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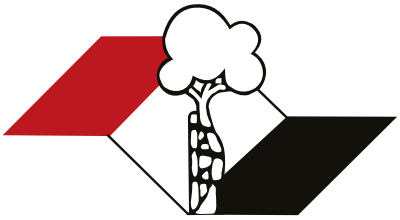

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ACKNOWLEDGEMENTS

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

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Levels of Evidence for Primary Research Question[a]

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

Types of study

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

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

SUMMARY

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Original Article

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EPIDEMIOLOGICAL PROFILE OF PATIENTS WITH ANKLE FRACTURE TREATED IN A TERTIARY LEVEL HOSPITAL

PERFIL EPIDEMIOLÓGICO DE PACIENTES COM FRATURA DE TORNOZELO TRATADOS EM UM HOSPITAL DE NÍVEL TERCIÁRIO

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3. Universidade Federal de São Paulo, Escola Paulista de Medicina, Departamento de Ortopedia e Traumatologia, São Paulo, SP, Brazil.

ABSTRACT

Objective: To evaluate the epidemiological profile of patients diagnosed with ankle fracture admitted to a tertiary hospital. Methods: Retrospective Cross-Sectional Observational Study. Inclusion Criteria: Individuals aged ≥18 (eighteen) years, diagnosed with ankle fracture, who underwent surgical and/or conservative treatment at a tertiary hospital in the city of São Paulo. Exclusion Criteria: Medical records with incomplete data, patients transferred to other hospital services. Results: There was a higher prevalence of: mechanism of trauma due to motorcycle accidents (27.9%), surgical treatment (92.7%), with a higher frequency of use of plates and screws (68.5%). The most common type of fracture were bimalleolar and trimalleolar (23.8%; 20.5%), classified as AO44B2 and AO44B3, both with 17.8%. Conclusion: Ankle fractures in this study were predominantly seen in male patients, aged from 30 to 39 years, with the main mechanism of injury being a motorcycle accident. There was a correlation between mechanism of injury and fracture classification , with the most common being types 44B2 and 44B3, and the use of an external fixator in 9.1% of cases. The death rate was significant when related to associated injuries, in polyfractured patients. ***Level of Evidence II, Retrospective study.***

Keywords: Bone Fractures. Ankle. Orthopedic Procedures.

RESUMO

Objetivo: Avaliar o perfil epidemiológico dos pacientes com diagnóstico de fratura de tornozelo, internados em um hospital de nível terciário. Métodos: Estudo Observacional Transversal Retrospectivo. Critérios de Inclusão: Indivíduos com idade ≥18 (dezoito) anos, com diagnóstico de fratura de tornozelo, que realizaram tratamento cirúrgico e/ou conservador em um hospital terciário da cidade de São Paulo. Critérios de Exclusão: Prontuários com dados incompletos, pacientes transferidos para outros serviços hospitalares. Resultados: Encontrou-se maior prevalência de: mecanismo de trauma por acidente motociclístico (27,9%), tratamento cirúrgico (92,7%), com maior frequência de utilização de placas e parafusos (68,5%), tipo de fratura mais comum foram do bimaleolar e trimaleolar (23,8%; 20,5%), classificação por AO44B2 e AO44B3, ambas com 17,8%. Conclusão: As fraturas de tornozelo neste estudo mostraram-se de forma predominante em pacientes do sexo masculino, entre faixa etária de 30 e 39 anos, sendo o principal mecanismo de trauma o acidente motociclístico, Houve correlação entre mecanismo de trauma e classificação da fratura, sendo as mais presentes as do tipo 44B2 e 44B3, e utilização de fixador externo em 9,1% dos casos. O índice de óbito apresentou significância quando relacionado às lesões associadas, em pacientes polifraturados. ***Nível de Evidência II, Estudo retrospectivo.***

Descritores: *Fraturas ósseas. Tornozelo. Procedimentos Ortopédicos.*

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The study was conducted at Enfermaria de Ortopedia do Hospital Sao Paulo, Escola Paulista de Medicina, Universidade Federal de Sao Paulo.
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INTRODUCTION

Ankle fractures correspond to 10% of all fractures in the human body, making the ankle the second most affected joint of the lower limbs, only behind hip fractures.[1] Recent studies conducted in the United States indicate that, between the years 1970 and 2000, there was an increase in tibiotarsal joint fractures among the bone injuries treated surgically, being diagnosed in 8.3 cases in 1000 medical consultations.[2]

Ankle fractures have a double peak of incidence, being frequent in young male adults, mostly due to sports injuries or traffic accidents, and in older female patients due to falls.[3,4]

The classification system of ankle fractures according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) group is based on the syndesmosis region level (A: infrasyndesmotic, B: transsyndesmotic, C: suprasyndesmotic) associated with subtypes according to the fracture degree.[5,6] For fractures of the articular surface of the distal third of the tibia, the Rüedi-Allgöwer system defines types I, II or III based on articular displacement and the degree of comminution.[7]

Despite the high incidence of this type of injury, there are still many conflicts in the literature on what treatment to perform. Choosing the appropriate treatment is essential to achieve fracture stabilization and consequently consolidation. Studies show that poorly stabilized fractures have a higher risk of new injury in addition to functional damage.[5,8]

In view of the scarcity of national studies related to the epidemiological profile of patients with ankle fractures, the exponential growth of this type of injury, and its impact on quality of life, it is essential to conduct studies on the matter. Thus, this study objective is to trace the epidemiological profile of ankle fractures treated in a tertiary level hospital, to verify the relation between mechanism of injury and age, type of treatment, and prevalence of complications after ankle fractures.

METHODS

This was a retrospective cross-sectional study. The Electronic Patient Records (EPR) system was used to search for patients with ankle fractures in the hospital admission records who were hospitalized and treated conservatively and surgically, in the period from January 2019 to July 2022. The following variables were analyzed: gender, age, mechanism of injury, type of fracture, fracture classification, associated injuries, previous pathologies, period of hospital stay, type of treatment, complications, and death. Medical records with incomplete data, patients aged under 18 years, or those transferred to other hospital services were excluded.

All the information used for this project was collected after the participants signed the Informed Consent Form (ICF), issued by the research team.

This study was registered and approved by the Research Ethics Committee registered in Plataforma Brasil, under CAEE number: 64374322.0.0000.5505

Statistical Methods

Data were presented descriptively, with frequency and percentage for categorical variables, and with measure and standard deviation (SD) for continuous variables. Data normality was assessed using the Shapiro-Wilk test. The Chi-square test and Cramer's V^2 test were used to verify the influence of age, gender, mechanism of injury, associated injuries, and type of fracture, previous pathologies, types of treatment, complications, period of hospital stay, and death, as well as the relation between these variables. A 0.05% significance level was used for all tests ($p < 0.05$). Statistical analyses were performed using the SPSS program (version 20.0).

RESULTS

A total of 245 medical records were selected, of which 35 were excluded for not meeting the inclusion criteria. Thus, the sample consisted of 219 individuals, 143 males (65.3%) and 76 females (34.7%), with a gender ratio of 1.8:1, individuals ranging from 18 to 75 years of age, with a mean age of 41.87 years and standard deviation (SD) of 14.41. Period of hospital stay with a minimum variation of one day and a maximum of 107 days, with a mean of 7.10 days, and standard deviation (SD) of 10.20 (Table 1).

Table 1. Sample characterization

VARIABLES	DESCRIPTION	FREQUENCY (f)	MALE	FEMALE	TOTAL (%)
GENDER		219	143 (65.3%)	76 (34.7%)	219 (100%)
AGE	18–75 YEARS OLD		41.93 years old SD 14.41	41.86 years old SD 14.37	41.87 years old SD 14.41
PERIOD OF HOSPITAL STAY	Minimum: 1 day / Maximum: 107 days				7.10 SD 10.20
AFFECTED SIDE	Right	91	62 (28.3%)	29 (13.2%)	41.5%
	Left	127	80 (36.5%)	47 (21.5%)	58%
	Bilateral	1	1 (0.5%)	0 (0%)	0.5%
MECHANISM OF INJURY	Car Accident	3	2 (0.9%)	1 (0.5%)	1.4%
	Motorcycle Accident	61	54 (24.7%)	7 (3.2%)	27.9%
	Physical Aggression	2	2 (0.9%)	0 (0%)	0.9%
	Run over	17	11 (5.0%)	6 (2.7)	7.8%
	Contusion	7	6 (2.7%)	1 (0.5%)	3.2%
	Sprain	60	27 (12.3%)	33 (15.1%)	27.4%
	Sprain during sport	6	5 (2.3%)	1 (0.5%)	2.7%
	Firearm injury	1	1 (0.5%)	0 (0%)	0.5%
	Fall from own height	27	13 (5.9%)	14 (6.4%)	12.3%
	Fall from height	25	14 (6.4%)	11 (5.0%)	11.4%
	Fall during sport	10	8 (3.7%)	2 (0.9%)	4.6%

Table 1. Sample characterization

VARIABLES	DESCRIPTION	FREQUENCY (f)	MALE	FEMALE	TOTAL (%)
TYPES OF FRACTURE	Lateral unimalleolar	53	35 (16%)	18 (8.2%)	24.2%
	Medial Unimalleolar	22	20 (9.1%)	2 (0.9%)	10.0%
	Posterior Unimalleolar	2	2 (0.9%)	0 (0%)	0.9%
	Bimalleolar (lateral + medial)	49	28 (12.8%)	21 (9.6%)	22.4%
	Bimalleolar (lateral + posterior)	3	2 (0.9%)	1 (0.5%)	1.4%
	Trimalleolar	45	22 (10.0%)	23 (10.5%)	20.5%
	Tibial Pilon	43	33 (15.1%)	10 (4.6%)	19.6%
	Tibial Pilon + Malleolar Fracture	2	1 (0.5%)	1 (0.5%)	0.9%
FRACTURE CLASSIFICATION	MALLEOLAR FRACTURE ACCORDING TO AO	174			79.5%
	AO 43B1	17	16 (7.3%)	1 (0.5%)	7.8%
	AO 44A1	2	1 (0.5%)	1 (0.5%)	0.9%
	AO 44A2	7	5 (2.3%)	2 (0.9%)	3.2%
	AO 44A3	2	1 (0.5%)	1 (0.5%)	0.9%
	AO 44B1	22	13 (5.9%)	9 (4.1%)	10%
	AO 44B2	39	18 (8.2%)	21 (9.6%)	17.8%
	AO 44B3	39	21 (9.6%)	18 (8.2%)	17.8%
	AO 44C1	22	15 (6.8%)	7 (3.2%)	10%
	AO 44C2	17	14 (6.4%)	3 (1.4%)	7.8%
	AO 44C3	7	5 (2.3%)	2 (0.9%)	3.2%
	TIBIAL PILON FRACTURE	43			19.6%
	Rüedi-Allgöwer Type I	5	3 (1.4%)	2 (0.9%)	3.2%
	Rüedi-Allgöwer Type II	16	11 (5.0%)	5 (2.3%)	7.3%
	Rüedi-Allgöwer Type III	21	18 (8.2%)	3 (1.4%)	9.6%
	Rüedi-Allgöwer Types I e II	1	1 (0.5%)	0 (0%)	0.5%
	PILON FRACTURE ASSOCIATED WITH MALLEOLAR FRACTURE	2			0.9%
	Rüedi-Allgöwer Type II / AO 43B1	1	1 (0.5%)	0 (0%)	0.5%
	Rüedi-Allgöwer Type II / AO 43B1	1	0 (0%)	1 (0.5%)	0.5%
ASSOCIATED INJURIES	Yes	117	84 (38.4%)	33 (15.1%)	53.4%
	No	102	59 (26.9%)	43 (19.6%)	46.6%
TYPE OF TREATMENT	Conservative	16	11 (5.0%)	5 (2.3%)	7.3%
	Surgical	203	132 (60.3%)	71 (32.4%)	92.7%
OPEN FRACTURE	Yes	33	26 (11.9%)	7 (3.2%)	15.1%
	No	186	117 (53.4%)	69 (31.5%)	84.9%
USE OF EXTERNAL FIXATOR	Yes	57	44 (20.1%)	13 (5.9%)	26.0%
	No	162	99 (45.2%)	63 (28.8%)	74.0%
COMPLICATIONS	IN-HOSPITAL	5			2.3%
	Hemodynamic alterations	2	1 (0.5%)	1 (0.5%)	0.9%
	Osteoarthritis	1	1 (0.5%)	0 (0%)	0.5%
	Inadequate soft tissues	1	1 (0.5%)	0 (0%)	0.5%
	Cellulite	1	1 (0.5%)	0 (0%)	0.5%
	POST-DISCHARGE	19			8.7%
	Surgical wound infection	8	8 (3.7%)	0 (0%)	3.7%
	Injury of the syndesmosis	2	2 (0.9%)	0 (0%)	0.9%
	Osteomyelitis	2	2 (0.9%)	0 (0%)	0.9%
	Nonunion	1	1 (0.5%)	0 (0%)	0.5%
	Pseudoarthrosis	1	1 (0.5%)	0 (0%)	0.5%
	Other	5	4 (1.8%)	1 (0.5%)	2.3%
PREVIOUS DISEASES					56.6%
	Diabetes Mellitus	17	10 (10.5%)	7 (7.4%)	17.9%
	Drug addiction	15	15 (15.8%)	0 (0%)	15.8%
	Alcoholism	12	12 (12.6%)	0 (0%)	12.6%
	Systemic arterial hypertension	25	14 (14.7%)	11 (11.6%)	26.3%
	Obesity	6	3 (3.2%)	3 (3.2%)	6.4%

Table 1. Sample characterization

VARIABLES	DESCRIPTION	FREQUENCY (f)	MALE	FEMALE	TOTAL (%)
	Smoking habit	22	20 (21.1%)	2 (2.1%)	23.2%
	Other	70	41 (43.2%)	29 (30.5%)	73.7%
READMISSION	Yes	21	19 (8.7%)	2 (0.9%)	9.6%
	No	198	124 (56.6%)	74 (33.8%)	90.4%
DISCHARGE CONDITIONS	Improved	211	136 (62.1%)	75 (34.2%)	96.3%
	Other	8	7 (3.2%)	1 (0.5%)	3.7%
DEATH	Yes	3	3 (1.4%)	0 (0.0%)	1.4%
	No	216	140 (63.9%)	76 (34.7%)	98.6%

Source: Electronic Patient Record System (EHR) – HSP

This study result shows a higher prevalence of fractures in males, aged from 30 to 39 years, corresponding to 18.7% of the cases. Females had a higher prevalence from 40–49 years and 60 years of age or older, both represented by 7.8%.

As illustrated in Table 2.1, the most common associated mechanism in young patients was motorcycle accidents, as 27.9% of the cases among patients from 30 to 39 years of age ($p < 0.001$; V^2 Cramer 0.32).

The most evident types of fracture were bimalleolar and trimalleolar, totaling 44.3% of the sample. Regarding the analysis of the fractures classification by OA, the most common was type 44B as 45.6% of the total sample. The most predominant subtypes were B2 and B3, both with a frequency of 39 (17.8%) individuals. Table 2.2 shows a higher incidence of this classification when related to the mechanism of injury, with sprains causing 19 (8.7%) cases ($p = 0.014$; V^2Cramer 0.26). For tibial pilon fractures, which were 19.6% of the sample, the Rüedi-Allgöwer classification was used to determine type III fractures (9.6%), type II (7.3%), and type I (2.3%).

Regarding the treatment performed, 203 (92.7%) of the patients underwent surgical treatment, while 16 (7.3%) patients were conservatively treated. The most commonly applied form of surgical intervention was stabilization of fractures with plate and screw (68.5%; Table 3.1). The use of external fixators comprises 26% of the sample, and 9.6% in the definitive treatment. According to the results in Table 3.2, its use can be observed in 9.1% of motorcycle accidents and 3.2% of injuries caused by sprains (p0.003; V^2 Cramer 0.36).

A total of 176 (79.7%) individuals with associated injuries were verified, with the highest rate for ankle dislocations (41.10%). The result related to death can be observed in patients who also had associated injuries, represented by $p < 0.001$ e V^2Cramer 0.81, with the highest frequency for polytraumas (Table 4).

Table 2.1. Mechanism of injury versus Age.

	18 TO 29 YEARS OLD	30 TO 39 YEARS OLD	40 TO 49 YEARS OLD	50 TO 59 YEARS OLD	60 YEARS OR OLDER	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL
						<0.001	0.325	
MECHANISM OF INJURY								
Car Accident	2	0	0	0	1			3 (1.4%)
Motorcycle Accident	22	24	12	2	1			61 (27.9%)
Physical Aggression	0	0	1	0	1			2 (0.9%)
Run over	2	4	2	5	4			17 (7.8%)
Contusion	1	2	1	2	1			7 (3.20%)
Sprain	6	17	13	13	11			60 (27.4%)
Sprains during Sport	4	1	1	0	0			6 (2.7%)
Firearm injury	0	0	0	1	0			1 (0.5%)
Fall from own height	4	3	5	6	9			27 (12.4%)
Fall from height	3	2	9	6	5			25 (11.4%)
Fall during Sport	6	0	3	1	0			10 (4.6%)
TOTAL (n:%)	50 (22.8%)	53 (24.2%)	47 (21.5%)	36 (16.4%)	33 (15.1%)			219 (100%)

Source: Electronic Patient Records (EPR) system – HSP

Table 2.2. Mechanism of Injury versus Classification by AO.

CLASSIFICATION BY AO	44B1	44A1	44A2	44A3	44B1	44B2	44B3	44C1	44C2	44C3	OTHER	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL (*f*%)
												0.014	0.266	
MECHANISM OF INJURY														
Car Accident	0	0	1	0	0	1	0	0	0	0	1			3 (1.4%)
Motorcycle Accident	11	1	3	0	2	6	6	7	7	1	17			61 (27.9%)
Physical Aggression	0	0	0	0	2	0	0	0	0	0	0			2 (0.9%)
Run over	2	0	0	0	1	2	2	1	4	1	4			17 (7.8%)
Contusion	1	0	0	0	0	2	2	2	0	0	0			7 (3.2%)
Sprain	2	1	0	2	9	16	19	5	3	2	1			60 (27.4%)

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Table 2.2. Mechanism of Injury versus Classification by AO.

CLASSIFICATION BY AO	44B1	44A1	44A2	44A3	44B1	44B2	44B3	44C1	44C2	44C3	OTHER	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL (*f* %)
Sprains during Sport	0	0	0	0	0	2	1	2	1	0	0			6 (2.7%)
Firearm injury	0	0	0	0	0	0	0	0	0	0	1			1 (0.5%)
Fall from own height	1	0	1	0	5	6	7	2	0	1	4			27 (12.3%)
Fall from height	1	0	1	0	1	3	3	1	0	0	15			25 (11.4%)
Fall during Sport	0	0	1	0	2	0	1	2	2	2	0			10 (4.6%)
TOTAL (f %)	18	2	7	2	22	38	41	22	17	7	43			219 (100%)

Source: Electronic Patient Records (EPR) system – HSP

Table 3.1. Types of Definitive Treatment.

		MALE	(%)	FEMALE	(%)	TOTAL (*f* %)
CONSERVATIVE		11	5	5	2.3	16 (7.3%)
SURGICAL	Tension band	3	1.4	0	0	3 (1.4%)
	External Trans. Delta Fix.	8	3.7	3	1.4	11 (5.0%)
	External Ilizarov Fix.	9	4.1	1	0.5	10 (4.6%)
	HIMB	4	1.8	0	0	4 (1.8%)
	Screws	20	9.1	2	0.9	22 (10%)
	Plate and Screws	85	38.8	65	29.7	150 (68.5%)
	Bridge plate	3	1.4	0	0	3 (1.4%)
TOTAL (n:%)		143	65.3	76	34.8	219 (100%)

Source: Electronic Patient Records (EPR) system – HSP
Abbreviations: Fix.: Fixator; Trans: Transarticular; HIMB : Intramedullary Interlocking Nail

Table 3.2. Mechanism of injury versus External Fixator.

	NO	YES	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL
			0.003	0.367	
MECHANISM OF INJURY					
Car Accident	1 (0.5%)	2 (0.9%)			3 (1.4%)
Motorcycle Accident	41 (18.7%)	20 (9.1%)			61 (27.9%)
Physical Aggression	2 (0.9%)	0 (0.0%)			2 (0.9%)
Run over	9 (4.1%)	8 (3.7%)			17 (7.8%)
Contusion	6 (2.7%)	1 (0.5%)			7 (3.2%)
Sprain	53 (24.2%)	7 (3.2%)			60 (27.4%)
Sprains during Sport	5 (2.3%)	1 (0.5%)			6 (2.7%)
Firearm injury	0 (0.0%)	1 (0.5%)			1 (0.5%)
Fall from own height	21 (9.6%)	6 (2.7%)			27 (12.3%)
Fall from height	15 (6.8%)	10 (4.6%)			25 (11.4%)
Fall during Sport	9 (4.1%)	1 (0.5%)			10 (4.6%)
TOTAL (n:%)	162 (74%)	57 (26%)			219 (100%)

Source: Electronic Patient Records (EPR) system – HSP

Table 4. Death versus associated injuries.

	NO	YES	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL
			<0.001	0.816	
MECHANISM OF INJURY					
Abrasions	1	0			1 (0.5%)
Fracture of the upper limbs	5	0			5 (2.3%)
Fracture of the lower limbs	37	0			37 (16.9%)
Fracture of the upper limbs/lower limbs	5	0			5 (2.3%)
Fractures of the lower limbs and others	4	0			4 (1.8%)
Other Fractures	1	0			1 (0.5%)
Ligament Injury	6	0			6 (2.7%)
Injury of the syndesmosis	3	0			3 (1.4%)
Ligament Injury + Injury of the syndesmosis	1	0			1 (0.5%)

Table 4. Death versus associated injuries.

