (cost-effectiveness, cost-utility, cost-benefit, cost-minimization) and any level of evidence. All articles underwent review by at least 2 of the authors for inclusion and exclusion criteria, as well as for final classification. At the end of the search, all articles were classified by type of analysis (complete or partial) and by type of economic study.

The search was conducted through PubMed and BVS (which collects data from LILACS, MEDLINE, and other non-indexed databases, including scientific events, theses, and open educational resources from South America and the Caribbean). The search strategies followed the BVS repository of search strategies for health economic evaluation, with terms suggested by the library for this type of research, in English, Spanish, and Portuguese. The terms "Brasil OR Brazil" and "Orthop OR Ortop" were added to define the research setting and the specialty of orthopedics. The search terms used were: "Economics" OR "Cost-Benefit Analysis" OR "Health Care Costs" OR "Costs and Cost Analysis" OR "Cost Allocation" OR "Health Care Rationing" OR "Cost Control" OR "Cost of Illness" OR "Cost Sharing" OR "Direct Service Costs" OR "Drug Costs" OR "Employer Health Costs" OR "Hospital Costs" OR "Health Expenditures" OR "Capital Expenditures" OR "Models, Economic" OR "Economics, Nursing" OR "Economics, Medical" OR "Economics, Pharmaceutical" OR "Economics, Hospital" OR

"Economics, Dental" OR "Fees and Charges" OR "Capitation Fee" OR "Fee for Service Plans" OR "Fees, Dental" OR "Fees, Medical" OR "Fees, Pharmaceutical" OR "Prescription Fees" OR "Hospital Charges" OR "Rate Setting and Review" OR "Budgets") OR mj: "/economia" OR ((mh: "Evaluation Study" OR mh: "Evaluation Studies as Topic" OR ti:(evaluaci* OR avali* OR evaluation* OR assessment*)) AND ti:(economic* OR economy OR economia*)) OR ti:(economic* OR economia OR cost OR costs OR costly OR costing OR price OR prices OR pricing OR pharmacoeconomic* OR pharmaco-economic* OR "marginal analysis" OR "marginal analyses" OR custo-efetividade OR costo-efectividad OR custo-beneficio OR custo-beneficio OR budget* OR expense OR expenses OR financial OR finance OR finances OR financed OR "value for money" OR "monetary value" OR "monetary value" OR "health expenditures" OR "capital expenditures") OR (ab:(evaluaci* OR avali* OR evaluation* OR assessment*)) AND ti:(economic* OR economy OR economia*)) OR ab:("análise custo-benefício" OR "cost-benefit analysis" OR "análisis costo-beneficio" OR "análise de custo-beneficio" OR "análise de custo-efetividade" OR "custo-efetividade" OR "dados de custo-beneficio" OR "costo efectividad" OR "datos de costo-beneficio" OR "cost benefit" OR "cost benefit analysis" OR "cost-effectiveness analysis" OR "cost-utility analysis" OR "costs and benefits" OR "evaluacion economica" OR "avaliacao economica" OR "economic evaluation" OR "marginal analysis" OR "cost benefit analyses" OR "cost benefit data" OR "cost effectiveness analysis" OR "cost utility analysis" OR "cost-benefit analyses" OR "cost-utility analyses" OR "cost-utility analyses" OR "marginal analyses" OR "cost effectiveness" OR "cost-benefit data" OR "value for money" OR "monetary value" OR "monetary value" OR "health expenditures" OR "capital expenditures" OR pharmacoeconomic* OR pharmaco-economic*) OR (ab:(economic* OR economia* OR cost OR costs OR costly OR costing OR price OR prices OR pricing OR budget* OR expense OR expenses OR financial OR finance OR finances OR financed) AND (mh: "Evaluation Study" OR mh: "Evaluation Studies as Topic" OR tw:("evaluation studies" OR "evaluation study" OR "estudos de avaliacao" OR "estudo de avaliacao" OR "estudios de evaluacion" OR "estudio de evaluacion" OR Assessment*)) OR tw:("custos de cuidados de saúde" OR "health care costs" OR "costos de la atención en salud" OR "custos de cuidados médicos" OR "custos de tratamento" OR "costos de la atención médica" OR "costos del tratamiento" OR "health costs" OR "healthcare costs" OR "health care cost" OR "health cost" OR "healthcare cost" OR "medical care cost" OR "treatment cost" OR "medical care costs" OR "treatment costs")) AND (Orthop* OR Ortop*) AND (Brasil* OR Brazil*).⁷

The search was performed on four different dates using the same search terms: June 3, 2022; October 20, 2022; May 9, 2023; and July 24, 2025.