	NO	YES	P-VALUE	V^2 CRAMER (P-VALUE)	TOTAL
Ankle Dislocation	89	1			90 (41.1%)
Ankle Dislocation + Other Fractures	4	0			4 (1.8%)
Ankle Dislocation + Dislocation of the syndesmosis	1	0			1 (0.5%)
Ankle Dislocation + Ligament Injury	1	0			1 (0.5%)
Ankle Subluxation	2	0			2 (0.9%)
Other Dislocations	2	0			2 (0.9%)
Polyfractures	8	2			10 (4.7%)
No associated injuries	46	0			46 (21.0%)
TOTAL (n:%)	216	3			219 (100%)

Source: Electronic Patient Records (EPR) system – HSP

Abbreviations: MMSS – Upper Limbs; MMII – Lower Limbs

Previous pathologies were present in 43.4% of the total sample. The diseases with the highest incidences were systemic arterial hypertension (SAH) (26.3%), followed by smoking habits and Diabetes Mellitus (DM) (23.2% and 17.9%, respectively). Complications during the hospital stay occurred in 2.3% of the sample, with prevalence of hemodynamic alterations (40%). In the post-discharge period, complications could be observed in 8.7% of the sample, of which 42.1% were surgical wound infection.

DISCUSSION

Ankle fractures have been growing annually and can cause disability, decreased productivity, time off work, and compromised quality of life, generating significant costs for health systems[8,9].

A total of 76 women and 143 men participated in this study, from 18 to 75 years of age, with a mean age of 41.87 years.

The most observed mechanism of injury was motorcycle accidents (27.9%) followed by ankle sprains (27.4%).

There was a correlation between the mechanism of injury and age, with motorcycle accidents being more frequent in young individuals, aged from 30 to 39 years ($p < 0.001$). This index can be attributed to multifactorial conditions, such as greater use of this vehicle as a work tool, driver vulnerability, and traffic conditions.[9,10] In the studies by Silva et al.[10] and by Santos et al.,[11] the representation of young people injured in motorcycle accidents was 83.5% and 87.43%, respectively. Traffic accident prevention policies, such as education and investing in infrastructure, should be implemented to seek the reduction of accidents incidence. Despite the technological evolution of automobiles, with life protection measures, such as the installation of airbags, among other technologies, the incidence of fractures remains high, as well as these injuries severity, which require greater care and treatment time.[12]

This study shows that 53.4% of these patients had other associated injuries, with ankle dislocation being the most observed (41.1%), followed by lower limb trauma. These data corroborate the findings of Debieux et al,[13] which pointed out that, of the 387 patients who suffered motorcycle accidents in a 16-month period, 16% of them had foot fractures and 12.7% ankle fractures. Associated lower limb injuries contribute to longer hospital stays and higher morbidity rates.[10,11] In our findings, there was a statistical correlation between multiple trauma patients and death ($p < 0,001$), which may be related to the severity and the mechanism of the injury, since high-energy trauma injuries are associated with severe sequelae.[12]

A recent study conducted in a hospital in the city of São Paulo found a high incidence of ankle fractures in older women, possibly due to postmenopausal osteoporosis.[14] This study showed a higher number of fractures in women aged 60 years or older, but the collected data were not statistically significant. The study carried out by Newman[15] et al. included patients who were admitted to emergency services in the United States and obtained a sample with a mean age of 37 years, with predominance of females (56%). The most observed mechanism of injury was falls from height (54%), followed by sports injuries (20.76%). The most affected age group was the one from 10 to 19 years, while women were more affected in the other age groups.

This study had a high rate of open fractures (15.1%), which corroborate the data presented by Mizusaki et al.[16] The author also states that the high number of open fractures is related to the large number of motorcycle accidents occurring near the hospital where the study was conducted.

The use of fixators in our study was significant when related to the mechanism of injury ($p = 0.003$) and was observed in 9.1% of motorcycle accidents. It is worth remembering that this form of accident is considered high energy trauma and of great exposure.[9,10,12]

This study showed a large number of surgically treated patients, totaling 203 (92.7%). For Mizusaki et al.,[16] the submission of patients to surgical treatment is not necessarily consistent with the success of the results, since these patients are exposed to additional complications.[17] In that study, only 25.34% of the individuals were treated conservatively, which demonstrates that surgical intervention is the most preferred.

The evolution of synthesis materials and operative techniques increases the treatment success rate. Surgical treatment is usually indicated for cases of the following types of fractures: AO44A1; AO44A2; AO44A3; AO44B1 and all above AO44B1.2.[18] Surgical stabilization is indicated for injuries with risk of fracture fragments displacement and joint involvement.

There was a correlation between the classification of the fracture and the mechanism of injury ($p = 0.014$), since the classifications AO44B2 and AO44B3 corresponded to 35.6% of the sample and, according to studies, subtype B is the most described in the national literature, considered a type of serious injury.[18,19]

In this study, there was a predominance of bimalleolar (23.8%) and trimalleolar (20.5%) fractures, differing from the data of Misuzaki et al.,[16] who reported in their research 83.33% unimalleolar fractures, 44.67% in the lateral malleolus, 38.66% in the medial malleolus, and 10% and 6.67% of bimalleolar and trimalleolar fractures, respectively. As the degree of the fracture increases, there is a worsening of the prognosis.[16,19-21] Tibial pylon fractures were observed in 20.6% (45 cases), of which most were type III fractures (21 cases; 46.7%). This classification is considered severe because it involves major soft tissue involvement.[19] Zelle et al.[21] mentions that patients affected by high-energy fractures tend to present functional impairments in addition to developing chronic diseases.

In this study, complications during hospitalization occurred in 5 patients (2.28%) and in the post-discharge period it occurred in 19

patients (8.17%). The most prevalent were those characterized as acute, such as surgical wound infection (42.10%) and osteomyelitis (10.5%), which were more frequently observed in more complex cases. For Hu et al.,[22] the emergence of postoperative infections may be attributed to factors such as surgery time, type of incision, comorbidities, and type of fracture. The rate of complications in this study differs from the findings of Sakaki et a1.,[9] who reported a high rate of infection (23.1%) among the studied patients.

Previous pathologies in this study were more observed in male patients (46.4% of the sample), with smoking habits and drug addiction being the most prevalent with 21.10% and 15.8%, respectively. These findings endorse the studies by Santos et al.,[23] which addresses the of these individuals exposure to major risk factors and behavioral influence. Among women, it was observed that systemic arterial hypertension (SAH) and diabetes mellitus (DM) were present in a higher percentage (11.6%; 7.4%). It is important to emphasize that diabetic patients have an increased risk of postoperative infection due to the impairment of the distal segments perfusion, impairing blood supply and, consequently, healing.[22]

There are few epidemiological studies of ankle fractures published in the national literature, and this type of study is extremely important to verify the main affected population and the mechanism of injury, in order to develop prevention policies, as well as to map the most performed type of treatment and period of hospitalization, important data for the health system, and hospital management.

In addition to the scarcity of information from national studies regarding the epidemiological survey of ankle fractures, this research had a information collection limitation due to the lack of a protocol for resident physicians to fill in data.

CONCLUSION

The sample consisted of 219 individuals, 143 males (65.3%) and 76 females (34.7%), with a mean age of 41.87 years, and a mean period of hospital stay of 7.10 days.

In this study, ankle fractures were predominant in male patients from 30 to 39 years of age, with the main mechanism of injury being motorcycle accidents. There was a correlation between the mechanism of injury and fracture classification, with the most common types being 44B2 and 44B3, and the use of external fixators in 9.1% of the cases. The death rate was significant when related to associated injuries in polyfractured patients.

Most of the treatment intervention was surgical (92.7%), with the use of plates and screws (29.7%).

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GAIT ASSESSMENT IN ANKLE FRACTURES WITH SYNDESMOSIS LESIONS UNDERGOING SURGERY

AVALIAÇÃO DA MARCHA NAS FRATURAS DO TORNOZELO COM LESÃO DA SINDESMOSE SUBMETIDOS A CIRURGIA

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ABSTRACT

Introduction: The three-dimensional evaluation of patients in the gait laboratory is a diagnostic method that is gaining ground in various orthopedic pathologies and, in the case of ankle fractures, can more accurately detail the degree of joint limitation. Objective: To present the importance of laboratory gait studies in the postoperative period of ankle fractures associated with syndesmosis ligament injuries, increasing the arsenal for assessing whether the surgical approach and outcome were satisfactory. Methods: Case series of 13 patients who underwent surgical treatment for ankle fractures associated with syndesmosis injuries, evaluated postoperatively in the gait clinic using the BTS GAITLAB hardware program. Kinetic and kinematic data using a three-dimensional movement system were collected and analyzed. Results: Alterations were found in the Temporal and Spatial Parameters and in the Statistical Angles of the lower limb joints, comparing the operated limb with the non-operated limb. Conclusion: The results of the study suggest that, despite subtle variations between the limbs assessed, the program was able to identify these differences in a significant way, demonstrating that gait assessments bring great benefits in understanding biomechanical limitations, and make more effective and individualized rehabilitation protocols possible. ***Level of evidence IV, Case series.***

Keywords: Ankle Fracture. Three-Dimensional Gait Assessment. Syndesmosis. Biomechanics.

RESUMO

Introdução: A avaliação tridimensional dos pacientes no laboratório de marcha é um método diagnóstico que vem ganhando espaço nas várias patologias ortopédicas e, no caso das fraturas do tornozelo, pode detalhar com mais precisão o grau de limitação articular. Objetivo: Apresentar a importância do estudo da marcha em laboratório no pós-operatório das fraturas do tornozelo assoc iadas a lesões dos ligamentos da sindesmose, aumentando o arsenal de avaliação se a conduta e o resultado cirúrgico foram satisfatórios. Métodos: Série de casos de 13 pacientes submetidos a tratamento cirúrgico das fraturas do tornozelo associada a lesão da sindesmose, avaliados no pós-operatório no ambulatório de marcha com uso do programa Hardware BTS GAITLAB. Dados cinéticos e cinemáticos através de sistema tridimensional de movimento foram coletados e analisados. Resultados: Alterações foram encontradas nos Parâmetros Temporais, Espaciais e nos Ângulos Estatísticos das articulações dos membros inferiores, comparando o membro operado com o não operado. Conclusão: Os resultados do estudo sugerem que, apesar de variações sutis entre os membros avaliados, o programa foi capaz de identificar essas diferen&c cedil;as de maneira significativa, demonstrando que avaliações de marcha trazem grandes benefícios no entendimento das limitações biomecânicas, e tornam possíveis protocolos de reabilitação mais efetivos e individualizados. ***Nível de evidência IV, Série de casos.***

Descritores: *Fratura do Tornozelo. Avaliação Tridimensional da Marcha. Sindesmose. Biomecânica.*

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INTRODUCTION

Ankle fractures are a common type of fracture, accounting for approximately one in ten orthopedic fractures, with lateral malleolus injury accounting for 55% of cases. In most cases, it is mainly caused by torsional trauma, and when it is associated with injury to the distal tibiofibular joint (syndesmosis), the chances of some kind of sequel increase, even when treated correctly. In this sense, the better and more assertive the assessment in the pre-and postoperative period, the greater the chances of successful treatment and functional return of the patient.[1-5]

Initially, it is necessary to understand the complexity of this joint, which is composed of a synovial fitting involving the articular surface of the tibia (ankle and talus), working together with the subtalar joint, that is, it acts as an improved hinge that allows plantar flexion, and flexion, sliding and rolling on the dorsal side. In addition, the ankle is bounded by three lateral ligaments and a strong medial delta ligament. Therefore, this is a complex area with many potential sites of injury.[3,4]

In recent years, new diagnostic imaging methods have been proposed. These methods aid in both the pre- and postoperative periods of these lesions. The three-dimensional assessment of patients in the gait laboratory is a diagnostic method that has been increasingly used for various orthopedic conditions. In the case of ankle fractures, it can provide a more detailed evaluation of the extent of joint limitations through gait analysis. Evaluating the principles of gait analysis, with a particular focus on the foot and ankle, has revealed some previously misunderstood concepts.[5,6]

The study of gait has contributed positively in the various pathologies of the foot and ankle segment, with studies showing its postoperative relevance mainly in patients undergoing ankle arthrodesis and ankle arthroplasty surgeries,[7-9] providing accurate assessments to intervene more effectively, with evident improvement in gait quality. Such contributions are fundamental in the anatomical restoration and stabilization of tibiofibular syndesmosis, preventing a chronic pattern characterized by persistent ankle pain, functional disability, and early osteoarthritis.[10-14]

Despite the importance of this type of assessment, studies that show the quality of gait after ankle fractures with ligament injury are still scarce in the literature. For this reason, the aim of this study was to evaluate the gait of patients with ankle fracture associated with syndesmosis ligament injury submitted to surgical treatment, through three-dimensional biomechanical analysis.

MATERIALS AND METHODS

Study Design

This is a prospective case series conducted on patients with ankle fractures associated with syndesmosis injury who underwent surgical treatment for both the fracture and ligament injury. Patients were recruited consecutively at the UNIMED, Português and Santa Joana hospitals. They were followed at the Movement Analysis Laboratory of the Instituto Rolim, in Pernambuco-Brazil, from June 2020 to August 2022. This study was approved by the Research Ethics Committee of the Universidade Federal de Pernambuco (no. 5,841,495) and followed the international declaration of intent to treat.

Eligibility criteria

Patients, both male and female, aged 25 to 62, who had undergone appropriate postoperative physiotherapy within 6 to 24 months were included. Patients who did not undergo a proper gait examination and those with other orthopedic issues in the lower limbs, upper limbs, or spine were excluded.

Surgical intervention

The recommended surgical technique for the study involved open reduction of the fracture using the OA technique, with osteosynthesis of the malleoli using plates and/or screws. To treat syndesmosis lesions, we performed fixation using either syndesmotic buttons or 3.5 mm screws.

Variables

Clinical and radiological evaluation

Patients were assessed using a questionnaire containing clinical data and a validated functional assessment tool, AOFAS. In addition, we performed X-ray examination to assess post-surgical alignment.

Anthropometric assessment

Static anthropometric data include distance between the anterior superior iliac spines (ASIS), pelvic girdle depth, length of the lower limbs, diameter of the knees, and diameter of the ankles. After collecting the static data, we also measured the dynamic data, such as the range of motion of the hips, knees, ankles, and feet.

Gait movement: reflective markers

Kinetic and kinematic studies were conducted in the gait laboratory using BTS GAITLAB Hardware, which includes 10 cameras and 6 force platforms, along with markers (sensors) as shown in Figure 1 and 2.

Figure 1. Center for Rare Diseases of Pernambuco (Rarus) and Movement Analysis Laboratory of Instituto Rolim.

After gathering the anthropometric data, the BTS-Gaitlab program was established, as previously described. The modified Helen Hayes protocol has been implemented. This protocol utilizes a specific set of markers (sensors), as described by Kadaba et al.[15] (15). Reflective markers for motion capture were placed on anatomical sites defined by the chosen protocol and attached to the patient's skin using painless adhesives.

After placing the markers, the patients were asked to perform two different tasks.

Static socket (Standing) - patients were instructed to maintain an orthostatic position for about 5 seconds, with the feet aligned at the top of the power platform as shown. This protocol calculates the patient's static pose joint angles and creates a three-dimensional reconstruction. During data processing, a report is generated that displays a table containing the angular values alongside the normative data.

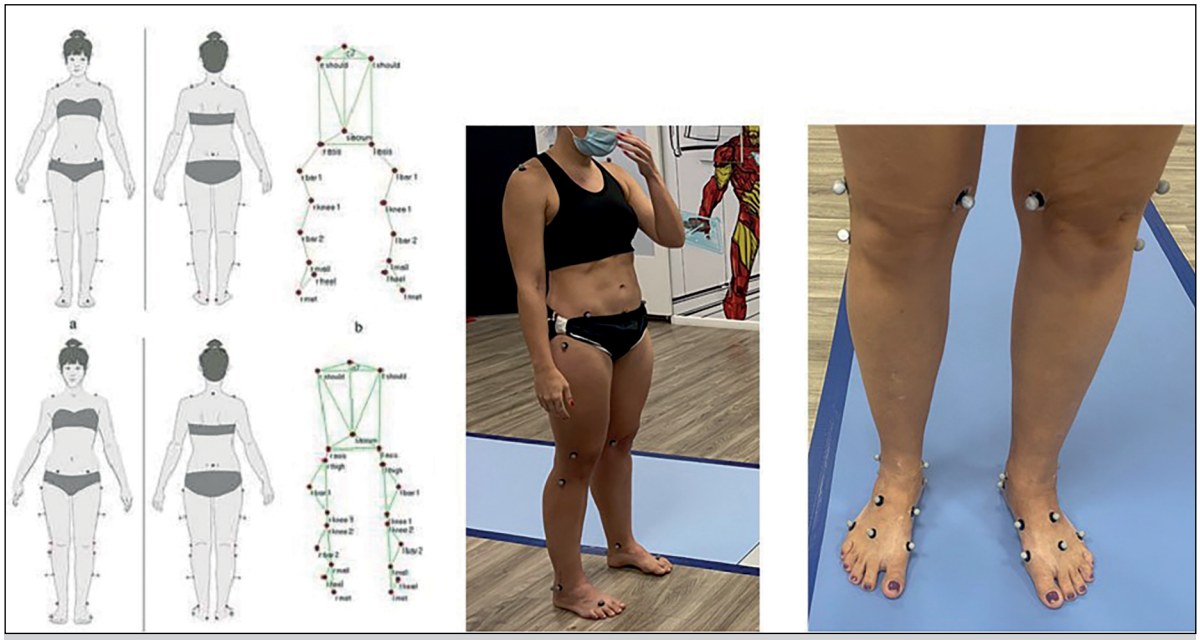

Figure 2. Reflective markers for motion capture: painless stickers on the patient's skin.

Dynamic take - The patients were instructed to walk naturally on the lab's track, equipped with six digital 3D force platforms that capture their reaction forces to the ground. Each patient performed approximately 18 repetitions. Reflective markers are tracked by 10 high-resolution, high-frequency infrared cameras, providing data on joint position and movement during walking. The data is recorded and transmitted to a computer using Bluetooth technology.
Each complete examination lasted on average one to two hours. It was necessary to use bathing suits, however, if patients chose, they could use other garments, such as shorts and T-shirts. Before the sessions began, the system was properly calibrated.

After collecting these kinetic and kinematic data, the Helen Hayes protocol was used automatically to process the examinations, which allows evaluating the joint movements of the lower limbs. Sessions were automatically filtered by protocol *Rep_Gait_Consistency*, obtaining an average gait parameter. The BTS-GAITLAB software offers various functions that allow detailed visualization of the collected data and the application of filters to ensure analysis accuracy. A multimedia report includes spatio-temporal parameters, kinematics and kinetics of the joints evaluated in the different phases of the gait cycle (Figure 3).

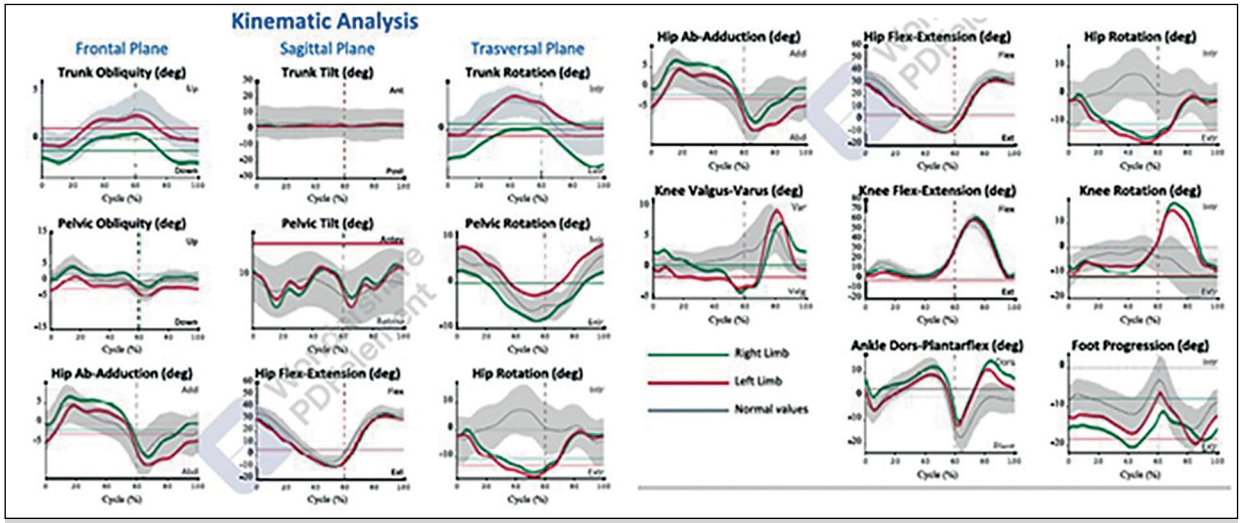

Figure 3. BTS-GAITLAB software has several functions that allow you to view in detail the data obtained in multimedia: spatio-temporal parameters, kinematics and kinetics of joints in different phases of the gait cycle.

Some variables were collected and considered important: cadence (number of steps / min), speed (m / s), average speed (percentage of Height/s), step length (expressed as a percentage of the gait cycle), stride length (m), STEP width (m), support phase (expressed as a percentage of the cycle) swing phase (expressed as a percentage of the gait cycle), double Support (time when both feet were in contact with the ground, expressed as a percentage of the gait cycle), single support (expressed as a percentage of gait cycle), stride Time (s), support Time (s) and Swing Time(s) (Figure 4).

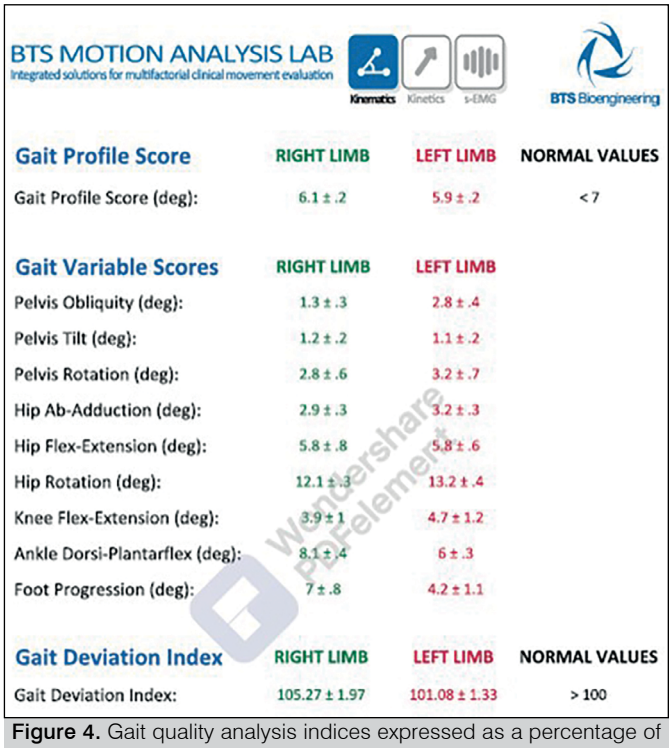

Figure 4. Gait quality analysis indices expressed as a percentage of the gait cycle: temporal, special and static.

For the assessment of ankle and foot deviations, the dorsiflexion and plantarflexion angle of the ankle, as well as the foot progression angle, were primarily evaluated. Gait deviation index (GDI) and gait profile score (GPS) were used as gait quality analysis indices. These analyzed variables were compared with normal data in order to obtain a complete understanding of the possible movement compensation activities in the different anatomical planes and identify possible treatments for dysfunctions presented by patients. The Gait Deviation Index or GDI is a measure of general gait pathology.[16] It was developed from the kinematic data of a large number of walking strides to derive a set of mutually independent joint rotation patterns that efficiently describe gait. These patterns are called gait characteristics. A GDI value ≥ 100 indicates a subject whose gait characteristics are statistically indistinguishable from the gait characteristics of a given control group. In other words, a GDI value ≥ 100 indicates a normal gait.

The Gait Profile Score (GPS) and the Gait Variable Score (GVS) are two indices that summarize the overall quality of the patient's gait kinematics. These indices facilitate the comparison of pathological and normal gait. The Gait Profile Score (GPS) is calculated as the Euclidean distance between the kinematic characteristics of the patient and the corresponding normative characteristics, for the entire gait cycle. GPS values greater than 7 degrees indicate a compromised gait pattern.[17]

The Gait Variable Score (GVS) is defined as the mean square root of the difference between a single gait characteristic and the corresponding mean gait characteristic for people without gait pathology. GVS is calculated for each gait characteristic, and the results are presented in a specific table. This table provides useful information to understand which variables are contributing to a high Gait Profile Score (GPS).

After all this process, the Final report is created using the specific protocol. This report contains the average spatio-temporal parameters of all selected trials. Synthetic indices that summarize the overall quality of the patient's gait make it easy to compare the pathological gait with the normal gait, which is well covered in the examination result. The graphs of kinematic and kinetic analysis are also presented. The unit of measurement used in the graphs is the degree (Y-axis) and the percentage of the March cycle (x-axis). The mean curves for each limb (green for the right lower limb and red for the left) are plotted against the normative data (in gray).

RESULTS

Sample data

The data describing the demographic characteristics of the 13 eligible patients showed that most were female 9 (69.2%), with a mean weight of 79.39 kg and a mean height of 1.68 m (Table 1). The data from the examinations are presented in Table 2. It is evident that the left side was the most frequently operated side, accounting for 61.5% of the total. According to the AO classification, Type B was the most frequent (69%), followed by Type C (31%), with no cases of Type A. In patients with Type B lesion, most were in Stage 2 and 3 (44% in each) and in Type C, 50% were in Stage 1 and 50% in Stage 2. In the LH classification, most patients were diagnosed with external supination-rotation (53.8%), 23.1% with external pronation-rotation and 23.1% with pronation-abduction. The mean follow-up time of patients after surgery and until examination was 12 months (minimum = 7 months; maximum = 19 months).

Table 1. Demographic characteristics of the sample.

Variable	N (%)
Gender	
Female	9 (69.2)
Male	4 (30.8)
Age (years) mean standard deviation) (SD)	40.54 (12.18)
Weight (kg) (mean SD)	79.39 (13.98)
Height (cm) (mean SD)	168.92 (9.98)
Postoperative time (months) (mean SD)	12.78 (4.36)

Table 2. Variables observed in the examination of patients.

Variable	n (%)
Side operated	
Right	5 (38.5)
Left	8 (61.5)
Classification AO	
44-A1	0 (0.0)
44-A2	0 (0.0)
44-A3	0 (0.0)
44-B1	1 (7.7)
44-B2	4 (30.8)
44-B3	4 (30.8)
44-C1	2 (15.4)
44-C2	2 (15.4)
44-C3	0 (0.0)
Classification Lauge Hansen	
external supination-rotation	7 (53.8)
Supination-Adduction	0 (0.0)
external pronation-rotation	3 (23.1)
Pronation-Abduction	3 (23.1)
AOFAS score Average	89.92 (4.63)

<< SUMÁRIO

AOFAS

Through the AOFAS score it was possible to observe that most patients (84.6%) had AOFAS score classified as good, followed by excellent with 15.4%. No patient studied had an AOFAS score classified as reasonable or poor. In Figure 5, it can be seen that the median score AOFAS was 90, the maximum value was 96, and the minimum value was 87 (disregarding the outlier value of 78).

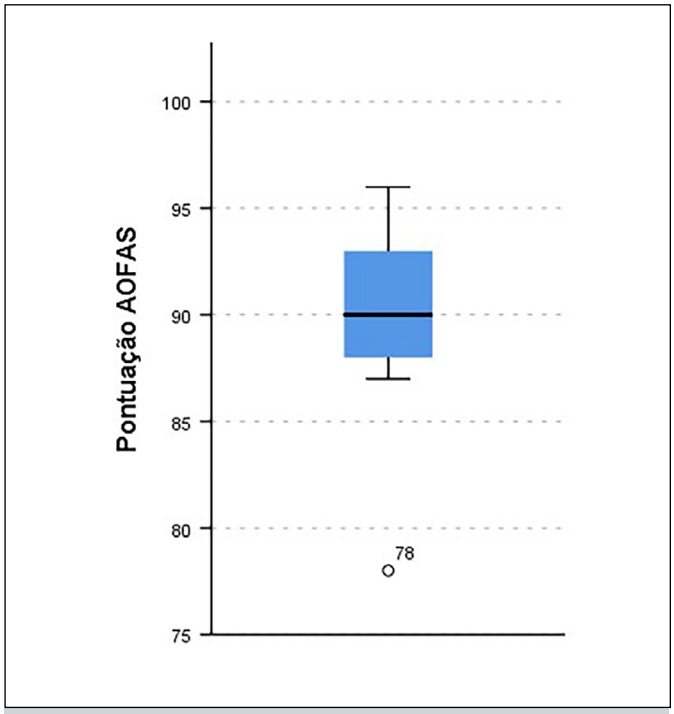

Figure 5. AOFAS chart.

Temporal parameters

Analyzing the temporal parameters, after the statistical analysis of the study patients, there was a difference between the operated limb and the contralateral side in the parameters support Time ($p < 0.0001$), Swing Time ($p < 0.0001$), Support Phase ($p < < 0.0001$), Swing Phase ($p< 0.0001$), Single Support Phase ($p < 0.0001$), and Double Support Phase ($p = 0.0062$).

The Swing Time and swing phase showed a significant variation on the operated side, with the normal parameter of 0.39 s (0.03). The Stride time and stride phase presented a reduction in time, both in relation to the contralateral limb and as a function of the parameters adopted as normal 0.93 s (0.04). The support Phase expressed in % also had a small increase with the right side 61.11% (1.75) and the left side 60.61% (1.27), with the normality value 57.97% (1.93). The double support phase and the Simple support Phase also showed significant differences, with a decrease in time in the left limb in the Simple Support Phase (34%) and an increase in both limbs in the Double Support Phase (D = 12%; E = 14%), compared to the standard value of 10%.

Other temporal parameters also showed changes, such as average speed in meters per second, average speed in % of height per second and cadence, which is expressed in steps per minute. The average normal speed is 1.2 m/s, and in patients it was 1.08 m/s. The Average Speed (% Height/s) was 63.97% Height/s, the normal value being 80% Height/s. On the other hand, the cadence had an average value reduced from a normal value 1.2 m/s to 1.08 m/s. The data are shown in Table 3.

Table 3. Mean ± SD of the values observed in the variables of the physical examinations of the patients.

	Members		
	Right	Left	Default value (p vlue (v
Temporal Parameters			
Passing Time (s):	1.11 (0.09)	1.10 (0.09)	1.10 (0.899)
Support Time (s):	0.73 (0.01)	0.68 (0.02)	0.65 (<0.0001)
Balance Time (s):	0.34 (0.003)	0.43 (0.004)	0.44 (<0.0001)
Support phase (%):	65.38 (0.44)	60.89 (0.5)	58.98(<0.0001)
Swing phase (%):	*34.61 (1.75)	38.14 (1.27)	40.03(<0.0001)
Single support phase (%)	38.73 (0.40)	34.86 (0.44)	38.87(<0.0001)
Double support phase (%):	12.07 (0.17)	14.23 (0.73)	10.27 (0.0062)
Average speed (m/s):	1*.08 (0.13)		
Average speed (%height/s):	*63.97 (6.20)		
Cadence (steps/min):	*106.99 (8.17)		

Spatial parameters

The spatial parameters showed few changes compared to the normal reference values, always within the limits considered normal. However, when comparing the operated limb with the contralateral one, a statistically significant difference was observed. Stride length, which is expressed in meters, had a slight increase overall, with an average of both the right (1.58 m) and left (1.48 m), with the average reference value being 1.13 m, with $p < 0.0001$. Stride length in % per height had a decrease in the overall value of the patients, with the normal value being 80 (10), in the right limb 65.29 (0.83) and left limb 63.58 (0.86) with $p < 0.0001$.

The step length, expressed in meters, was the only parameter without significant difference between the limbs, with little variation in relation to the reference value, p = n. s. These values are expressed in Table 4.

Table 4. Mean ± SD of the values observed in the variables of the physical examinations of the patients.

	Members		
	Right	Left	P-Value
Spatial Parameters			
Stride length (m):	1.58 (0.27)	1.48 (0.28)	<0.0001
Stride length (%alt.):	64.29 (0.83)	63.58 (0.86)	<0.0001
Step length (m):	0.51 (0.16)	0.52 (0.15)	0.61
Step width (m):	0.09 (0.02)		

Statistical angles

Regarding the statistical angles (expressed in degrees), some small changes were observed in the pelvis, hip, knee, ankle and foot. Hip Ab-adduction (°) was the parameter that presented a significant difference between the operated and contralateral limbs ($p = 0.017$) the other data were not statistically different, as shown in Table 5.

Table 6, which details the descriptive measures of the parameters of Gait Profile Score, Gait Variable Scores and Gait Deviation Index, it is possible to observe that neither the mean observed value of GPS nor the GDI were statistically different from the standard value.

Table 5. Mean ± SD of the values observed in the variables of the physical examinations of the patients.

	Members (average and SD)		
	Right	Left	P-value
Static Angles			
Pelvic obliquity (degrees):	1.09(0.20)	1.09 (0.20)	> 0.99
Pelvic Tilt (degrees):	10.28 (1.78)	10.28 (1.78)	> 0.99
Pelvic rotation (degrees):	3.2 (2.98)	3.2 (2.96)	> 0.99
Hip Ab-adduction (°):	1.29 (0.50)	3.22 (0.15)	0.017*
Flexion-extension of the hip (°):	7.39 (5.00)	6.71 (5.54)	0.239
Hip rotation (°):	9.06 (3.8)	7.73 (2.73)	0.77
Flexion-extension of the knee (°):	0.90 (3.31)	0.77 (3.95)	0.82
Plantar dorsiflexion of the ankle.(°):	4.01 (0.12)	4.89 (0.33)	0.063 (or 0.22)
Foot progression (°):	9.18 (0.7)	9.30 (0.8)	0.89

Table 6. Mean (standard deviation) of the values observed in the variables of the physical examinations of the patients.

	Member		
Variables	**Right**	**Left**	**Default value (p value)**
Gait Profile Score			
Gait Profile Score (deg):	7.92 (0.8)	7.69 (1.2)	< 7 (p = 0.643)
Gait Variable Scores			
Pelvic obliquity (degrees):	1.74 (0.64)	2.22 (0.80)	
Pelvic Tilt (degrees):	4.08 (3.01)	4.06 (3.03)	
Pelvic rotation (degrees):	2.99 (0.68)	2.95 (0.42)	
Hip Ab-adduction (°):	3.23 (1.41)	2.91 (1.29)	
Flexion-extension of the hip (°):	5.18 (2.37)	4.67 (2.29)	
Hip rotation (°):	9.84 (3.84)	10.07 (3.94)	
Flexion-extension of the knee (°):	5.22 (1.51)	5.56 (2.59)	
Plantar dorsiflexion of the ankle.(°):	5.26 (1.19)	6.00 (1.30)	
Foot progression (°):	7.16 (4.88)	6.48 (4.77)	
Gait Deviation Index	90.92 (2.6)	89.50 (2.8)	> 100 (p = 0.034)

DISCUSSION

Adequate treatment of syndesmosis complex lesions is challenging but necessary to avoid malreduction, which can alter the kinematics of the Tibio-fibular joint and lead to chronic instability, cartilage damage, and early osteo-arthritic changes of the ankle joint. Therefore, the accuracy and maintenance of syndesmosis reduction are considered essential in the treatment of ankle fractures with concomitant syndesmosis injury. The postoperative parameters of physical examination and imaging tests give us an insight into what degree of limitation the operated patient may have, but not in a dynamic way.

The study of gait in fractures of the lower limbs has been gaining ground, evaluating the kinetics and kinematics of patients. Observing some specific works of patients with ankle fracture associated or not with syndesmosis injury, several small changes in gait pattern were observed.

Researchers compared gait patterns among patients treated for ankle fractures with those of healthy individuals. They analyzed 18 patients with ankle fracture using PROM and gait, with a multisegmental foot model (modified Oxford foot model) with at least one year postoperatively. Twelve patients had lateral uni-maleolar fracture and six had tri-maleolar fracture, and all were treated with open reduction and internal fixation. The results were compared with those of healthy subjects and the contralateral leg. The study found lower flexion / extension between the hindfoot and tibia in the fracture group compared to healthy subjects during support, and lower ROM (flexion/extension) in the swing phase compared to the uninjured side. They found that the Olerud and Molander ankle score (OMAS) questionnaire correlated moderately to moderately with kinematic parameters in the sagittal plane during the swing (flexion/extension) phase.[19] These changes were also observed in the present study.

During early rehabilitation, ankle fracture patients may develop asymmetry of trunk movement in the vertical direction accompanied by slower gait speed and cadence and shorter step lengths, which may contribute to muscle imbalances and potential injury. Thus, appropriate rehabilitation strategies should be employed for these patients.[18-20]

Losch et al.[21] analyzed gait in 20 patients with surgically treated ankle fracture one year after the operation and compared the results with those of 20 healthy adults. They found lower flexion / extension in the ankle joint, lower speed, and shorter stride length in the injured group compared to healthy individuals. However, they found no significant correlation between kinematic parameters and Patient Reported Outcome Measures (PROM).

The work of Segal et al.,[22] evaluated some parameters such as step length, walking speed and plantar pressure in patients operated on ankle fractures. The 41 patients with ankle fracture were divided into uni-maleolar fracture (n = 12), bi-maleolar fracture (n = 15) and tri-maleolar fracture (n = 15). The results were compared with the gait of 72 healthy subjects. There were significant differences in all parameters, primarily walking speed and step length. Patients with uni-maleolar fracture performed better than others with bi-maleolar or tri-maleolar fractures.

Hancock et al.[23], and that of Egol et al.[12], also evaluated the functional outcome after ankle fractures, but reported different results regarding the severity of the fracture and the functional outcome. Researchers saw that individuals with uni-or bi-malleolar ankle fractures had better functional outcome than patients with tri-malleolar fractures, based on the OMAS and Lower Extremity Functional Scale (LEFS). In contrast, the work of Egol et al. They concluded that the type of fracture had no influence on the functional outcome after ankle fracture surgery, according to the Orthopedic Trauma Association (OTA) system and the Lauge-Hansen system.

Various gait changes occur after ankle fracture, including reduction in stride length, Swing Time, single support time, stride length, cadence, speed, and a fore-foot exit time on the affected side. In addition, the symmetry of trunk movement (especially vertical) is significantly reduced after ankle fracture.

The differences in the kinematic profile of the gait of the lower limbs of patients recovering from ankle fracture compared to healthy controls, were evaluated in a study. In addition, we asked whether the profile would be different between the groups of fracture severity. A total of 48 patients participated in the prospective case-control study. The gait of 24 patients recovering from an ankle fracture injury and 24 healthy paired controls was examined using an inertial measurement unit sensor system. The following gait parameters were evaluated: knee range of motion (ROM) during the swing phase, maximum knee flexion angle during support, thigh and calf ROM, and stride duration. Statistically significant differences were found between the ankle fracture group and the control group for all parameters. Patients with ankle fracture had lower ROM of the knee during the

rocking phase compared to the control group (mean ± standard deviation 43.0° ± 15.5° compared to 66.7° ± 5.1°, respectively ($p < 0.001$). The maximum knee flexion angle during support was lower in patients with ankle fracture than in the control group (mean ± standard deviation 10.5° ± 6.1° compared to 21.2° ± 4.5°, respectively; $p < 0.001$). Ankle fracture patients also had lower thigh and calf ROM angles ($p < 0.001$) and longer stride duration ($p < 0.001$) compared to the control group. No statistically significant differences were found between the severity groups. These results suggest that gait kinematic characteristics vary between healthy people and patients recovering from an ankle fracture during the short period after the injury[24].

The hypothesis was that patients after ankle fracture surgery had less ankle flexion/extension compared to healthy subjects and that fracture severity had a significant influence on kinematics and patient satisfaction. Thirty-three patients (n = 33 feet) operated for ankle fractures were recruited. Ankle kinematics were analyzed using the Oxford Foot, and the results were compared with a healthy control group of the same age (n = 11 patients, 20 feet). In addition, patients were divided by fracture classification (severity) and kinematic results were correlated with PROM and radiographic findings. Patients treated for ankle fracture showed lower walking speed ($p < 0.001$) when asked to walk preferably at normal speed. When compared at equal speed, significantly lower range of motion (ROM) between the hindfoot and tibia in the sagittal plane (flexion/extension) during loading and push-off ($p = 0.003$ and $p < 0.001$) was found in patients after ankle fractures compared to healthy subjects. Lower ROM and worse PROM outcomes were found for patients with tri-malleolar fractures of the ankle. There was a significant correlation between ROM (flexion/extension) during the push-off phase and physical functioning SF-36 ($r2 = 0.403$, $p = 0.027$) and SF-36 general health ($r2 = 0.473$, $p = 0.008$). Fracture severity was significantly correlated with ankle flexion/extension ROM during the load and thrust phases ($r2 = -0.382$, $p = 0.005$ and $r2 = -0.568$, $p < 0.001$) and was also significantly correlated with PROM. This study found that patients with ankle fractures had significantly altered ankles in kinematics compared to healthy subjects.

Several parameters are evaluated in the gait study, with subtle or slightly more exacerbated changes, which was also evaluated in the present study. In the Temporal Parameters it is noted that the greatest changes were in the Average Speeds and Cadence. The spatial parameters showed few changes compared to the normal reference values, always within the limits of normality. Regarding the statistical angles, some small changes were observed in the pelvis, hip, knee, ankle and foot, without much relevance.

The descriptive measurements of the gait Profile Score, Gait Variable Scores and Gait Deviation Index parameters allow to observe that neither the mean observed value of GPS nor the GDI were statistically different from the standard value.

Evaluation of markers with the use of gait movements can provide an objective characterization of gait changes after ankle fracture. This assessment is important not only in clinical practice to assess patient performance, but also in clinical research as a reference point for evaluating existing or new rehabilitative interventions, and can provide an objective characterization of gait changes after ankle fracture.

The kinetics and kinematics of the ankle used in this research showed to be efficient in verifying the behavior of the individual during the main phases of gait. The data collected showed consistency with the expected pattern of normal gait for all volunteers, in an absolute analysis. Further research should be carried out with a larger number of samples, comparing specific groups, and investigating intervening variables of the gait cycle.

The study was greatly limited by the small number of patients evaluated. Despite the fact that it is a relatively common fracture treated in emergencies, the analysis in the Gait Laboratory requires a relatively long time to perform the examination, and many patients refuse to perform it for this reason. In addition, the collection of the examination requires a health professional who knows how to handle the sensors and use the specific program. It should also be noted that Gait Laboratories are scarce in the country because they are very expensive, in addition to interpreting the three-dimensional data is quite difficult and requires trained professionals.

The results presented in this study justify the use of gait in clinical practice and encourage the development of intervention methods that emphasize function. Gait markers positively interfere with gait locomotor function in patients with ankle fracture associated with syndesmosis and enhance the retention of skills developed in training in the medium term.

CONCLUSION

The results of the study suggest that, despite subtle variations between the evaluated limbs, the program was able to identify these differences significantly, demonstrating that gait evaluations after ankle fracture surgeries with syndesmosis fixation, with a biomechanical program, will bring great benefits both to understand the possible limitations that the patient may present, and to form earlier rehabilitation protocols and consequently improve short-and long-term results.

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EVALUATION OF IDIOPATHIC SCOLIOSIS IN SUBTYPES OF PECTUS EXCAVATUM AND CARINATUM

AVALIAÇÃO EPIDEMIOLÓGICA DA ESCOLIOSE IDIOPÁTICA NOS DIFERENTES SUBTIPOS DE *PECTUS EXCAVATUM* E *CARINATUM*

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ABSTRACT

Objective: Evaluation of epidemiological data on Idiopathic Scoliosis in patients with different pectus subtypes. Methods: A medical record analysis of 418 patients with pectus, associated with idiopathic scoliosis above 10°, with research on: subtypes of pectus (Lateral Pectus Carinatum, Inferior Pectus Carinatum, Superior Pectus Carinatum, Broad Pectus Excavatum, and Localized Pectus Excavatum), and characteristics of the scoliotic curve (Cobb angle, laterality, and location). Results: The mean age was 14.6 years (22° mean Cobb, 52% females and 48% males). The most frequent kind of pectus was Inferior Pectus Carinatum (28%). The left-convex thoracolumbar type was the most frequent. Scoliosis was more severe in thoracic location and females. The main type was LPC ($p < 0.05$) in those with severe scoliosis. BPE was more present in men (68%), and LPC and SPC in women ($p < 0.05$). No significant differences were found between the pectus type and the side or location of the scoliosis curve. Conclusion: Depending on the subtype of pectus, the scoliotic curve presents distinct epidemiology and characteristics. ***Level of Evidence IV, Case Series – study prognostic.***

Keywords: Idiopathic Scoliosis. Pectus Excavatum. Pectus Carinatum. Epidemiology.