RESULTS

The search retrieved 95 articles, published between 1994 and 2024. The summary of article exclusions and inclusions for the scoping review analysis is presented in the flowchart (Figure 1). Initially, our search identified 95 articles. We used the BVS-recommended health economic study identifiers to capture as many articles in the field as possible across all time periods, supplemented by the terms "Brasil OR Brazil" and the prefixes "Ortop OR Orthop" to identify articles conducted in Brazil in the specialty of orthopedics. First, seven articles were identified as duplicates and immediately excluded. In the initial review of the remaining 88 articles, six were identified and excluded because they had been conducted in other populations: two from Germany, two from the United States, one from Bangladesh, and one covering all of Latin America. In the final screening, of the remaining 82 articles, 47 were excluded

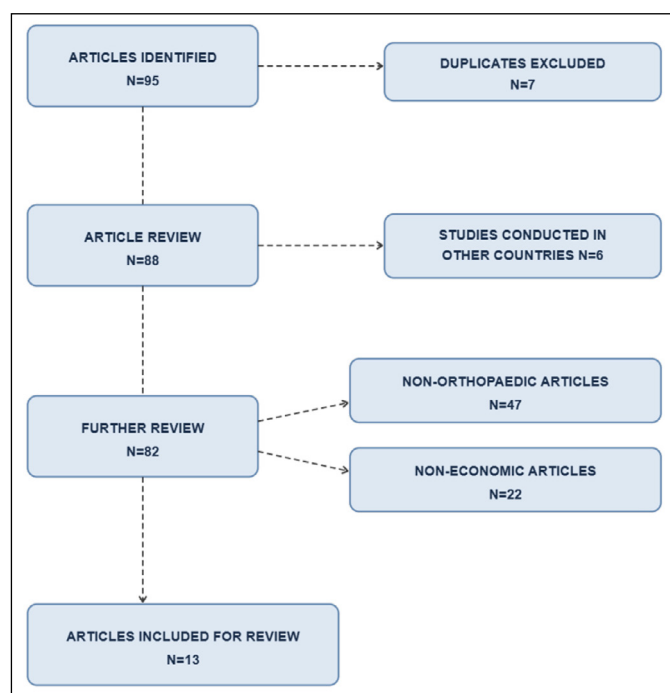


Figure 1. Articles included in the review.

because they were classified as non-orthopedic — that is, articles addressing conditions and treatments from other specialties that did not involve the musculoskeletal system, or even from fields outside medicine such as veterinary or dental articles — and 22 articles were excluded for not being health economic studies, leaving 13 articles that are in fact economic studies in orthopedics conducted in Brazil.

The 13 final articles included in the scoping analysis were classified as either complete or partial analyses, and by type of economic study (cost-effectiveness, cost-utility, cost-benefit, cost-minimization,

or simple cost study for partial analyses). The results are presented in Table 1. Of the 13 articles, four were classified as partial analyses, eight as complete economic evaluations that assessed health outcomes, and one was an expert review that considered cost-effectiveness to indicate or include medications in the proposed treatment protocols.

DISCUSSION

The objective of this study was to evaluate the profile of health economic analysis publications, particularly in orthopedics and traumatology in Brazil, thereby providing an overview of this type of research in our setting. We observed that despite orthopedics being one of the specialties with the highest use of high-cost materials, and despite Brazil's heavy reliance on a public healthcare system, we found only 13 economic studies related to orthopedics conducted in Brazil. According to the ANS (National Supplemental Health Agency), orthopedics was the fifth specialty with the highest volume of outpatient consultations in 2019 (the last year before the pandemic), accounting for more than 14 million outpatient visits in Brazil — this in the supplemental health sector alone, to which only 22% of the population had access through health insurance plans in that year. According to Caetano et al.⁸ in an article from February 2023, over the past 15 years, Brazil has undergone a progressive institutionalization of health technology assessment (HTA), particularly within the public system, highlighting the growing need for the system to draw on economic studies to support healthcare decision-making. The scarcity of studies in this area led the Ministry of Health to establish committees charged with producing scientific evidence to justify policy decisions. However, the fact that these decisions are politically driven rather than grounded in health outcomes and high-quality studies is a concern and underscores the need for the scientific community to engage in this research. Healthcare spending in Brazil is a growing concern, given the challenges facing the healthcare system. According to the Brazilian Institute of Geography and Statistics (IBGE), in 2019 (the last year before the pandemic), total health expenditures

Table 1. Articles included in the review.