RESUMO

Objetivo: Avaliação dos dados epidemiológicos da Escoliose Idiopática em pacientes com o pectus carinatum e excavatum. Método: Foi realizada uma análise retrospectiva dos prontuários de 418 pacientes com pectus associados a escoliose acima de 10°, sendo pesquisado: subtipos de pectus (carinatum: inferior-PCI, lateral-PCL e superior-PCS; e excavatum: amplo-PEA e localizado--PEL), característica da curva escoliótica (ângulo de Cobb, lateralidade e localização: –torácica, toracolombar e lombar). Resultados: A idade média foi de 14,63 anos na primeira consulta, o ângulo de Coob médio de 22°. O tipo toracolombar sinistro-convexo foi o mais frequente. As escolioses torácicas foram mais severas que as toracolombares e lombares, e tiveram o lado direito como mais frequente. Nas escolioses mais severas o principal tipo foi o PCL($p<0,05$). O PEA foi mais presente em homens (68%), e o PCL e PCS em mulheres ($p<0,05$). Não foram encontradas diferenças significativas entre o tipo de pectus e o lado ou local da curva da escoliose. Conclusões: A depender do subtipo de pectus, a curva escoliótica apresenta epidemiologia e características distintas. ***Nível de Evidência IV, Série de Casos – Estudo Prognóstico****.*

Descritores: *Escoliose Idiopática. Pectus Excavatum. Pectus Carinatum. Epidemiologia.*

INTRODUCTION

The set of anterior chest wall deformities is universally defined as pectus.[1] It has an incidence of 0.2% to 3% of the population with a report of 1:300/400 live births and a ratio of 3/5:1 in men.[2-4]
A chest wall protrusion deformity is defined as pectus carinatum, while pectus excavatum is the depression deformity. In addition, they can be subdivided regarding the location of the apex of the deformity, classifying them as Superior (SPC) / Inferior (IPC) / Lateral (LPC) for pectus carinatum, and as Localized (LPE) / Broad (BPE) for pectus excavatum.[5]
Idiopathic scoliosis is a three-dimensional deformity of the spine defined by a Cobb angle greater than 10° without a defined cause. It has an incidence of 2–3% in the general population, being more common in females from adolescence onwards. It is subdivided according to the age it appears, into infantile (0–3 years old), juvenile (4–10 years old), and adolescent (> 10 years old).[6,7]

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The study was conducted at Centro Clínico Orthopectus and Hospital de Base do Distrito Federal, Orthopedic Department.
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<< SUMÁRIO

After the first description of the idiopathic scoliosis association with pectus by Walter in 1989, other studies reported the incidence of these pathologies together.[4,8,9] These studies showed increased incidence compared to the normal population (17.61% – 28.6%). Hong et al. reported a higher incidence of females having both pectus and scoliosis. Zhong et al. reported a higher incidence of right-convex curves in those with pectus, and Wang et al. reported that the higher the Haller, the greater the severity of scoliosis.
There are no studies evaluating the incidence and characteristics of scoliotic curves in the pectus subtypes.
Thus, in view of the importance of knowledge for these pathologies proper monitoring, this study aims to analyze the scoliosis epidemiology in the pectus subtypes.

MATERIAL AND METHODS

Data was collected for patients diagnosed with Pectus Excavatum and Carinatum and Idiopathic Scoliosis treated at two pectus centers from 1995–2023 by two pediatric orthopedists references in the non-surgical treatment of pectus.*This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee* under CAAE number 70798923.3.1001.8153. A written informed consent was obtained from the parents. For 7,101 medical records of patients with pectus, 2,225 (31%) had a record of scoliosis, 418 of which had complete information necessary for the study. Data on age of the first appointment, gender, type of pectus, and characteristic of the scoliotic curve were collected from the medical record.
The pectus was classified as described by Haje:[5] as Lateral Pectus Carinatum (LPC), Inferior Pectus Carinatum (IPC), Superior Pectus Carinatum (SPC), Broad Pectus Excavatum (BPE), and Localized Pectus Excavatum (LPE).
The following characteristics of scoliosis have been researched: (a) the Cobb angle of the largest curve (scoliosis severity was defined as: Mild up to 20°, Moderate from 20–50°, and Severe above 50°); (b) laterality of convexity; and (c) affected segment: Thoracic (T); Thoracolumbar (TL), and Lumbar (L). The type of scoliosis was defined by laterality (right/left) and affected segment.
Statistical analysis:
The chi-squared test or Fisher's exact test were used to compare categorical variables. To compare age among pectus groups, the Analysis of Variance (ANOVA) method with Bonferroni correction was applied. For statistical significance, $p \leq 0.05$ was adopted in all analyses.
The following variables were statistically related:

- Gender x Severity of scoliosis
- Curve severity x Location of scoliosis
- Location of scoliosis x Side of scoliosis
- Type of pectus x Gender
- Type of pectus x Laterality of scoliosis
- Type of pectus x Type of scoliosis
- Type of pectus x Location of scoliosis
- Type of pectus x Scoliosis severity
- Type of scoliosis x Age at first appointment

RESULTS

The study presented a group of 215 (52%) women and 203 (48%) men. The mean age at the first evaluation appointment was 14.63 years old, ranging from 2.06 to 50 years old. The mean Cobb Angle was 22° (Moderate), ranging from 10° to 90°. The most frequent curve was Thoracolumbar, corresponding to 306 cases (73.2%), and the most frequent segment was T12-L4 (11%). In addition, 50.5% of the cases were right-convex scoliosis and 49.5% were left-convex scoliosis.
Within the analysis of the scoliosis, it was found a significant difference in relation to:
a) Scoliosis severity and gender ($p < 0.001$*; $\chi^2 = 26.22$), more common in females.The male gender had a significantly higher incidence in the Mild scoliosis type (68.5% > 45.1%), while the percentage of females was significantly higher in the Moderate type (49.8% > 25.6%).
b) Scoliosis severity and location ($p = 0.002$), the most severe curves being Thoracic. The percentage of Mild scoliosis is significantly higher in the Lumbar location, when compared to T (75% > 38.1%); and the percentage of Moderate scoliosis is significantly higher in T compared to L (53.6% > 25%).
c) Scoliosis location and the side of the curve ($p < 0.001$*; $\chi^2 = 36.20$), with the most prevalent being Thoracolumbar scoliosis with left curve, present in 41.9% of the cases. The percentage right curves was significantly higher in Thoracic scoliosis in relation to Lumbar and Thoracolumbar (79.8% > 46.4% and 42.8%). By symmetry, the percentage of left curves is significantly higher in Locations L and TL in relation to T (57.28% and 53.6% > 20.2%).
About the pectus subtypes, the prevalence was: IPC (118, 28.2%), LPC (110, 26.3%), SPC (19, 4.54%), BPE (79, 18.8%), and LPE (92, 22%).
Regarding the type of pectus and gender, there is a significant difference ($p < 0.001$*; $\chi^2 = 25.62$). The percentage of males is significantly higher in Broad Pectus Excavatum (BPE) compared to all other pectus (69.6%; $p \leq 0.05$ in all comparisons). The percentage of males is significantly higher in Inferior Pectus Carinatum (IPC) than in Lateral Pectus Carinatum (LPC) (50.8% > 35.5%, $p \leq 0.05$). In a complementary way, for the female gender, BPE has lower incidence than the other pectus (30.4%); the percentage of females is significantly higher in LPC compared to IPC (64.5% > 49.1%, $p \leq 0.05$).
No statistical differences were observed between the type of Pectus and laterality of the scoliosis ($p = 0.59$; $\chi^2 = 2.81$); the type of Pectus and type of scoliosis (e.g., right thoracolumbar) ($p = 0.12$; χ^2); the type of Pectus and scoliosis location ($p = 0.31$; $\chi^2 = 9.37$); the type of scoliosis and age at first appointment ($p = 0.13$).
There is no general difference ($p = 0.11$; $\chi^2 = 12.83$) comparing pectus with scoliosis severity, however, fixing the sample in the subtypes, there is a difference. Among the Severe ones, there is a difference between the percentages (LPC 47.8% > SPC 4.3%, BPE 13%, and LPE 13%) ($p = 0.01$*; $\chi^2 = 12.87$). Among the Moderate cases, there is difference between the percentages (LPC 28.3%, IPC 31.4%, BPE 18.2%, and LPE 18.2% > SPC 3.8%) ($p < 0.001$*; $\chi^2 = 38.05$). Among the Mild ones, there is difference between the percentages (LPC 26.8%, IPC 20.8%, BPE 19.9%, and LPE 25.4% > SPC 5.1%) ($p < 0.001$*; $\chi^2 = 39.81$).

DISCUSSION

The idea of the correlation between Pectus and Scoliosis arises from clinical observations of patients with chest deformities associated with syndromes such as Marfan syndrome.[10] Subsequently, the correlation was theorized based on the anatomical precept of the thorax — anterior section with the sternum and posterior section with the spine — and a joint treatment was even proposed for the two deformities.[11] In addition, studies have shown the genetic correlation between the two pathologies.[12] Gurnett et al. demonstrated the correlation of both pathologies with chromosome 18q.
Pectus, seen as an isolated entity, is considered the most common congenital deformity of the chest wall. It is more common in men in proportions of 4:1 in the literature,[2,13] but it is characterized differently in the specific pectus/scoliosis population.[4] In our study, in agreement with the findings of Hong et al., a higher prevalence of females was observed. This difference seen in the pectus/scoliosis

population may be influenced by scoliosis. In our study, however, in comparison to the Pectus subtypes, it was found a higher prevalence of males in Broad Pectus Excavatum (BPE).

The Pectus is classified according to the Carinatum or Excavatum deformity, however, it can also be classified by the deformity position according to Haje's classification.[5] Although most of the literature reports that the pectus excavatum is more frequent, our study was in line with other previous studies that showed the highest prevalence of pectus carinatum in the pectus/scoliosis population.[14,15] According to a previous study by Haje, the prevalence of the type of pectus remained, with the Inferior Pectus Carinatum (IPC) being more prevalent, followed by the Lateral Pectus Carinatum (LPC), and the Localized Pectus Excavatum (LPE) in third place. It was seen, however, that the proportion of LPC in those with pectus and scoliosis was much higher in our study than that reported by Haje in a study reporting a global sample of pectus. Furthermore, the proportions of excavatum in the pectus/scoliosis population increased in relation to the isolated pectus population. In the pectus isolated group Carinatum 78% x Excavatum 22%,[1] while in the Pectus/scoliosis population Carinatum 59% x Excavatum 41%)

In the analysis of scoliosis, especially in adolescents, a higher percentage of the female gender is found in proportions of 1.5/3:1. When evaluating the Cobb angle severity, the numbers go to 7.2:1.[16] In our study, we found that Mild scoliosis were more prevalent in males, and Moderate and Severe conditions more prevalent in the females. The scoliosis location and the side of the curve are, however, distinct from the epidemiology of scoliosis. The literature treats the incidence of Thoracic scoliosis with right curve as the most common,[16,17] while our study found Thoracolumbar scoliosis with left curve as the most prevalent.

Comparison of scoliosis with pectus subtypes did not show significant differences between the side of the curve, the scoliosis location, and the scoliosis type. We found a significant correlation between the LPC type associated with Severe scoliosis, when compared to the other subtypes. Our theory is that Severe scoliosis cases present vertebral body rotation, causing the rotation of the entire hemithorax to be secondary to the rotation of the ribs inserted in the affected vertebrae, which may generate asymmetries in only one hemithorax, or a compatible LPC condition.

Patients with pectus associated with scoliosis had a distinct epidemiology from those with isolated pectus or isolated scoliosis, with more frequent left-convex thoracolumbar curves. Scoliosis in pectus patients was more severe in females, in those with right-convex thoracic curves, and in the LPC subtype.

CONCLUSION

Depending on the pectus subtype, the scoliotic curve has different epidemiology and characteristics.

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SHOULDER PAIN, ULTRASOUND CHANGES, AND FUNCTIONAL PERFORMANCE IN OBESE PATIENTS

DOR NO OMBRO, ALTERAÇÕES ULTRASSONOGRÁFICAS E DESEMPENHO FUNCIONAL EM PACIENTES OBESOS

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ABSTRACT

Objective: To evaluate the prevalence of shoulder pain, level of functional performance, and morphological involvement of the rotator cuff on ultrasound in morbidly obese patients. Methods: The study included 54 morbidly obese patients receiving follow-up care in a bariatric surgery outpatient clinic, which were compared with a control group consisting of 49 participants. Presence of shoulder pain, shoulder functional performance, ultrasound of the rotator cuff and blood tests were the parameters evaluated. Results: The obese group showed a greater incidence of shoulder pain ($p < 0.0001$; OR: 17.5), lower functional performance according to UCLA ($p < 0.0001$; OR: 7.5) and DASH scales ($p < 0.0001$) and a greater incidence of pathological ultrasound and c-reactive protein test changes ($p < 0.0001$). Conclusions: These findings suggest that being overweight is an important exacerbating factor for shoulder pain, lower shoulder functional performance and pathological changes of the rotator cuff and c-reactive protein test. ***Level of Evidence II, Cross-sectional study.***

Keywords: Shoulder. Obesity. Pain. Diagnosis.

RESUMO

Objetivo: Avaliar, em pacientes com obesidade mórbida, a prevalência de dor no ombro, o nível de desempenho funcional e o comprometimento morfológico do manguito rotador na ultrassonografia. Métodos: Foram incluídos 54 pacientes com obesidade mórbida, acompanhados em um ambulatório de cirurgia bariátrica, comparados com um grupo controle de 49 indivíduos. Foram avaliados os seguintes parâmetros: presença de dor no ombro, desempenho funcional do ombro, imagens ultrassonográficas do manguito rotador e exames de sangue. Resultados: O grupo obeso apresentou maior incidência de dor no ombro ($p < 0,0001$; OR: 17,5), menor desempenho funcional segundo as escalas UCLA ($p < 0,0001$; OR: 7,5) e DASH ($p < 0,0001$), maior incidência de alterações patológicas na ultrassonografia e aumento da proteína c-reativa ($p < 0,0001$). Conclusões: Estes dados sugerem que o excesso de peso é importante fator de exacerbação da dor no ombro, menor desempenho funcional do ombro, alterações patológicas do manguito rotador e aumento da proteína c-reativa. ***Nível de Evidência II, Estudo transversal controlado.***

Descritores: *Ombro. Obesidade. Dor. Diagnóstico.*

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INTRODUCTION

According to the World Health Organization (WHO), obesity is a condition characterized by a percentage of body fat large enough to impair one's health,[1] resulting from a complex interaction of variables including genetics, lifestyle, dietary habits, caloric expenditure, nutritional factors, and adipocyte metabolism.[2,3] Recent research reports an association between obesity and greater pain or osteoarthritis (OA) in non-load bearing or traction joints, including the shoulder joint, suggesting possible association of other factors such as low-level systemic inflammation[4-6] and genetic factors.[7]

This chronic inflammation process is directly related to adipokines, bioactive peptides originating from visceral fat that have roles in insulin action and in inflammatory cytokines production in chondrocytes.[4,6] In morbidly obese patients (BMI ≥ 40 kg/m2), the prevalence of shoulder pain, level of functional performance, and morphological involvement of the rotator cuff on ultrasound have yet to be adequately described. Determining clinical and imaging parameters that could point to the need for early intervention are important when formulating therapeutic and preventive strategies.[8] The primary objective of this study was to assess the prevalence and intensity of shoulder pain and functional performance in morbidly obese patients selected for bariatric surgery. Secondary objectives included assessing the prevalence of morphological involvement of the rotator cuff on ultrasound and analyzing blood tests, including lipidemia, glycemia, and inflammatory markers, comparing their results with those of a control group.

METHODS

Study design

This was a controlled cross-sectional study conducted in accordance with the norms set forth by the World Medical Association's Declaration of Helsinki and approved by the Research Ethics Committee of Ipanema Hospital, Rio de Janeiro, Brazil, under Certificate of Presentation for Ethical Appraisal (CAAE) No. 69073215.2.0000.5646, opinion No. 2.127.775. Data were collected between March 2020 and April 2021 in Rio de Janeiro, Brazil. All study participants signed an informed consent form. The study sample comprised 54 morbidly obese patients, 8 (14.8%) men and 46 (85.2%) women, who were selected for bariatric surgery for weight reduction or diabetes control. Additionally, 49 healthcare professionals in active work—6 men (12.2%) and 43 women (87.8%)—were included in the control group. Patients aged ≥18 years and who provided consent to participate in the study were included. Individuals with fractures, those who had undergone previous surgery in the upper limbs, and those who presented rheumatologic diseases were excluded. Pains was assessed by the 0-10 Visual Analog Scale (VAS), in which 0 is painless and 10 is maximum pain. VAS score of >3 was considered strong pain and significant for odds ratio analysis. Functional evaluation of the shoulders was performed using the Disabilities of the Arm, Shoulder, and Hand (DASH) and University of California at Los Angeles (UCLA) functional scales. DASH[9] is a decreasing scale, i.e., a lower score indicates better functional performance, that assesses the functional performance of the upper limbs. A value of zero would mean the absence of any deficit, whereas a value of 150 would mean the worst possible impairment. The UCLA scale[10] assesses only the shoulders where the highest possible score is 35, with values below 20 indicating deficits in functional performance. Participants' shoulders were morphologically evaluated via ultrasound imaging to verify impairment using the high frequency 3-12MHz linear transducer, Philips EPIQ 7 Ultrasound Machine, as per the European Society of Musculoskeletal Radiology guidelines of ultrasound technical for shoulder. All ultrasound shoulder examinations were performed by trained musculoskeletal sonographers. Erythrocyte sedimentation rate by the Westergren method, serum total cholesterol serum levels (low density lipoprotein and high-density lipoprotein fractions) and triglycerides by enzymatic-colorimetric method, C reactive protein (CRP) by conventional method, and glycated hemoglobin (HbA1c) by the high-performance liquid chromatography method were the laboratory parameters used for metabolic evaluation.

Statistical analyses

Data analysis focused on the limb with the most symptoms in each patient (i.e., the limb with the highest VAS score) to prevent bias in the statistical analysis as when both limbs (shoulders) are evaluated as statistically separate units, as previously described by Menz.[11] If a participant reported no pain or functional complaints relative to a specific upper limb, the shoulder on the dominant side was selected for evaluation. Descriptive analysis presented the observed data as tables, expressed as adequate measures of central tendency and dispersion for numeric data and as frequencies and percentages for categorical data. Intergroup comparisons regarding clinical and laboratory variables were performed using Student's t-test for independent samples or Mann–Whitney U test for numeric variables, and the chi-squared test ($\chi 2$) or Fisher's exact test for categorical variables. Association of the VAS, DASH, and UCLA scales with the laboratory variables was calculated using Spearman's correlation coefficient. Non-parametric methods were used as all variables, except for age, showed non-normal distribution following rejection of the normality hypothesis by the Shapiro–Wilk test. Significance level was set at 5%. Statistical analysis was processed using the statistical software program SAS® System, version 6.11 (SAS Institute, Inc., Cary, North Carolina, USA).

RESULTS

Table 1 presents the values observed regarding the clinical and laboratory variables for each group (bariatric surgery candidates and control group) and the corresponding descriptive level (p-value) of the statistical test. Excepting age, the numeric variables evaluated did not follow a normal (Gaussian) distribution at 5% level, according to the Shapiro–Wilk test, in at least one of the groups. Thus, quartile measurements were most appropriate for data summarization—i.e., median, interquartile range (IQR) from the first to the third quartile (Q1–Q3), minimum value, and maximum value. Numeric data were expressed either as means and standard deviations or as medians and IQR (Q1–Q3), and compared using Student's t-test for independent samples or the Mann–Whitney U test. Categorical data were expressed as frequencies (n) and percentages (%), and compared using either the chi-squared test ($\chi 2$) or Fisher's exact test (Table 2).

Table 1. Numeric clinical and laboratory variables for each group.

Variable	Case group			Control group			pvalue
	n	Median	IQR	n	Median	IQR	
Clinical							
Age (years)	54	48 ± 10		49	53 ± 11		0.021
VAS	54	7	4–8	48	0	0–0	< 0.0001
DASH	54	59	38–81	49	35	29–52	< 0.0001
UCLA	54	22	17–31	48	35	29–35	< 0.0001
BMI (kg/m2)	54	41	39–45	49	27	25–29	< 0.0001
Laboratory							
ESR	15	24	17–40	20	21	15–32	0.50
CRP	32	0.87	0.43–1.49	27	0.23	0.12–0.36	< 0.0001
HbA1c	38	5.70	5.40–6.00	40	5.55	5.30–5.95	0.29
Total cholesterol	41	197	166–236	40	196	173–230	0.76
Triglycerides	40	108	79–169	40	95	64–162	0.49
HDL	40	47	41–56	40	50.5	41–68	0.73
LDL	40	117	97–136	40	116	98–137	0.80

IQR: interquartile range (quartiles 1–3); VAS: Visual Analog Scale; DASH: Disabilities of the Arm, Shoulder, and Hand scale; UCLA: University of California at Los Angeles scale; BMI: body mass index; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; HbA1c: glycated hemoglobin; HDL: high-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol. Age was expressed as mean ± standard deviation and compared using Student's t-test for independent samples. The other variables were expressed as medians and IQR and compared using the Mann–Whitney U test.

Table 2. Categorical clinical variables for each group.

Variable	Case group			Control group			pvalue
	N	%		N	%		
Gender							
Male	8	14.8		6	12.2		0.70
Female	46	85.2		43	87.8		
Ultrasound changes							
Yes	42	84.0		15	31.9		< 0.0001
No	8	16.0		32	68.1		
Ultrasound findings							
Normal	8	16.0		32	68.0		< 0.0001
Tendinosis	30	60.0		13	27.7		
Tendinosis + rupture	12	24.0		2	4.3		
Side with greater pain							
Neither	7	13.5		36	75.0		< 0.0001
Right	27	51.9		8	16.7		
Left	18	34.6		4	8.3		
Dominant side							
Right	48	92.3		46	93.9		0.53
Left	4	7.7		3	6.1		
VAS > 3							
Yes	42	77.8		8	16.7		< 0.0001
No	12	22.2		40	83.3		
UCLA < 20							
Yes	18	33.3		3	6.2		0.001
No	36	66.7		45	93.8		

VAS: Visual Analog Scale; DASH: Disabilities of the Arm, Shoulder, and Hand scale; UCLA: University of California at Los Angeles scale. Data were expressed as frequencies (n) and percentages (%) and compared using either the chi-squared test ($\chi 2$) or Fisher's exact test.

The case group showed a significantly lower age ($p = 0.021$) and UCLA score ($p < 0.0001$), but a significantly higher VAS ($p < 0.0001$), DASH ($p < 0.0001$), BMI ($p < 0.0001$), and CRP levels ($p < 0.0001$) than the control group. We identified no significant intergroup difference for the other numeric variables (Table 1). Regarding categorical variables, the obesity group showed significantly higher percentages of ultrasound shoulder examination changes ($p < 0.0001$), tendinosis-type changes and association with rupture ($p < 0.0001$), right side with more pain compared to the left side ($p < 0.0001$), VAS > 3 ($p < 0.0001$), and UCLA < 20 ($p = 0.001$) than the control group. We found no significant intergroup difference for the other categorical variables (Table 2). Odds ratio (OR) in the obesity group was 17.5 for VAS > 3 (95% confidence interval [CI]). In the subgroup with ultrasound shoulder changes, only CRP levels appeared to be significantly higher than in the subgroup with normal ultrasound examination ($p = 0.008$). We identified no significant intergroup difference for the other laboratory variables (Table 3).

Table 3. Laboratory variables according to ultrasound findings.

Variable	Ultrasound with changes			Normal ultrasound			p value
	n	Median	IQR	N	Median	IQR	
Laboratory							
ESR	24	18	15–29.5	11	23	21–41	0.21
CRP	40	0.75	0.303–1.46	19	0.23	0.14–0.52	0.008
HbA1c	46	5.70	5.30–6.05	32	5.50	5.40–5.93	0.23
Total cholesterol	48	198	163–238	33	192	178–230	0.97
Triglycerides	48	116.5	68–169	32	98.5	66–162	0.59
HDL	48	49	39–61	32	50	43–66	0.88
LDL	48	115	97–135	32	118	98–143	0.57

IQR: interquartile range (quartiles 1–3); ESR: erythrocyte sedimentation rate; CRP: Creactive protein; HbA1c: glycated hemoglobin; HDL: high-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol. DU+0078ds2ata were expressed as medians and IQR and compared using the Mann–Whitney test.

Table 4 shows a weak direct correlation between VAS score and HbA1C levels (r = 0.263; p = 0.020; n = 78). Thus, a higher HbA1C level was associated with a higher VAS score. Another weak correlation was observed between the DASH score and CRP levels (r = 0.269; p = 0.039; n = 59), suggesting that a higher CRP level was associated with a higher expected DASH score. A weak inverse correlation was found between the UCLA score and CRP levels (r = −0.334; p = 0.010; n = 59), indicating that the higher the CRP level, the lower the UCLA score.

Table 4. Correlation between the VAS, DASH, and UCLA scales and the laboratory variables in the entire sample

Variable	VAS			DASH			UCLA		
	N	rs	pvalue	N	rs	pvalue	n	rs	pvalue
ESR	35	−0.108	0.54	35	0.018	0.92	35	0.012	0.94
CRP	59	0.226	0.085	59	0.269	0.039	59	−0.334	0.010
HbA1c	78	0.263	0.020	78	0.168	0.14	78	−0.146	0.20
Total cholesterol	81	0.003	0.98	81	0.048	0.67	81	−0.033	0.77
Triglycerides	80	0.008	0.94	80	0.213	0.058	80	−0.115	0.31
HDL	80	0.126	0.26	80	0.062	0.59	80	−0.030	0.79
LDL	80	−0.025	0.83	80	−0.013	0.91	80	0.008	0.94

VAS: Visual Analog Scale; DASH: Disabilities of the Arm, Shoulder, and Hand scale; UCLA: University of California at Los Angeles scale; rs: Spearman's correlation coefficient; BMI: body mass index; ESR: erythrocyte sedimentation rate; CRP: Creactive protein; HbA1c: glycated hemoglobin; HDL: high-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol.

We observed a predominance of right-handed individuals among the study participants, with 92.3% in the obesity group and 93.9% in the control group. The right side presented pain in 51.9% of the obesity group participants, the left side was affected in 34.6%, and 13.5% had no pain. Conversely, these percentages were 16.7%, 8.3%, and 75%, respectively, in the control group (Table 2).

DISCUSSION

The analyzed outcomes revealed that morbidly obese patients had a higher incidence of shoulder pain, at much higher levels than the control group of active workers. Previous studies[6] conducted with industrial workers and in broader population groups have shown a correlation between obesity and painful shoulder joint impairment. Functional impairment evaluation revealed a significant functional shoulder limitation in the obese group. Studies that systematically evaluated shoulder performance in groups of obese individuals corroborate that lower shoulder functionality is typically observed in cases of significant obesity.[6] Eichinger et al.[12] proposed the causal hypotheses of the effect of arm weight, broader torso, deconditioning, or a combination of these factors as a reason for this limitation. In the present study, morphological evaluation of the rotator cuff using ultrasound revealed how often this anatomical structure was affected in morbidly obese individuals: 60% patients presented tendinosis and 24% had tendinosis and rupture of the rotator cuff, compared with 27.7% tendinosis and 4.3% partial cuff tear in the control group. These values are significantly higher in obese people than in the general population within the same age range,[8] with an expected percentage of rotator cuff tears (both partial and total) of 6.7% and 12.8%, respectively. Obesity has been listed as a risk factor for tendinopathy, and both mechanical stress and low-level inflammatory process associated with obesity have been considered etiological factors.[4-6,13] Chronic inflammatory processes caused by obesity predispose obese patients to other chronic diseases such as type-II diabetes mellitus, cardiovascular disorders, degenerative and autoimmune diseases—all of which are risk factors for musculoskeletal diseases. This would partially explain the high degree of musculoskeletal involvement observed in these patients; however, low-level inflammatory process must be considered a direct etiological factor associated with this involvement.[4,6,8] Despite efforts to attempt age pairing, patients in the control group were slightly older than those in the obesity group. Older age has a known correlation with worsened functional scores, increased shoulder pain, and increased rates of rotator cuff tears.[14] This consequently reinforced that functional impairment and morphological involvement of the rotator cuff were extremely significant in the obesity group, despite the younger mean age, showing significantly higher changes than the control group. Serum HbA1c levels, total cholesterol, and cholesterol fractions values were similar for both groups, possibly because the obese participants were awaiting bariatric surgery and therefore had undergone a rigorous program of clinical control and surgery preparation. This could explain why no significant differences were observed in these serum parameters in relation to the control group, which intends to reflect the general population. CRP level indirectly measures an in-progress inflammatory process. Although some laboratory

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parameters (glucose, cholesterol and fractions) could be controlled with diet and medical measures in the pre-surgery group, the end organs alterations were not reverted. Short-time period control of glucose levels does not alter morphological alterations in kidney vessels or retinopathy in diabetic patients. Similarly, control of these laboratory parameters does not influence the morphological changes and inflammatory process in knee joints, ankle joints and spine caused by morbid obesity[8]—which justifies the high CRP levels. Despite impossibility to establish a correlation between lipid and glycemic levels and rotator cuff tears, the requirement to be under good clinical control before undergoing surgery could explain the serum cholesterol levels and its fractions mostly tending to normal values in the obesity group. This does not rule out the possibility of these individuals having presented high cholesterol and HbA1c levels in the past, and that these factors might have led to a rotator cuff tear. A cross-sectional study showed a snapshot of the studied group at a specific moment.[8] CRP levels appeared to be significantly higher in the obesity group compared with the control group. This finding corroborates those of other articles, and demonstrate that obesity is an inflammatory process that adversely affects the joints, muscles, and tendon insertions.[4-6,13,15] Statistical analysis clearly showed the correlation between elevated serum CRP levels and tendinosis and partial and total rotator cuff tears. The statistical correlation found between increased CRP levels and poorer functional performance in the DASH and UCLA scales highlights the systemic nature of obesity as a metabolic disease[13,14,16] whose effects on the musculoskeletal system were mediated via humoral agents such as adipokines, free radicals, and interleukins.[16]

Limitations

Study limitations include its cross-sectional nature, which can provide correlations between the studied parameters but cannot determine a specific cause–effect relation between them. Additionally, there was no adequate pairing of participants' ages. However, the poorer functional results observed in the group of younger obese patients further reinforce the significance of functional impairment in the obese population. Our study sample was relatively small, yet significant results were obtained which highlights the comprehensive extent of functional shoulder impairment and pain that the studied individuals suffer.

What Does This Study Add To Current Knowledge?

Notably, the present study is an original research addressing a very specific study population composed of overweight individuals selected for bariatric surgery. Most studies in the literature refer to overweight individuals or to obesity defined generically as BMI ≥ 30 kg/m2, rarely analyzing subgroups with BMI ≥ 40 kg/m2. Data obtained in this study may be useful for understanding musculoskeletal system diseases resulting from metabolic syndrome-related aspects of overweight and obesity that affect the upper limbs, particularly the shoulders. These findings may be especially useful for formulating preventive and therapeutic strategies for this particular subgroup.

CONCLUSIONS

Morbidly obese patients presented a higher incidence of shoulder pain, loss of function and pathological changes, as well as higher c-reactive protein than the control group.

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TREATMENT OF ADHESIVE CAPSULITIS WITH THE TRIPLE PROCEDURE: INTRA-ARTICULAR INJECTION WITH CORTICOSTEROIDS, HYDRODILATION AND SHOULDER MANIPULATION UNDER SEDATION

TRATAMENTO DA CAPSULITE ADESIVA COM O PROCEDIMENTO TRÍPLICE: INFILTRAÇÃO INTRA-ARTICULAR COM CORTICÓIDE, HIDRODILATAÇÃO E MANIPULAÇÃO DO OMBRO SOB SEDAÇÃO

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ABSTRACT

Objective: There are several conservative treatment options for adhesive capsulitis (AC), but no previous study combines hydrodilation, corticosteroid injection and joint manipulation under sedation (triple procedure), followed by daily home exercises. Methods: Patients included were evaluated before the procedure, at 30 days, 3, 6 and 12 months after treatment in prospective cohort. The outcomes used were the ASES, UCLA, SANE, VAS scales and passive range of motion (ROM). Results: 65 shoulders of 63 patients were included. The mean ASES score progressed from 37.7 ± 17.9 to 94.1 ± 10.3 at 12 months after the procedure ($p < 0.001$). The mean UCLA went from 15.9 ± 5 to 33.2 ± 2.8 and SANE from 50.4 ± 18.3 to 94.3±9.0. At 12 months, the passive elevation improved from 114°±24° to 176° ± 6°, external rotation in neutral from 29° ± 17° to 72° ± 11° and internal rotation in neutral from 18.6 ± 3.6 points to 9.4 ± 2.4 points. No patient presented a fracture after manipulation. Conclusions: Treatment with the triple procedure resulted in a statistically and clinically relevant improvement in functional results and gains in shoulder range of motion, with no reports of complications. ***Level of evidence IV, Prospective study.***

Keywords: Frozen Shoulder. Adhesive Capsulitis of the Shoulder. Manipulation. Intra Articular Injection.

RESUMO

Objetivo: Há várias opções de tratamento conservador para a capsulite adesiva (CA), mas nenhum estudo anterior combina hidrodilatação, injeção de corticosteroide e manipulação articular sob sedação (procedimento triplo), seguido de exercícios diários em casa. Métodos: Os pacientes incluídos foram avaliados antes do procedimento, 30 dias, 3, 6 e 12 meses após o tratamento em uma coorte prospectiva. Os resultados utilizados foram as escalas ASES, UCLA, SANE, VAS e a amplitude de movimento passivo (ADM). Resultados: Foram incluídos 65 ombros de 63 pacientes. A pontuação média da ASES progrediu de 37,7 ± 17,9 para 94,1 ± 10,3 12 meses após o procedimento ($p < 0,001$). A UCLA média passou de 15,9 ± 5 para 33,2 ± 2,8 e a SANE de 50,4 ± 18,3 para 94,3 ± 9,0. Em 12 meses, a elevação passiva melhorou de 114° ± 24° para 176° ± 6°, a rotação externa em ponto morto de 29° ± 17° para 72° ± 11° e a rotação interna em ponto morto de 18,6 ± 3,6 pontos para 9,4 ± 2,4 pontos. Nenhum paciente apresentou fratura após a manipulação. Conclusões: O tratamento com o procedimento triplo resultou em uma melhora estatística e clinicamente relevante nos resultados funcionais e ganhos na amplitude de movimento do ombro, sem relatos de complicações. ***Nível de evidência IV, Estudo prospectivo.***

Descritores: *Ombro congelado; Capsulite adesiva do ombro; Manipulação; Injeção intra-articular*

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INTRODUCTION

Adhesive capsulitis is a disease that affects 2 to 5% of the population,[1] with a 13.5% prevalence in an outpatient clinic specialized on shoulder.[2] Symptoms involve pain, which varies depending on the stage of the disease, and limitation of passive and active movement of the joint.[3,4] Its cause is unknown,[5] and preferentially affects women between 50 and 60 years,[6] with increased risk for Asian individuals,[7] those with diabetes,[5] hypothyroidism[8] and dyslipidemia.[9]

Several treatment options for adhesive capsulitis exist, with conservative treatment being the preferred option and yielding good results.[10,11] Among the conservative modalities, physical therapy is the most common modality currently and presents good results in the long term.[12,13]

The use of intra-articular corticosteroids injections demonstrates benefits, especially in terms of pain improvement, when compared to only rehabilitation.[13-15] Favejee et al.,[16] in a systematic review, concluded regarding range of movement (ROM), intra-articular injection associated with physical therapy is more effective than isolated interventions. In contrast, Hopewell et al.,[17] did not demonstrate clinical differences after 12 months of corticosteroids injection treatment, but observed better results for this group at 2 months of follow-up.

Shoulder manipulation under anesthesia is another treatment option. In a randomized study, Kivimaki et al.[18] demonstrated better ROM after 3 months, mainly for flexion, but with no difference in pain and function, compared to a control group with specific exercises. And in a current multicenter randomized trial, the authors observed that manipulation associated with corticosteroids injection was the most cost-effective treatment.[19]

Capsular hydrodilation is also described, with results superior to placebo for early ROM (3 weeks).[20] Buchbinder et al.[20] showed that distension followed by physical therapy was more effective compared to physical therapy alone in relation to pain and ROM after 8 weeks.[20] When compared to injection with corticosteroids, of three randomized studies, only one demonstrated a significant difference in favor of hydrodilation in relation to ROM.[20] According to Maund et al.[21] arthrographic distension associated with manipulation under anesthesia presents better results on pain and ROM after 6 months, compared to distension alone.

Despite several comparative articles published, no study matches hydrodilation, injection with corticosteroids and joint manipulation, followed by daily home exercises for passive shoulder stretching. The authors' hypothesis is that combined treatment under sedation, called the "triple procedure" is effective and safe for the short and medium term for improvement of ROM pain for adhesive capsulitis.

Objectives

Primary objective: to analyze functional results, according to the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES) scale[22] at 30 days, 3, 6 and 12 months.

Secondary objectives: to evaluate the Modified-University of California at Los Angeles Shoulder Rating Scale (UCLA),[23] the Single Assessment Numeric Evaluation (SANE) of patients undergoing conservative treatment of adhesive capsulitis, at 30 days, 3, 6 and 12 months of follow-up and evaluating ROM at the same follow-up times.

METHODS

Study design

Patients with adhesive capsulitis were included in a prospective cohort. The patients were treated by 3 shoulder surgeons from the same institution, members of the Brazilian Society of Shoulder and Elbow Surgery and with more than 15 years of experience.

Population

Patients older than 18 years and with clinical diagnosis of adhesive capsulitis, according to Zuckerman and Rockito criteria,[4] set by limitation of active and passive shoulder ROM when compared to the contralateral side. We used magnetic nuclear resonance of 1.5 T or higher to corroborate the diagnosis in all cases.

Patients with secondary limited ROM were not included (complete rotator cuff tear, glenohumeral arthrosis, osteonecrosis of the humeral head, shoulder fractures or dislocation). Patients were also not included if they had bone deformities of the humerus or scapula, previous shoulder surgery, bones and soft tissues tumors, as well as patients with infection in the affected shoulder and the lack of mental capacity to understand the questionnaires. Patients lost to follow-up before the 3-month evaluation were excluded. After evaluating the inclusion criteria, the patients filled out the informed consent form.

Interventions

The patients underwent, while admitted to a day hospital, the combination of 3 non-surgical techniques: joint injection with corticosteroids, hydrodilation and joint manipulation under sedation (triple procedure). The patients underwent anesthetic sedation, without the use of a mask or intubation. An anesthetic (5 ml of 2% lidocaine without vasoconstrictor) was applied to the anterior surface of the shoulder, 1 cm lateral to the coracoid, directed towards the joint. Next, a Jelco 16 was used for joint injection of another 5 ml of 2% lidocaine without vasoconstrictor, 10 ml of 7.5 ropivacaine, 40 mg of triamcinolone hexacetonide (2 ml), followed by another 10 to 30 ml of SF 0.9%. In cases of doubt about the joint location, ultrasound or radioscopy was used, at the physician's discretion.

The patients then underwent shoulder manipulation. We performed progressive movements, with a lever arm close to the shoulder and with stabilization of the scapula and clavicle. Forced elevation was initially performed, followed by abduction, external rotation in abduction, internal rotation in abduction and adduction (Figure 1, 2 and 3). The same procedure was repeated once more to ensure the maximum possible ROM gain. No aggressive manipulation was performed, and if the amplitude did not improve, the procedure was interrupted.

Figure 1. Range of movement before the procedure: flexion (A), lateral rotation (B) and medial rotation (C).

Figure 2. Manipulation under sedation, to gain flexion (A), lateral rotation (B) and medial rotation (C).

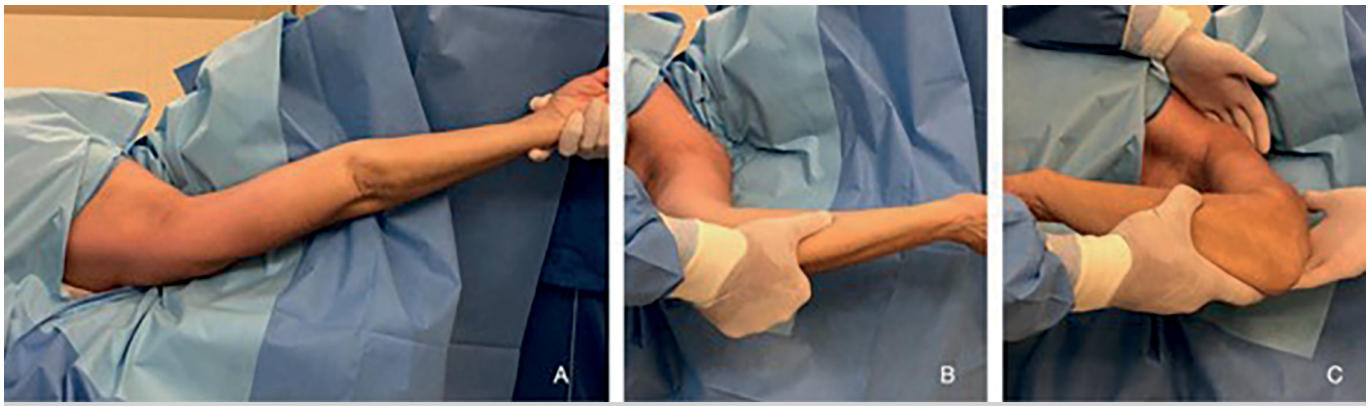

Figure 3. Range of movement immediately after the procedure: flexion (A), lateral rotation (B) and medial rotation (C).

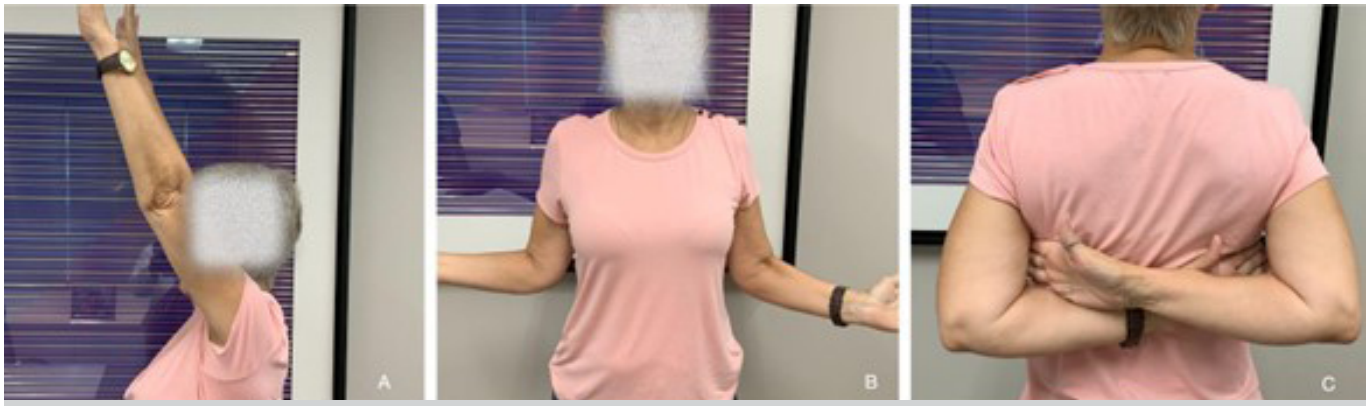

Figure 4. Range of movement 30 days after the procedure: flexion (A), lateral rotation (B) and medial rotation (C).

The patients were discharged 3 hours after the procedure, medicated with dipyrone 1 g 6/6 h for 7 days, non-hormonal anti-inflammatory for 3 days and opioids if severe pain (EVA > 7). Patients received a pamphlet with guidelines for home exercises, being taught in person by the doctor and instructed to perform 4x/day for 30 days.