Article	Year	Analysis type	Study type	Design	Journal	Summary
Fonseca ¹⁰	1999	Partial	Cost	Prospective	Infection control and hospital epidemiology	Cost reduction through an antibiotic prophylaxis program
Ferreira ¹	2011	Complete	Cost-minimization	Prospective	The IOWA orthopaedic Journal	Cost of 2 congenital clubfoot treatment protocols
Loures ²	2015	Complete	Cost-utility	Retrospective cohort	Revista de saúde pública	Treatment of hip fractures in the elderly
Kaleka ³	2016	Complete	Cost-effectiveness	Prospective	American Journal of Sports Medicine	Analysis of 2 meniscus measurement methods
Kamamoto ⁴	2017	Complete	Cost-effectiveness	RCT	Clinical Science	Analysis of 2 wound treatment methods
Gomes ¹¹	2017	Partial	Cost	Retrospective	Revista Brasileira de Reumatologia	Cost of rheumatoid arthritis treatment
Passalini ¹²	2018	Partial	Cost	Retrospective	Revista da Associação Médica Brasileira	Public insurance expenditure on orthopedic conditions
Souza ⁵	2019	Complete	Cost-effectiveness	Retrospective cohort	Revista Brasileira de Ortopedia	Analysis of 2 tibial plateau fixation techniques
Ministério da Saúde ⁶	2021	Complete	Cost-minimization	Narrative review	Relatório de recomendação de medicamento - CONITEC	Costs of ibuprofen, naproxen, and diclofenac for musculoskeletal pain
Brito ⁷	2022	Complete	Cost-effectiveness	Prospective	Value in Health Regional Issues	Analysis of 3 medications for thromboprophylaxis in arthroplasties
Antonioli ⁸	2023	Complete	Cost-effectiveness	Retrospective	BMC Health SR	Cost-effectiveness analysis of alternative treatments to spinal surgery
Veronese ⁹	2024	Complete	Cost-effectiveness	Narrative review	Aging clinical Exp R	Narrative review of osteoporosis treatments considering cost-effectiveness
Souza Santos ¹³	2024	Partial	Cost	Prospective	J Orthop Sports Phys Ther.	Analysis of costs incurred for musculoskeletal pain treatment in children

Legend: RCT – Randomized controlled trial.

represented approximately 9.2% of the country's Gross Domestic Product (GDP). These expenditures encompass public investments, private spending, medication costs, medical consultations, hospital admissions, and other healthcare services.⁸⁻¹⁰

According to the WHO (World Health Organization), public health expenditures vary considerably across nations, accounting for less than 20% of total health costs in high-income countries and up to 66% in low-income countries.¹¹ In the US, the projected savings from interventions capable of reducing waste — excluding savings from reduced administrative complexity — ranged from US\$191 billion to US\$286 billion, representing a potential 25% reduction in total costs, which raises important questions about the implementation of effective measures to eliminate waste. Countries such as Australia, Canada, Sweden, and England (United Kingdom) have already adopted alternative approaches and developed their own guidelines to incentivize the production of economic analyses.⁴ Shrank et al.¹² (2019), in a more recent study, estimated the magnitude of waste in the American healthcare system to be between US\$760 billion and US\$935 billion (taking into account waste categories such as overtreatment, care delivery failures, and overpricing, among others).

Another important aspect, beyond the small number of publications, was the types of analyses and studies identified. Health economic analyses can be classified as partial (studies that typically assess only the simple cost of a treatment or a given disease without evaluating health outcomes) or complete (studies that assess cost in relation to some health gain). Complete health economic evaluations are divided into four types: cost-minimization; cost-utility; cost-benefit; and cost-effectiveness. In general, what distinguishes them is the way health outcomes are measured. Cost-minimization studies are those in which identical outcomes are expected from the interventions being compared, and the focus is on comparing total costs. Cost-utility studies assess the effects of interventions on mortality or morbidity, analyzing costs in relation to outcomes such as deaths avoided. Cost-benefit analyses evaluate outcomes in monetary terms, enabling comparisons of expected economic returns relative to investments, thereby facilitating decision-making and efficient resource allocation. Finally, cost-effectiveness studies assess the costs of interventions relative to the best health outcome achieved, enabling concrete clinical practice decisions from these analyses.¹³