Outcomes

The outcomes evaluated were the following scales, carried out before treatment and after inclusion in the study, after 1 month, 3, 6 and 12 months:

- American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES)[22] (primary outcome)
- Modified University of California at Los Angeles Shoulder Rating Scale (UCLA)[23]
- Single Assessment Numeric Evaluation (SANE)
- Passive range of motion: assessed with the patient in upright position. The maximum tolerated position was measured by the evaluator. Elevation, lateral and medial rotation of the shoulder at 0 and 90 degrees of abduction (or the greatest tolerated abduction) were evaluated. All measurements were performed with a goniometer, except medial rotation at 0 degrees, which was evaluated according to the position of the patient's hand in relation to the vertebral spinous processes and, subsequently, converted to continuous numbers, using a scale from 1 to 25 (T1 to T12 are equivalent to values from 1 to 12, L1 to L5 to values from 13 to 17, the sacrum is equivalent to 20 and the trochanter is equivalent to 25).
- Complications: fractures, rotator cuff tear, shoulder instability

Variables

The following were patient-related variables were evaluated: age, gender, dominance, ethnicity, thyroid diseases, diabetes, dyslipidemia and history of previous adhesive capsulitis in the contralateral shoulder.

Sample size

The sample was defined by convenience, picking the total number of patients who wished to participate in the study. The recruitment period was 4 years.

Bias and follow-up loss

The clinical assessment questionnaires used were applied in person, by telephone or email. For the assessment of ROM, only data collected in person were used. Cases with missing data were treated by imputation with the last observation carried forward (when with a minimum of 2 months of follow-up) or by excluding the patient (when with no post-operative evaluation).

Statistical analysis

Continuous variables were assessed for normality by the Kolmogorov-Smirnov test, and homogeneity by the Levene test. The continuous data were exposed by mean and standard deviation. Categorical variables were displayed in absolute value and percentage. The score obtained by the different clinical scales and to ROM were compared by Friedman's Test. Comparison between sequential evaluation times was performed using the Wilcoxon test, with Bonferroni adjustment for multiple comparisons, using $p < 0.05$ as the significance level. For the primary outcome, a comparative analysis of the results obtained between diabetic and non-diabetic patients was carried out using the Mann-Whitman test. For data analysis, we used the SPSS version 21.0 program (SPSS Inc®, Chicago, IL, USA).

RESULTS

During the period evaluated, 72 patients with a confirmed diagnosis of adhesive capsulitis underwent the triple procedure. After applying the inclusion and non-inclusion criteria, our series included 63 patients (65 shoulders). Of these, 46 (69.2%) were female and 32 (49.2%) had the right side treated. The mean age was 51.4 ± 8.8 years. The variables related to patients are exposed in the **Table 1.**

Table 1. Variables related to patients

Variables	N = 65	
Age (years)	51.4	8.7
Female	45	(69)
Right Shoulder	32	(49)
Involvement of the dominant arm	31	(48)
Asian Ethnicity	10	(15)
Thyroid diseases	18	(28)
Diabetes	12	(19)
Dyslipidemia	19	(29)
Contralateral capsulitis	7	(11)

Continuous data are presented as means and standard deviations. Categorical data are presented as absolute numbers, with percentages in parentheses.

According to the ASES, the mean score was 37.7 ± 17.9 in the initial assessment and 90.0 ± 9.6 at 30 days of follow-up, showing significant improvement ($p < 0.001$). At 12 months of follow-up, the mean score was 94.1 ± 10.3, with statistically significant difference ($p < 0,001$). The results were also greater than the minimally significant clinical difference in 64 shoulders (98.5% of the sample). The UCLA and SANE functional scales showed significant improvement after the procedure ($p < 0.001$). Clinical results can be seen in Table 2.

The results regarding ROM are shown in Table 3. Patients showed significant improvement after the procedure ($p < 0.001$), as shown by an example in Figure 4. After 30 days of the procedure, elevation showed a 50° improvement, external rotation at 90° of abduction of 34° and internal rotation at 90° of abduction of 26°.

No patient had complications related to the procedure, such as fractures or anesthetic complications. No patient underwent arthroscopic capsular release.

Table 2. Results of functional scales before and after the procedure.

Scores	Initial	30 days	3 months	6 months	12 months	*p*
ASES	37.7 ± 17.9 *	90 ± 9.6 **	92.7 ± 9.6	92.1 ± 10.7	94.1 ± 10.3	< 0.001
SANE	50.4 ± 18.3 *	87.6 ± 14.9 **	92 ± 12.7	94 ± 11	94.3 ± 9.0	< 0.001
UCLA	15.9 ± 5*	32.2 ± 2.9	33.2 ± 2.8	33.1 ± 2.7	33.2 ± 2.8	< 0.001

Data are presented as means and standard deviations.
Post-hoc analysis:
* $p < 0.005$ compared to other post-treatment times (30 days, 3 months, 6 months and 12 months)
** $p < 0.005$ compared to 3 months, 6 months and 12 months

Table 3. Range of motion (ROM) results before and after the procedure.

ROM	Initial	30 days	3 months	6 months	12 months	p
Forward elevation	114.3 ± 24.4*	164.6 ± 14.3**	174.6 ± 8.1	176.2 ± 6.5	176.5 ± 6	< 0.001
External rotation 0°	29.2 ± 17.2*	60.9 ± 13.7**	69.2 ± 12***	71.2 ± 11.9	72.5 ± 11.5	< 0.001
External rotation 90°	33.1 ± 20.7*	67.2 ± 16.5**	77.7 ± 12.7***	79.2 ± 11.5	80.7 ± 9.9	< 0.001
Internal rotation 0°	18.6 ± 3.6*	11.8 ± 2.8**	10 ± 2.9	9.6 ± 2.7	9.4 ± 2.4	< 0.001
Internal rotation 90°	18.9 ± 11.8*	45.4 ± 14**	51.6 ± 11.9	53.7 ± 11.7	54.1 ± 11	< 0.001

Data are presented as means and standard deviations.
Post-hoc analysis:
* $p < 0.005$ compared to other post-treatment times (30 days, 3 months, 6 months and 12 months)
** $p < 0.005$ compared to 3 months, 6 months and 12 months
*** $p < 0.005$ compared to 12 months

DISCUSSION

Our results demonstrate that the treatment of adhesive capsulitis with the triple procedure leads to an early functional improvement, as well as maintenance of the response over 12 months, with satisfactory results demonstrated in all functional scales evaluated.

Recent studies demonstrate the efficiency of using intra-articular corticosteroids in the treatment of adhesive capsulitis.[14] However, short-term assessment is little explored in most studies.[14,24] Due to the severe symptoms and functional limitations of adhesive capsulitis, short-term responses can significantly impact patient

<< SUMÁRIO

quality of life. In our study, we demonstrated a significant early response in ROM gain and functional pain scales. Although it was not objectively investigated in our study, we were able to observe satisfactory responses within the first 7 days after the procedure. The gain in range of motion was also shown to be rapid and satisfactory 30 days after treatment, with 50° as the mean gain for elevation during the studied period.

When comparing functional scales at 12 months, we observed similar results to recently published prospective studies.[14,17,19,25,26] Few recent studies used 30-day assessment for comparison. When comparing our early results (30 days) to those of the hydrodilation and corticosteroids group by Dai et al.,[25] we observed superior results regarding elevation (164° versus 105°), external rotation (61° vs 19°) and internal rotation (11 vs 16 points). Our results were also superior to the early results of the same author's surgical group. We also observed better results regarding the UCLA scale at 3 months (32 vs 22 points).

Brealey et al.,[24] in a pragmatic multicenter randomized study, compared 3 treatment options for adhesive capsulitis: structured physical therapy, manipulation under anesthesia and capsular release by arthroscopy. The authors did not perform hydrodilation in either group. In the first 2 groups, around 80% of cases were concomitantly submitted to intra-articular injection with corticosteroids. The authors demonstrated initial results (3 months of follow-up) that were unfavorable to surgical treatment, but similar results between the groups at 12 months of treatment, with no clinically relevant difference, with slight superiority for the surgical group. However, they demonstrated better cost-effectiveness for the manipulation under anesthesia group.[27] Although we do not evaluate the cost of the procedure, we highlight that the combination of a single procedure, in a day hospital and without the use of high-cost medications, associated with performing only home exercises has a great potential for reducing costs for the treatment of adhesive capsulitis.

In line with more current studies of manipulation under anesthesia, the complication rate is low and no fractures were observed after the procedure.[19,21,28,29] We believe that the absence of complications in our sample is related to how the manipulation was performed. The use of a lever arm very close to the shoulder, both for elevation and rotations, avoided this type of complication. Although it was not objectively evaluated, it was possible to hear the capsular tear in most patients, but in patients with diabetes and older patients, this type of observation was smaller, as was the immediate gain in ROM. Mainly in this subgroup of patients we avoid aggressive manipulation for complete ROM gain. We also believe that hydrodilation may have contributed to the ease of early ROM gain.

Our study has some limitations. We do not have a control group, which does not allow direct conclusions regarding other treatment options. Our study had a relatively small sample size, but had sufficient power to evaluate the efficacy and safety of the procedure. We did not investigate complications related to the rotator cuff through imaging tests in all cases, and MRI was only performed in patients with any residual symptoms.

As positive points, our study performed a prospective assessment at standardized times, including an early assessment of 30 days. The evaluation of different functional scales and the standardized measurement of ROM is also a strong point of the study. The high short- and medium-term success rate of the triple procedure for adhesive capsulitis will allow us to explore new prospective and randomized studies on this treatment, as well as its comparative cost-effectiveness analysis.

CONCLUSIONS

Treatment of adhesive capsulitis with the triple procedure (intra-articular corticosteroids injection, hydrodilation and manipulation of the shoulder under sedation) resulted in statistically and clinically relevant improvement in functional results and gains in shoulder range of motion, with no reports of complications.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. MECG: study design, text writing and carrying out the procedures; JHA: statistical analysis and carrying out the procedures; MMP: data collection and text writing; FBAS: reviewing the text and carrying out the procedures; AAFN: text review and approval of the final version of the manuscript; EAM: preparation of the research protocol and text review.

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INCREASED INCIDENCE OF INJURIES IN THE SÃO PAULO SOCCER CHAMPIONSHIP POST-PANDEMIC

AUMENTO DA INCIDÊNCIA DE LESÕES NO CAMPEONATO PAULISTA DE FUTEBOL PÓS PANDEMIA

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ABSTRACT

Objective: Soccer shows a high incidence of injuries and its cause is multifactorial. The impacts of the coronavirus pandemic are unknown. This study aims to evaluate the incidence of injuries in the 2023 Campeonato Paulista de Futebol (São Paulo Soccer Championship) and compare it to the championships prior to the pandemic. Methods: This study was conducted by collecting data on injuries among players in the A1 Series of the 2023 São Paulo Soccer Championship. Injuries were recorded by each team's medical staff via an online questionnaire. The variables included: Type of Field, Weather, Temperature, Distance, Home Advantage, Age, Type and Location of Injury. The primary outcome is to evaluate the incidence of injuries, and the secondary outcomes are to analyze the relationship between the described variables, the observed incidence, and the comparison of data obtained from 2016 to 2019. Results: In 2023, 76 injuries were recorded, an incidence of 22.1 injuries/1,000h. Muscle injuries (46.1%) and sprains (18.4%) were the most common. From 2016 to 2019, there was a decrease in the incidence of injuries per 1,000h, respectively: 24.2; 17.6; 14 and 10.5. Conclusion: the incidence in 2023 was 22.1 injuries/1,000h, which points to an increase compared to the pre-pandemic period. ***Level of Evidence II, Comparative Prospective Study***

Keywords: Soccer. Pandemics. Trauma in athletes. COVID-19. Sports Medicine.

RESUMO

Objetivo: O futebol apresenta elevada incidência de lesões e sua causa é multifatorial. Os efeitos da pandemia do coronavírus são desconhecidos. O objetivo deste estudo é avaliar a incidência de lesões no Campeonato Paulista de Futebol 2023 e compará-la aos campeonatos anteriores à pandemia. Métodos: estudo conduzido pela coleta de dados referente a lesões dos jogadores da série A1 do Campeonato Paulista de Futebol 2023. As lesões foram registradas pelos médicos de cada time, através do preenchimento de questionário online. As variáveis foram: Tipo de Gramado, Clima, Temperatura, Distância, Mando de jogo, Idade, Tipo e Local de Lesão. O desfecho primário é avaliar a incidência de lesões e os secundários a relação entre as variáveis descritas, a incidência observada e a comparação dos dados obtidos nos anos de 2016 a 2019. Resultados: Em 2023 ocorreram 76 lesões, uma incidência de 22,1 lesões/1000h. As mais comuns: musculares (46,1%) e entorses (18,4%). Nos anos de 2016 a 2019 houve queda na incidência a cada 1000h de jogo, respectivamente: 24,2; 17,6; 14 e 10,5. Conclusão: a incidência em 2023 foi de 22,1 lesões/1000h. Um aumento, comparado ao período pré-pandemia. ***Nível de evidência II, Estudo Prospectivo Comparativo***

Descritores: *Futebol. Pandemia. Trauma em atletas.* COVID-19. *Medicina Esportiva.*

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INTRODUCTION

Soccer is played by approximately 240 million amateur athletes and more than 200,000 professional athletes worldwide.[1,2] Its popularity is global, and the modality covers different age groups, ethnicities, and genders. At the same time, soccer shows a high incidence of injuries, with an estimated rate of up to 70 injuries per 1,000 hours of play[2]. The dynamic nature of the sport also contributes to the injury rate, with rapid movements, accelerations, decelerations, changes of direction, jumps, and considerable physical contact.[1,3] Over the years, several studies have analyzed the most prevalent injuries in soccer. International organizations such as the United States and the Union of European Football Associations (UEFA) conduct research on the subject, aiming to develop programs aimed at preventing injuries and reducing soccer-related morbidity[4]. Muscle injuries, bruises, and sprains are known to account for 75% of injuries affecting professional players, with most in the lower extremities (60–85%).[3,4]

A study conducted by the UEFA from 2021–2022 pointed to an incidence of 30.5 (+/−11) per 1,000 hours of play,[5] whereas a 2005 Swedish study showed 16 to 28 injuries per 1,000 hours of play.[6] Moreover, a higher incidence has been found in shorter competitions, such as in the 2011 Copa America, in which an incidence of 70.7 injuries per 1,000 hours of play was observed.[2]

The incidence of sports-related injuries is known to be multifactorial but little is known about the possible impacts of the COVID-19 pandemic[7]. In this context, this study aims to compare the last four pre-pandemic soccer seasons (2016–2019) and the first post-pandemic season (2023).

The study focuses on the A1 series of the *Campeonato Paulista de Futebol* (São Paulo Soccer Championship) and assesses the incidence of injuries that occurred during the 2023 season, comparing them to the pre-pandemic period. Other influencing factors are also assessed, such as the type of field, temperature, weather, distance, and the age of the players.

MATERIALS AND METHODS

A prospective comparative study (Level II evidence) was conducted to investigate injuries in the A1 series of the 2023 São Paulo Soccer Championship. An electronic questionnaire was administered, with a model similar to that used in the 2016–2019 championships after each round played.

Data collection occurred collaboratively, with the physicians of each team being responsible for filling out the questionnaire after each match, reporting the occurrence or absence of injuries resulting from the games. The questionnaires were completed ensuring the anonymization of the data provided.

All athletes regularly registered in the A1 Series of the 2023 São Paulo Soccer Championship were included in this study. Athletes registered by clubs that did not play at least one match were excluded from the study. The definition of injury adopted followed the study by Fuller et al.[8] on the 2005 FIFA/F-MARC Consensus Group, in which an injury is defined as "any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities."

The electronic questionnaire consists of a set of 24 questions, including the same ones used in the 2016 to 2019 seasons, with additions covering the categorical and numerical variables assessed. Encompassing characteristics of the matches and players, such as: age, weather, temperature and distance, as well as information about the type of injury (contusion, sprain, muscle, concussion, blunt injury, dislocation, and fracture). The construction of the questionnaire was based on previous studies, which share the same purpose.[9,10]

The incidence of injury was estimated based on a metric that enables assessing the risk of injury occurrence according to the number of injuries per 1,000 hours of exposure.[8,11] The formula below was used to estimate exposure:

Exposure = number of matches x number of players who started the match (22) × duration of the match in minutes (90) / 60

To estimate the incidence during matches, the formula used was as follows:

Incidence in Matches = Number of Injuries/Exposure × 1000

This study was approved by the Human Research Ethics Committee under number 1,660,701

STATISTICAL ANALYSIS

Exploratory data analysis was performed by summary measures (mean, standard deviation, minimum, median, maximum, frequency, and percentage) and construction of graphs. The Z test for proportions was employed to compare prevalences. The groups with and without lesions were compared using the Chi-square test (categorical variables) or the Mann-Whitney test (numerical variables).

The level of significance was set at 5% (p value < 0.05).

RESULTS

In the A1 series of the 2023 São Paulo Soccer Championship, 76 injuries were observed in 104 matches (Table 1). The main injuries observed included muscle injuries (strains), representing 46.1%, followed by sprains (18.4%) and concussions (10.5%) (Table 3). In the 104 games of 2019, 36 injuries were observed, which represents a prevalence of 35%, significantly lower (p-value < 0.001) than that found in 2023, of 75%. The incidence in 2019 was 10.5, and in 2023, it was 22.1 injuries per 1,000 hours of play (Figure 1).

Table 1. Comparison between groups (categorical variables – Chi-square test).

Parameter	Total (N=213)	With Injury (n=76)	Withour Injury (n=1,237)	p-value
Type of field:				0.713
Natural	181 (85.0%)	66 (86.8%)	115 (83.9%)	
Synthetic	32 (15.0%)	10 (13.2%)	22 (16.1%)	
Home advantage:				0.617
Home team	103 (48.4%)	39 (51.3%)	64 (46.7%)	
Visiting team	110 (51.6%)	37 (48.7%)	73 (53.3%)	
Weather:				0.093
Sunny	70 (32.9%)	32 (42.1%)	38 (27.7%)	
Cloudy	35 (16.4%)	9 (11.8%)	26 (19.0%)	
Sunshower	7 (3.29%)	2 (2.63%)	5 (3.65%)	
Thunderstorm	2 (0.94%)	2 (2.63%)	0 (0.00%)	
Clean night	62 (29.1%)	17 (22.4%)	45 (32.8%)	
Night with rain	26 (12.2%)	11 (14.5%)	15 (10.9%)	
Rainy	11 (5.16%)	3 (3.95%)	8 (5.84%)	
Match location				0.844
House	103 (48.4%)	39 (51.3%)	64 (46.7%)	
Up to 200 km	70 (32.9%)	23 (30.3%)	47 (34.3%)	
200 – 400 km	28 (13.1%)	9 (11.8%)	19 (13.9%)	
Over 400 km	12 (5.63%)	5 (6.58%)	7 (5.11%)	

Table 2. Comparison between groups in relation to temperature on the day of the game (Mann-Whitney test).

Statistic	Total (N=213)	With Injury (n=76)	Without Injury (n=137)	p-value
Mean	25.5	26.1	25.2	0.056
Standard deviation	3.2	2.7	3.4	
Minimum	17	19	17	
Median	26	26	25	
Maximum	32	32	32	

Table 3. Characteristics of matches and players with injuries in the 2023 São Paulo Soccer Championship.

Parameter	N (%)		Parameter	N (%)
Age >27 years			Punishment:	
No	35 (46.1%)		Nothing	67 (88.2%)
Yes	41 (53.9%)		Foul, no card	4 (5.26%)
Position:			Foul, yellow card	4 (5.26%)
Defender	16 (21.1%)		Foul, red card	1 (1.32%)
Side midfielder	15 (19.7%)		Injury site:	
Center back	15 (19.7%)		Thigh	32 (42.1%)
Forward	15 (19.7%)		Head/Face	13 (17.1%)
Midfielder	10 (13.2%)		Ankle	11 (14.5%)
Goalkeeper	5 (6.58%)		Knee	8 (10.5%)
Time of play:			Leg	4 (5.26%)
0–15 minutes	8 (10.5%)		Foot	3 (3.95%)
16–30 minutes	13 (17.1%)		Shoulder	3 (3.95%)
31–45 minutes	14 (18.4%)		Hip	1 (1.32%)
46–60 minutes	15 (19.7%)		Abdomen	1 (1.32%)
61–75 minutes	14 (18.4%)		Side:	
76–90 minutes	8 (10.5%)		Right	33 (43.4%)
Extra time 1st period	1 (1.32%)		Left	27 (35.5%)
Extra time 2nd period	3 (3.95%)		Both	2 (2.63%)
Contact:			Not applicable	14 (18.4%)
Yes	37 (48.7%)		Type of injury:	
No	39 (51.3%)		Stretch	35 (46.1%)
"Contra a(o):"			Sprain	14 (18.4%)
1	1 (1.32%)		Concussion	8 (10.5%)
2	5 (6.58%)		Contusion	7 (9.21%)
3	31 (40.8%)		Blunt injury	4 (5.26%)
4	33 (43.4%)		Overuse Injuries	4 (5.26%)
5	6 (7.89%)		Fracture	3 (3.95%)
Foul:			Dislocation	1 (1.32%)
Yes	9 (11.8%)			
No	67 (88.2%)			

There is also a decrease in the incidence per 1,000 hours of play from 2016 to 2019 and an increase in 2023. From 2016 to 2019, the mean incidence per 1,000 hours of play was 16.5 (Figure 1).
Table 1 shows the comparison between the matches with and without injuries. No statistically significant differences were found between the groups for the type of field (p-value = 0.713), home advantage (p-value = 0.617), weather (p-value = 0.093), and match location (p-value = 0.844). Table 2 shows that no significant differences were found between the temperature of the games with and without injury (p-value = 0.056).
Table 3 presents the profile of players and games with at least one injury in the 2023 São Paulo Soccer Championship.
Among the 76 players who suffered an injury, 41 (53.9%) are over 27 years old. This proportion is not statistically different from 50% (p-value = 0.566).

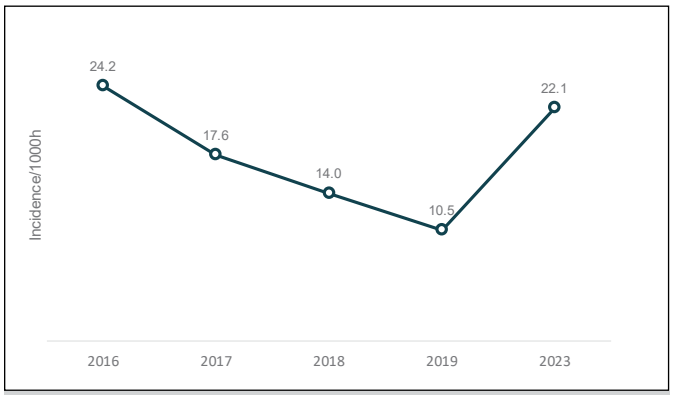

Figure 1. Incidence of injury from 2016 to 2023.

DISCUSSION

In the 2023 season, 76 injuries were recorded, whereas 36 injuries were found in 2019 across the 104 championship matches, resulting in prevalences of 75% and 35%, respectively. The incidence of injuries also showed change, with 10.5 injuries per 1,000 hours of play in 2019 and a significant increase to 22.1 injuries per 1,000 hours of play in 2023. The data found in the 2023 season are consistent with the current literature, which mostly presents a variation of 15 to 30 injuries per 1,000 hours of practice.[4,10,5] However, the increase in incidence suggests an analysis of the possible influences, in particular the role of the pandemic.
In the years 2016 to 2019, it is possible to observe a downward trend in the incidence of injuries,[10] contrasting with the increase in 2023. The mean incidence value from 2016 to 2019 (16.5 injuries per 1,000 hours of play) suggests relative stability and control of injuries during this period. However, the reversal of this pattern in 2023 draws attention.
Another point evaluated in this study was the type of field (natural vs. synthetic), questioned as a potential risk factor for the occurrence of injuries. The data found in this study are compatible with those found in a recently published Systematic Review and meta-analysis,[12] not suggesting impact of the type of field with the incidence of injuries. Other factors such as home advantage, weather, age of the athletes, and match location also showed no association with the increase in injuries. This finding suggests that, although these elements are potentially relevant to the occurrence of injuries,[9] they did not show a direct or immediately identifiable correlation with the increase found in 2023.
The COVID-19 pandemic has introduced a number of changes to the dynamics of the sport, including health protocols, audience restrictions, and changes to schedules and calendars. After its end, most of these adaptations ceased to exist, causing an abrupt increase in the volume of training and games with the resumption of normality in the competition calendar. Factors such as mental health, a tendency toward increased sedentary behavior during the pandemic (isolation), and a sudden increase in external workload are identified as potential contributors to the observed change in patterns.

The proportion of players who suffered injuries and were over 27 years of age (53.9%) did not present a significant difference when compared to the proportion of players under 27 years of age, different from what has been reported in other studies.[13]
Some limitations of this study must be considered. The administered questionnaire does not enable the evaluation of factors such as injury history, medical comorbidities, sleep quality, nutrition, sports experience, stress management, and physical conditioning, which are known to be associated with injury recovery and incidence.[14,15] Additionally, reliance on the voluntary and accurate participation of club physicians in completing the questionnaire may lead to underreporting of cases. We also know that concussion is an underdiagnosed condition, and may be underreported.[16]
The fact that it is a competition at the beginning of the season impacts the athletes' conditioning and, indirectly, the incidence of injuries. In terms of analyzing the type of field, the number of clubs with artificial turf in their stadiums was found to be small, reported for only two out of the 16 participants. This results in few games played under these conditions, hindering the impact assessment of the type of field.

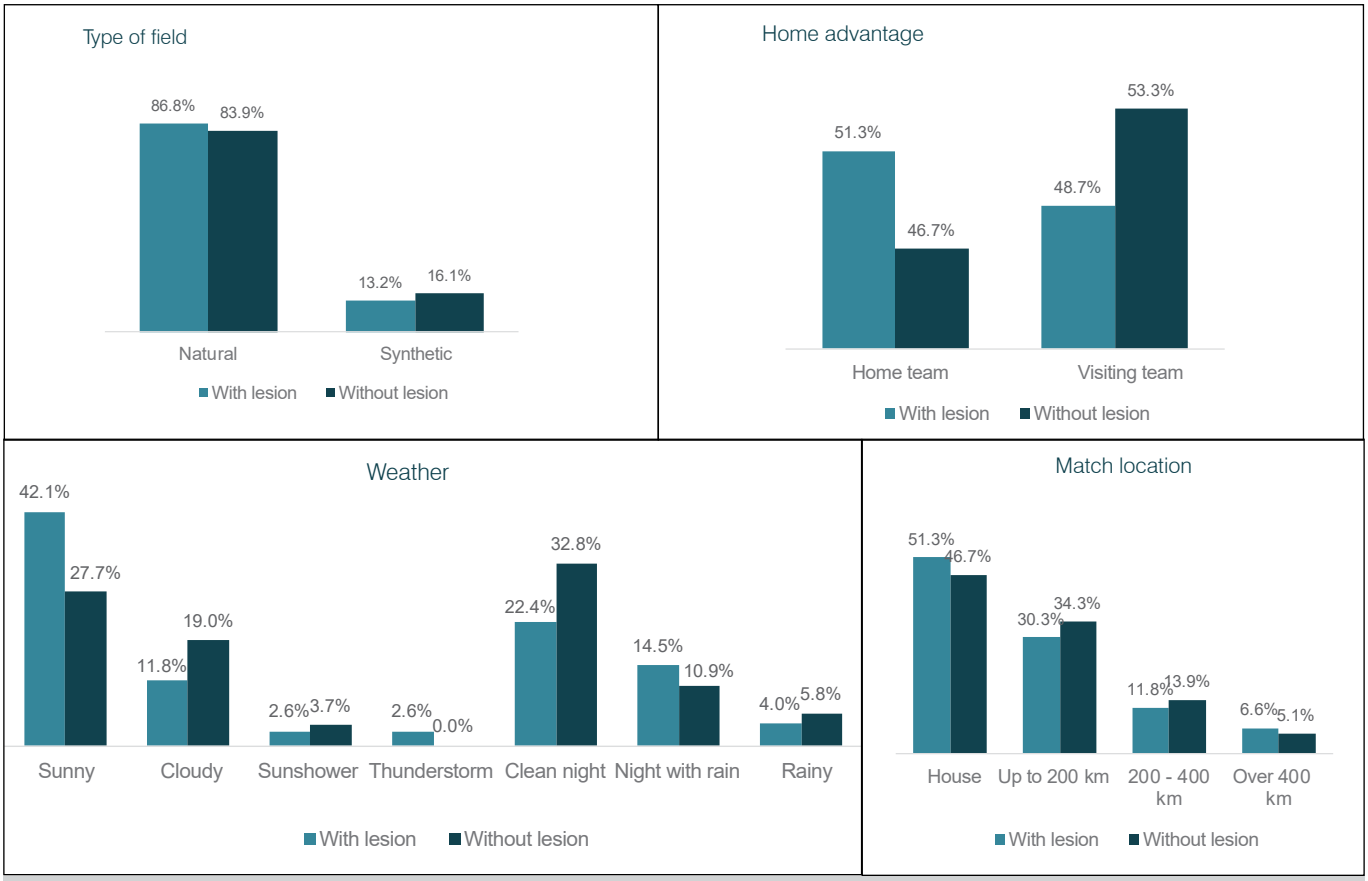

Figure 2. Comparison between the groups.

CONCLUSION

The A1 series of the 2023 São Paulo Soccer Championship showed an incidence of 22.1 injuries per 1,000 hours of play. An increase of 33% when compared to the mean incidence in the pre-pandemic period (2016 to 2019).

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. AMS (0009-0003-9311-0822)*: writing the article, literature review, data collection and analysis; PHSL (0000-0002-1623-2071)*: writing the article, analyzing the data, and reviewing the article; NBB (0000-0003-3421-6953)*: data collection; RRM (0009-0000-9883-2048)*: data collection; MC (0000-0001-7671-8113)*: discussion and review of the article and also in the entire intellectual concept of the article; GGA (0000-0003-4371-5041)*: writing and revision of the article and also in the entire intellectual concept of the article and preparation of the research project. *ORCID (Open Researcher and Contributor ID)."

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ANNEX

QUESTIONNAIRE:

Q1 – Which matches in the 2023 São Paulo Soccer Championship will you take part in?
Q2 – Which club are you answering for?
Q3 – What was the weather at the time of the match?
Q4 – What was the temperature at the time of the match?
Q5 – Were there any injuries during the match?
Q6 – Match location
Q7 – Who suffered the injury? (Date of birth)
Q8 – What is the athlete's position?
Q9 – When did the injury occur? (Playing time)
Q10 – Did the injury occur after contact or collision with the ball or another player?
Q11 – If so, what was the circumstance?
Q12 – Was is considered a foul?
Q13 – What was the referee decision?
P14 – Injury site
P15 – Side of the lesion
P16 – Type of injury
P17 – Foot and Ankle
P18 – Leg
P19 – Knee
P20 – Pelvis, hip, and thigh
P21 – Trunk
P22 – Head
P23 – Shoulder
P24 – Other

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INJURIES DURING THE COVID-19 PANDEMIC IN THE 2021 PAULISTA SOCCER CHAMPIONSHIP IN BRAZIL

LESÕES DURANTE A PANDEMIA DO COVID-19 NO CAMPEONATO PAULISTA DE FUTEBOL DE 2021 NO BRASIL

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ABSTRACT

Objective: To assess the incidence and characteristics of injuries that occurred during the 2021 season of the Paulista Soccer Championship during the coronavirus disease 2019 pandemic and to compare these characteristics before and after the championship interruption. Methods: A prospective study was conducted using an electronic form developed by the Medical Committee of the Paulista Soccer Federation. The results were sent by the team physicians of Series A1 after each round of the Paulista Soccer Championship. Results: Series A1 presented 7.2 injuries per 1,000h of game time. Most injuries occurred within 31–45 min of the match, with muscle injuries being the most frequent and the lower limbs the most affected. Only 10% of injuries required surgery. The strikers were the most affected players and most injuries occurred in penalty-free movements. There was no statistical difference between pre- and post-interruption of the championship due to the pandemic. Conclusion: The incidence of injuries per 1,000h was below the average reported in the literature. Most injuries occurred in the lower limbs; muscle sprains were the most common type of injury, followed by sprains and fractures. MRI was the most commonly requested examination; and most injuries were classified as moderate. Overall, 10% of the injuries were treated surgically. There was no difference between pre- and post-championship interruption. ***Level of evidence VI, Descriptive epidemiology study.***

Keywords: Soccer. Athletes. Injuries. Epidemiology.

RESUMO

Objetivo: Avaliar a incidência e características das lesões ocorridas durante a temporada de 2021 do Campeonato Paulista de Futebol que ocorreu durante a pandemia do Covid-19 e comparar as características antes e depois da pandemia dessa doença. Metodologia: Estudo prospectivo que utilizou um questionário eletrônico desenvolvido pelo Comitê Médico da Federação Paulista de Futebol. Os resultados foram enviados pelos médicos das equipes da Série A1 após cada rodada do Campeonato Paulista de Futebol. Resultados: Série A1 apresentou 7.2 lesões por 1000 horas de tempo de jogo. Maioria das lesões ocorreu entre 31-45 minutos de jogo, com lesões musculares sendo as mais comuns e o membro inferior o mais acometido. Apenas 10% das lesões necessitaram de cirurgia. Os atacantes foram os jogadores mais comumente lesionados, e a maioria das lesões ocorreu em situações em que não foi assinalada infração. Não houve diferença estatística em relação às lesões nos períodos antes e após interrupção pela pandemia do Covid-19. Conclusão: A incidência de lesões por 1000 horas de tempo de jogo foi abaixo da reportada na literatura. Maioria das lesões ocorreu nos membros inferiores; lesões musculares foram o tipo mais comum de lesão, seguido de entorses e fraturas. Ressonância foi o exame de imagem mais comumente solicitado, e a maior parte das lesões foi classificada como moderada. Não houve diferença entre antes e após interrupção pela pandemia nas características das lesões. ***Nível de evidência VI, Estudo epidemiológico descritivo.***

Descritores: *Futebol. Atletas. Lesões. Epidemiologia.*

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INTRODUCTION

Among different sports, soccer has the largest number of practitioners worldwide, with approximately 200,000 professional athletes and at least 240 million amateur athletes covering all age groups of both sexes.[1] This sport demands quick acceleration and deceleration, changes in direction, jumping, and increased physical contact. Due to these characteristics, soccer presents with, in absolute terms, a relatively high number of injuries and thus arouses corresponding interest in sports traumatology.[2,3]

High-performance sports have undergone significant changes, such as increased physical demand and the subsequent risk of injury. Epidemiological studies have estimated injury incidence rates of 16–28 and 2–11 on match and practice injuries, respectively, for every 1,000h of exposure at the professional level.[4,5] In soccer, for example, it has been estimated that the injury-related absences of athletes of the major European soccer leagues result in the loss of approximately 500,000€ per month to teams, in addition to compromising the team's performance and success during a championship season.[6]

Previous studies reported that muscle injuries, contusions, contractures, and sprains represent approximately 75% of injuries in professional soccer players, with most affecting the lower limbs, especially the thighs, knees, and ankles.[6] In addition, contusion is the most common type of traumatic knee injury. The lateral ankle sprain is also one of the most common joint injuries in soccer and exposes high rates of persistent symptoms and relapses, with consequent local morbidity and a decrease in the athlete's sports performance. In the thighs, the hamstring muscle strain is the most prevalent injury in soccer, representing 12% of all injuries in high-level players.[6] Other studies have shown that the susceptibility to certain types of injuries varies according to the position of each athlete in a match, possibly due to inherent changes in game style and intensity, as the roles involved in each position require specific technical, physiological, and tactical demands.[7]

Thus, it is presumed that the incidence of this type of injury is higher in male soccer athletes, principally during matches, thus having more risk exposure to muscle injuries, especially in the lower limbs.

METHODS

This study was approved by the Research Ethics Committee of our institution (number: 1,660,701). This prospective study applied an electronic form, developed by the Medical Commission of the Paulista Soccer Federation (FPF). Patient data were anonymously extracted, and the results were sent by the physicians to the A1 series teams after each round of the 2021 Paulista Soccer Championship. This form was developed to analyze the incidence and characteristics of soccer-related injuries and it contained 15 questions about the specifics of the match, athlete, and injury (Appendix 1). The definition used to determine a soccer injury was based on the statement by Fuller et al. for the 2005 FIFA consensus, as follows: "Any physical complaint sustained by a player that results from a football [soccer] match or football [soccer] training, irrespective of the need for medical attention or time loss from football [soccer] activities".[8]

The research subjects were players from 16 clubs participating in the 120th edition of the main division of the Paulista Soccer Championship, which is this sport professional competition in the state of São Paulo, that occurred from February 27th to May 23rd, 2021, organized by the FPF. The schedule of each match was registered by the FPF, which is the oldest soccer league in Brazil, being held uninterruptedly since 1902. Forms were completed by the physicians from each team after the matches as of their return from the field and were used to analyze the outcome of each reported injury. Eight questions were structured in the form of complementary examinations and final diagnoses (Appendix 2). The time of each match was registered by FPF (morning: departures starting before 12 p.m., afternoon: departures before 6 p.m., and night: departures after 6 p.m.). After the first three rounds of the A1 series, Paulista Soccer Federation (FPF) stopped the championship for 15 days due to the worsening coronavirus disease 2019 (COVID-19) infection rates in Brazil. The remaining matches, including the finals, were played afterwards.

To obtain data, a form was initially sent to inquire whether there was an injury. In the cases in which the physician reported an injury, another form was sent inquiring the injury details: if any imaging examination was performed, how long the athlete was kept away from training, and if surgical intervention was necessary. Cases of physicians not answering the first form or the second form even though they reported an injury in the first one were excluded (Figure 1).

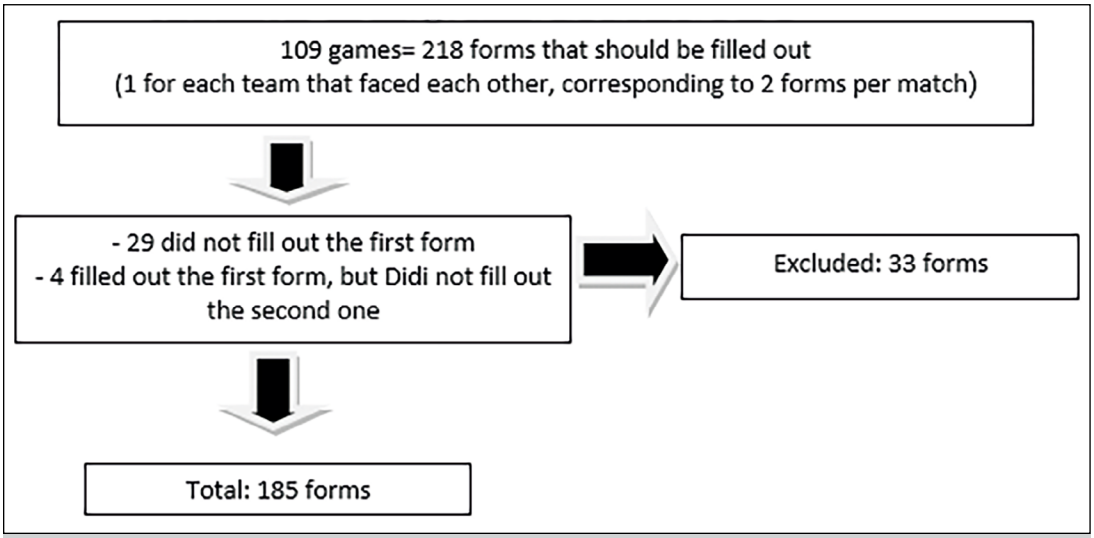

Figure 1. Adressing inclusion and exclusion criteria.

The incidence of injuries was calculated to assess the risk, expressed as the number of injuries per 1,000h of exposure.[8,9] The following formula was used to calculate the exposure:

<< SUMÁRIO

$$Exposure = \frac{no.of\ matches * no.players(22) * match\ duration\ in\ minutes\ (90)}{60},$$

Whereas the formula below was used to calculate the incidence at matches:

$$Incidence = \frac{no.of\ lesions\ in\ matches}{time\ of\ exposure} * 1000.$$

Statistical analysis

Parametric statistics were used for quantitative and continuous data. Two-tailed tests were used to characterize the relative frequency distribution of qualitative variables. Differences were considered statistically significant at $p<0.05$. Statistical Package for the Social Sciences version 20.0 (IBM Corp., Armonk, NY, USA), Minitab (Minitab, LLC, State College, PA, USA), and Excel Office 2010 (Microsoft Office 2010, Microsoft Corporation, Redmond, WA) were used to perform the analyses.

RESULTS

Injury characteristics

Overall, there were 109 games in the championship. Therefore, 218 forms should have been completed (1 for each team that faced each other, corresponding to 2 forms per game, one for each team's responsible physician). However, of these 218 forms, 29 first forms (13.3%) were not filled out and 4 second forms (1.7%) were not filled out despite the injury report in the first form; thus, 185 (85%) forms were completely filled.

The average age of injured players was 24.6 years, and the average time of absence due to injury was 20.2 days. Most matches occurred at night (77.1%), while 20.2% and 2.8% occurred in the afternoon and morning, respectively. A total of 26 injuries were reported during all 109 matches, corresponding to an average of 0.24 injuries per match. Most injuries occurred on penalty-free movements (81.8%). In terms of game position, 34.6% of the injuries were experienced by strikers, 19.2% by defenders, 19.2% by full-backs, 15.4% by wide midfielders, and 11.5% by central midfielders, with no injuries to goalkeepers (Figure 2).

Most injuries occurred within the 31–45min time interval (26.9%), followed by 61–75min (23.1%) and 16–30min (19.2%) (Figure 3).

Regarding the distance of the matches, most injuries occurred during home games (46.2%), followed by distances of up to 200km (30.8%); 200–400km (15.4%); and >400km for the matches (7.7%). Injuries occurred mostly in matches played at night with clear weather (69.2%), followed by injuries occurring in rainy weather (11.5%). The mean temperature during the match was lower in the injured group (22.9 °C) than in the uninjured group (23.9 °C), but there were no statistical differences between the injury groups and the analyzed variables.

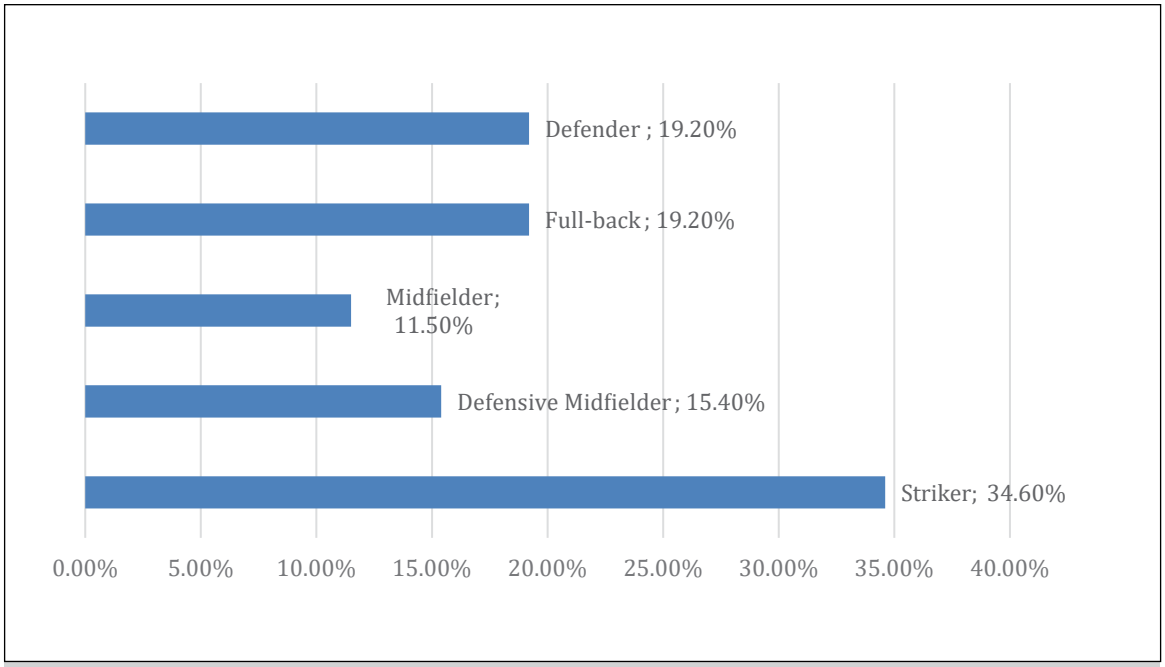

Figure 2. Player positions.