We found 4 partial analyses in our review. These are important studies for providing a macro-costing perspective, drawing attention to spending concentrations in a given area, and stimulating the conduct of comprehensive studies on a particular topic; however, they do not allow for high-quality assessment of decision-making. Complete economic evaluations, in contrast, assess health outcomes — most often based on quality of life or preventable events — in relation to cost, thereby enabling evidence-based decision-making by healthcare managers. According to Drummond et al.,¹⁴ without a complete systematic economic analysis, it is difficult to clearly identify efficient alternatives, increasing the likelihood of wasting time and resources on an inefficient choice. According to Maniadakis et al.¹, the landscape for economic studies in orthopedics in the US is expected to improve due to recent guidelines and incentives for the production of new research, as is the case in the United Kingdom and Canada.

Among the complete economic evaluations identified in our review, we found two cost-minimization studies, one cost-utility study, and 6 cost-effectiveness studies. The article by Ferreira et al.¹⁵ was a retrospective study that analyzed the costs of treating congenital clubfoot in a group of 10 children, half of whom were treated using the Kite protocol and the other half using the Ponseti protocol. The study assessed the direct costs of both treatments, and we

classified it as a cost-minimization study given that both treatments yield the same outcome according to the literature. The article by Loures et al.¹⁶, conducted a retrospective decision-tree analysis of the costs of hip fracture treatment, in which patients were divided into 2 groups: early treatment (within four days of trauma) and late treatment, assessing quality of life and mortality outcomes. Kaleka et al.¹⁷ conducted a prospective study in which they analyzed the most cost-effective imaging method for measuring menisci, comparing magnetic resonance imaging and radiography. Kamamoto et al.¹⁸ conducted a randomized controlled trial in which they treated 2 groups of patients with complex wounds: one group using a proprietary negative-pressure wound therapy device and another using a low-cost method connected to the hospital vacuum system, which proved to be less expensive and equally effective. Souza et al.¹⁹ retrospectively studied the cost of two types of implants for tibial osteosynthesis, accounting for device effectiveness by assessing quality of life, functional outcomes, and clinical and radiographic improvement. The Ministry of Health study was a cost-minimization analysis, as a literature review led the authors to conclude that diclofenac, naproxen, and ibuprofen yield the same clinical outcome for chronic musculoskeletal pain, and costs of each were therefore compared for this type of treatment. Brito et al.²⁰ conducted a decision-tree analysis to determine which medication is most cost-effective for preventing deep vein thrombosis after knee and hip arthroplasty. Antonioli et al.²¹ also conducted a cost-effectiveness study evaluating 1,088 patients, assessing costs and clinical outcomes in patients with indications for spine surgery who could benefit from alternative treatments. The analysis demonstrated cost savings with clinical effectiveness of USD 6,705 per patient.

A ISPOR²² (The Professional Society for Health Economics and Outcomes Research) developed a guideline to promote and standardize high-quality economic studies, known as CHEERS (Consolidated Health Economic Evaluation Reporting Standards), a 24-item checklist. No article mentioned the use of this or any other checklist to guide the economic study, and when we applied CHEERS to the studies, none was able to complete all items on the list.

Cost-effectiveness studies are economic analyses considered appropriate for maximizing health outcomes relative to costs and, as such, are needed in greater numbers to support better and more efficient decision-making; likewise, completing all CHEERS checklist items would help produce studies with stronger methodology.²³ If we apply rigorous criteria for the selection of cost-effectiveness economic studies in orthopedics, restricting to prospective designs, our review would yield only 3 adequate studies in a country with more than 200 million inhabitants, where approximately 80% rely exclusively on a precarious public health system, in one of the highest-volume specialties.

As a limitation of this type of study, it is difficult to include search terms that capture all relevant articles; however, we believe that our search methodology came close to identifying the totality of indexed studies within the desired scope. Nonetheless, some articles in the field may not have been retrieved because they do not use terms related to the word orthopedics in their texts.

In our search, we found a precarious landscape of health economic studies in orthopedics in Brazil. Very few studies have been conducted overall, and only nine when counting complete analyses. Health economic studies are essential for better evidence-based decision-making in clinical practice, particularly in a resource-constrained setting such as Brazil, where the vast majority of the population depends on the public health system. It is necessary to disseminate this situation and to stimulate the production of new studies so that resources can be deployed more efficiently.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. CPV: manuscript drafting and article analysis; RLA: data analysis, article review, and intellectual conception of the article.

DATA AVAILABILITY DECLARATION

The data underlying the research text are contained within the manuscript.

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