A rate of 7.2 injuries per 1,000 h of matches in Series A1 was observed in 2021. The most common injury sites were the thigh (42.3%), ankle (19.2%), and head/face (11.5 %). Injuries occurred more frequently on the dominant side (53.8%). The most common type of injury was muscle strain (50%), followed by sprains (15.4%), and then fractures (11.5%), contusion (7.7%), concussion (7.7%), and others characterized by dislocation (3.8%) and laceration (Figure 3). Regarding the final diagnosis, the most frequent injuries were hamstring muscle strain (40%), quadriceps muscle strain (10%), and ankle sprain (10%) (Figure 4).

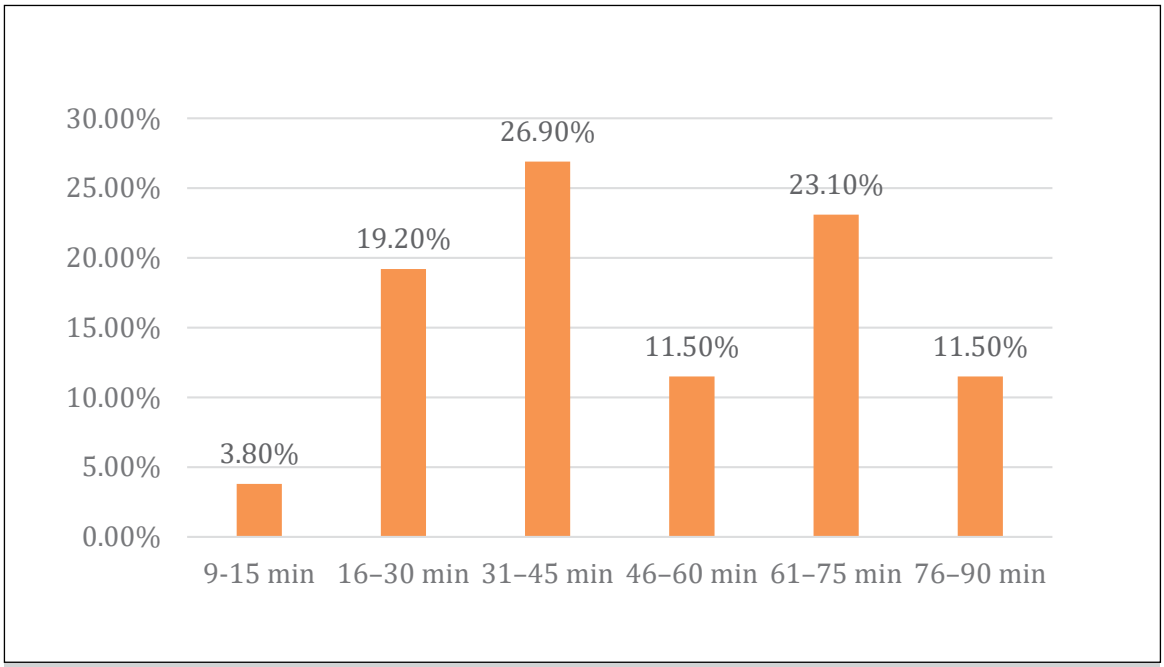

Figure 3. Time interval of injury occurrence

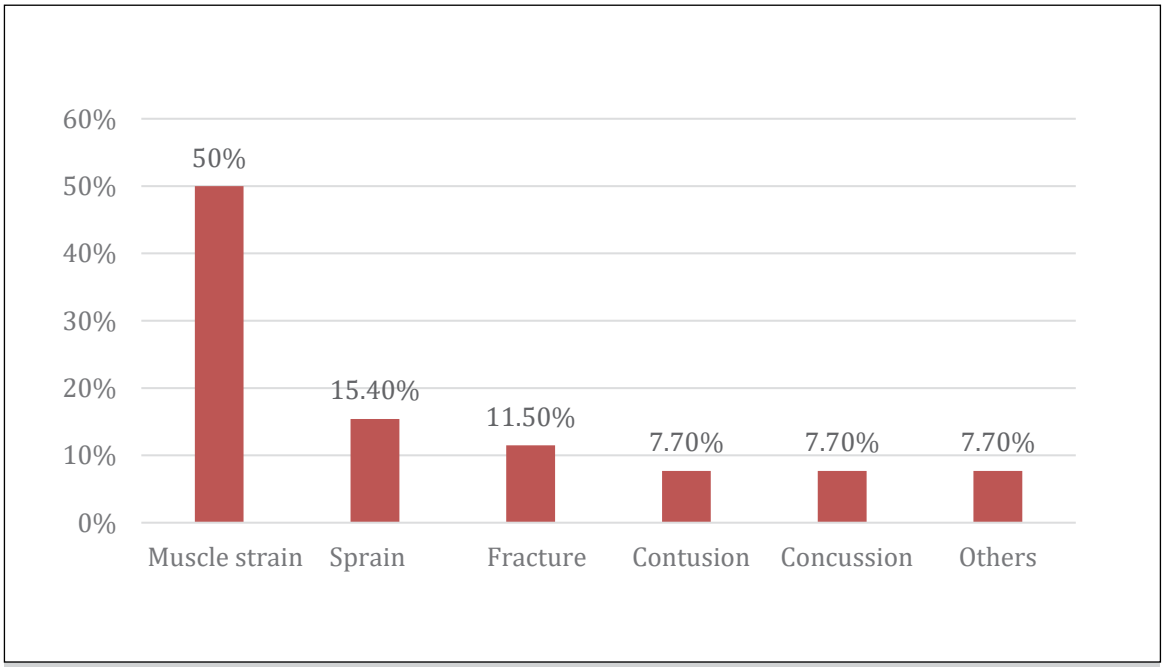

Figure 4. Tipe of injury

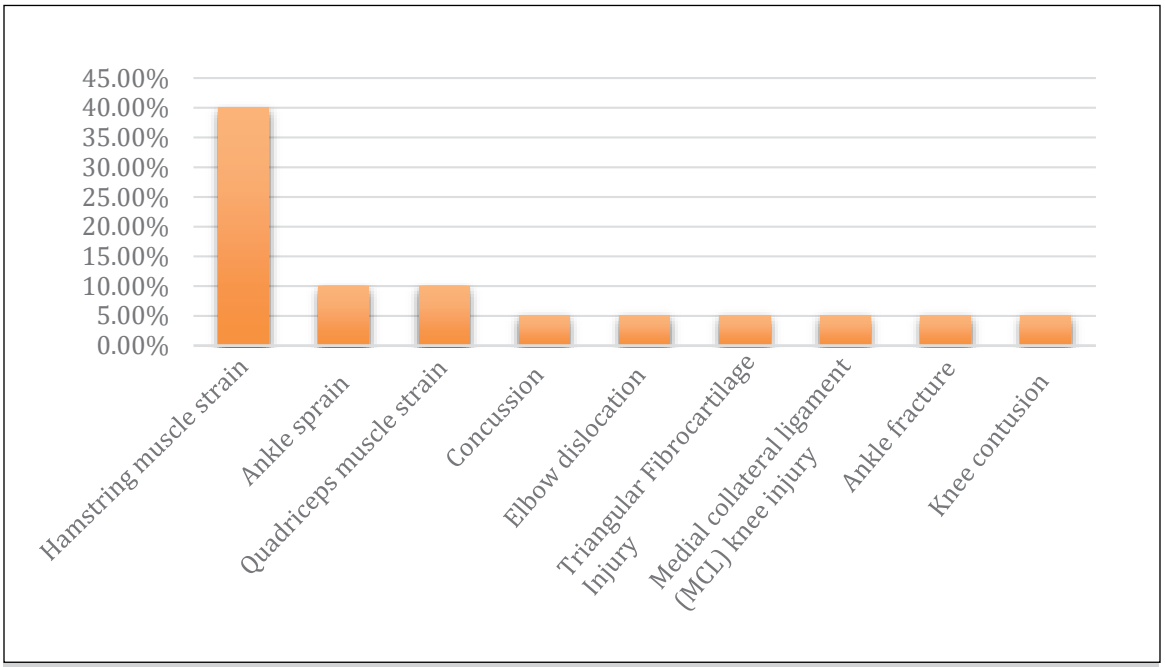

Figure 5. Final diagnoses

Injury treatments

When requested, the most frequent complementary examinations were magnetic resonance imaging (MRI) (40%), followed by ultrasonography (35%) and radiography (20%) — no specific protocol was used for the imaging exams. No examination was required for 5% of injuries. Surgery was required for foot and ankle fractures, corresponding to 10% of all registered injuries. Most injuries were considered moderate according to the severity scale, with a medical leave ranging from 8 to 28 days (50%) (Figure 6).

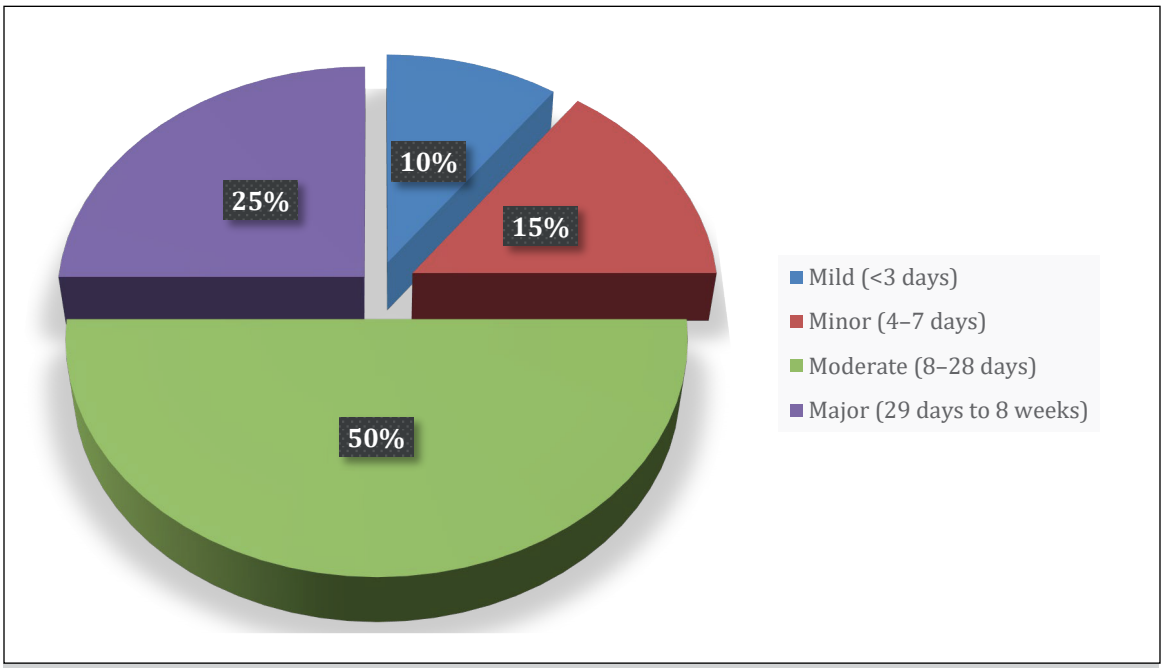

Figure 6. Injury severity.

Before and after the championship interruption

The championship was paused from March 15th to March 30th, with 31 (28.4%) and 78 (71.6%) matches played before and after the interruption, respectively, including the finals. To perform this analysis, we used the Chi-square test to compare pre and post championship interruption for injury distribution. The main results are presented in Table 1.

Table 1. Comparisons of injury distribution before and after championship interruption.

	Before Interruption		After Interruption		Total	
	N	%	N	%	N	%
No Injury	55	88.7%	105	85.0%	160	86.2%
With Injury	7	11.3%	18	15.0%	25	13.8%
Total	62	32.8%	123	67.2%	185	100%

p = 0.492

Note that there were no statistically significant differences in the occurrence of injuries between the two periods, in which a reduction in the rate from 88.7% to 85.0% is noted.

DISCUSSION

The study of injuries in professional soccer is important due to their influence on the team final results in national and international tournaments; moreover, understanding the characteristics of these injuries may allow for the implementation of preventive strategies to increase the team's chances of gaining recognition, such as prizes and titles.[10] In several competitions worldwide, epidemiological investigations were performed to identify the patterns of common practices in the main leagues, world tournaments, and World Cups.[11] Although soccer is the most popular sport in Brazil, few epidemiological studies have been conducted, and data are scarce on injuries in the main regional and national leagues in the country.[3]
In early March 2020, the World Health Organization declared the COVID-19 pandemic, an infection caused by the severe acute respiratory syndrome coronavirus 2. Due to the state of global public health, security protocols were implemented by countries to avoid agglomerations of people to reduce viral transmission. Thus, several soccer championships[12] and the collective training of the teams were halted indefinitely. Thus, most athletes had to train at home while following conditioning and strength routines provided by the teams. Despite this, however, many players still displayed signs of detraining, increasing the risk of injuries after returning to the sport, necessitating a multi-component soccer training program including aerobics, endurance, balance, coordination, and power-specific motor skills.[12,13]
This study main findings were an incidence of 7.2 injuries per 1,000 hours of gameplay, with most injuries in lower limbs. The mean number of days the athletes were kept away from practice and matches per injury was 20.2. Most injuries occurred during the last 15 minutes of the first half of the match, and only 10% of the injuries required surgical treatment.
The incidence of injuries in this study was lower than that reported in the literature, although the characteristics of the injuries were similar.[3,11,14,15,16] This reduction in incidence may be due to reduced exposure, as well as the preventive measures implemented by the clubs and a better condition of the soccer fields. Muscle strains and sprains accounted for most injuries (65%), which could be associated with the increased demand on the player's performance, following a general trend in soccer, a result similar to that reported previously.[17,18,19] Most injuries were treated conservatively, with only 10% requiring a surgical approach.
Similar to other studies developed by our group, magnetic nuclear resonance imaging was the most requested examination.[3,11,16] As most injuries occurred in muscular (50%) and ligamentous (15%) tissues, thus magnetic resonance imaging is the most useful method for these injuries investigation. Most injuries occurred within the 31–45min time interval of the first half of the match.[16,11,3] In other studies, most injuries occurred in the last 30 min of the final half of the match.[17,3] However, in some of these studies, the tournaments were organized in a simple elimination system, in which each game defined the team classification or elimination, most likely contributing to the increased athlete endeavor and increased risk of injury in the final minutes of the matches.
Evaluation of the incidence rates showed injury rates of 11.3% and 15%, respectively, before and after the championship interruption. In both periods, muscle strain was the most common injury, accounting for almost half of the cases (43% before and 52.6% after the interruption), indicating that the interruption did not change the injury characteristics. Furthermore, differences in the injury occurrence were observed. Before the interruption, injuries were more common within the 31–45min time interval of the match (43%). After the championship return, injuries occurred mostly within three different time periods: 16–30min; 31–45min; and 61–75min; in which each period accounted for 21% of the injury occurrence. However, no significant differences were observed in the evaluated factors. Pucsok et al.[14] showed that home training during the championship interruption effectively improved aerobic fitness but did not allow players to maintain their usual speed endurance. Grazioli et al.[20] reported that 63 days of quarantine impaired the various physical performance abilities compared to the normal period between seasons. These findings can be justified by the number of limited locomotor movements, which ends up impairing the speed endurance capacity that is one of the vital components of current soccer performance. Special attention should be paid to body composition, speed, and power-related capabilities after long-term detraining. Moreno-Pérez et al.[21] showed decreased eccentric strength of the hamstrings during isolation at home; this magnitude of muscle weakness may indicate an increased risk of injury. Despite the increased risk of injuries, we observed no significant difference between the incidence and type of injuries and the time that they occurred.
Recent studies have demonstrated the impact of interruption on the physical qualities of athletes.[12,13]
In comparison with other popular sports in Brazil, a study by Rosa et al. [22] addresses predictors of injuries in Brazilian athletes of other sport categories . Female handball, followed by male volleyball, presented anterior cruciate ligament (ACL) injury as the most prevalent. Isolated ACL injury occurred in 37 (6.3%) of the 585 athletes in the study. The incidence in women was slightly higher compared to that in men, with 18 cases (7.2%) in 249 athletes. Regarding men, there were 19 injuries (5.6%) in 336 athletes.
This study limitation was the reliability of the information provided by the clubs' medical teams, as well as the lack of official records of injuries occurring during matches. Furthermore, it was not possible to accurately measure the exposure of each athlete.

CONCLUSION

The incidence of injuries per 1,000 game hour was below the average reported in the literature. Most injuries occurred in the lower limbs. Muscle strains were the most common type of injury, followed by sprains and fractures. Magnetic resonance imaging was the most commonly requested examination. Most injuries were classified as moderate. Ten percent of the injuries were treated surgically. The results were similar before and after the championship interruption due to the COVID-19 pandemic. This study findings indicate possible preventive measures to reduce or minimize the number and severity of soccer injuries since it addresses probable risk factors.

AUTHOR'S CONTRIBUTION: Each author contributed individually and significantly to the development of this article. GGA: writing and review; DJLG: writing and data collection; PHSL: writing and review; JRP: review; MC: review.

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APPENDIX 1

Mapping of the Injuries in the 2021 Paulista Soccer Championship

REPORT ON ORTHOPEDIC INJURIES OCCURED DURING THE 2021 PAULISTA SOCCER CHAMPIONSHIP

1) THIS REPORT REFERS TO THE FOLLOWING MATCH:

_____

2) WHAT WAS THE WEATHER LIKE AT THE TIME OF THE MATCH?
- ( ) SUNNY
- ( ) CLOUDY
- ( ) RAINY
- ( ) SUN SHOWER
- ( ) RAIN AND LIGHTNING
- ( ) NIGHT – CLEAR SKY
- ( ) NIGHT –RAINY

3) TEMPERATURE MEASURED AT THE TIME OF THE MATCH:

_____

4) LOCATION
- ( ) HOME GAME
- ( ) UP TO 200KM AWAY
- ( ) FROM 200 TO 400KM AWAY
- ( ) MORE THAN 400KM AWAY

5) WERE THERE INJURIES SUSTAINED DURING THE MATCH?
- ( ) YES
- ( ) NO

FILL OUT THE FOLLOWING ITEMS IN CASE OF REPORTED INJURIES

6) NAME OF THE INJURED ATHLETE:
DATE OF BIRTH_____

7) ATHLETE'S POSITION:
- ( ) GOALKEEPER
- ( ) CENTRAL DEFENDER
- ( ) FULL-BACK
- ( ) WIDE MIDFIELDER
- ( ) CENTRAL MIDFIELDER
- ( ) STRIKER

8) WHEN WAS THE INJURY SUSTAINED?
- ( ) 0–15 MIN
- ( ) 15–30 MIN
- ( ) 30–45 MIN
- ( ) 45–60 MIN
- ( ) 60–75 MIN
- ( ) 75–90 MIN
- ( ) OVERTIME – 1ST HALF
- ( ) OVERTIME – 2ND HALF

9) DID THE INJURY OCCUR AFTER CONTACT OR COLLISION WITH THE BALL, GOAL, OR WITH ANOTHER ATHLETE?
- ( ) YES
- ( ) NO

10) IF YES, IN WHICH CIRCUMSTANCES?
( ) ANOTHER PLAYER
( ) BALL
( ) GOAL
( ) OTHERS

11) DID THE REFEREE CONSIDER THE INJURY MECHANISM A MISCONDUCT?
( ) YES
( ) NO

12) WHAT PUNISHMENT WAS APPLIED?
( ) FOUL, NO CARD.
( ) FOUL AND YELLOW CARD
( ) FOUL AND RED CARD
( ) NO PENALTY

13) WHERE WAS THE INJURY SUSTAINED?
( ) HEAD
( ) TRUNK
( ) UPPER LIMBS/EXTREMITIES
( ) LOWER LIMBS/EXTREMITIES
( ) N/A

14) SIDE OD THE INJURY
( ) RIGHT
( ) LEFT
( ) N/A
( ) BILATERAL

15) TYPE OF INJURY
( ) Strain
( ) Sprain
( ) Contusion
( ) Fracture
( ) Joint Dislocation
( ) Wound (with contusion)
( ) Concussion
( ) Cramp
( ) Others

PROBABLE FINAL DIAGNOSIS:

APPENDIX 2

Injury Report: 2021 Paulista Soccer Championship

REPORT ON ORTHOPEDIC INJURIES SUSTAINED DURING THE 2021 PAULISTA SOCCER CHAMPIONSHIP

1) NAME OF THE INJURED ATHLETE
DATE OF BIRTH:_____
POSITION:_____
INJURY:_____
DATE OF THE INJURY:_____

2)COMPLEMENTARY TESTS/EXAMS REQUESTED:
( ) NONE
( ) RADIOGRAPHY (RX)
( ) ULTRASOUND (US)
( ) CAT SCAN
( ) MRI
( ) OTHERS:_____

3) DID THE INJURY REQUIRE SURGERY?
( ) YES
( ) NO

4) IF YES, SPECIFY:
_____

5) ATHLETE'S RETURN DATE TO SPORTS ACTIVITIES:
_____

6) DAYS KEPT AWAY FROM PRATICE:
_____

7) INJURY SEVERITY SCALE:
( ) MILD (UP TO 3 DAYS AWAY)
( ) MINOR (3 TO 7 DAYS AWAY)
( ) MODERATE (7 TO 28 DAYS AWAY)
( ) MAJOR (7 DAYS TO 8 WEEKS AWAY)
( ) SEVERE (MORE THAN 8 WEEKS OF TIME LOSS)

8) DID THE FINAL DIAGNOSIS CONFIRM THE INITIAL DIAGNOSIS?
( ) YES
( ) NO

FINAL DIAGNOSIS:
_____

DOI: http://dx.doi.org/10.1590/1413-785220243206e282517

ASSESSMENT OF SATISFACTION IN PATIENTS UNDERGOING SURGICAL TREATMENT BY THE WALANT TECHNIQUE

AVALIAÇÃO DA SATISFAÇÃO DOS PACIENTES SUBMETIDOS A TRATAMENTO CIRÚRGICO PELA TÉCNICA DE WALANT

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ABSTRACT

Objective: To analyze the satisfaction of patients who underwent hand surgical treatment with the wide-awake local anesthesia no tourniquet (WALANT) anesthesia technique. Methods: This is a cross-sectional study on the satisfaction of patients who underwent hand surgical treatment with the WALANT technique. These patients were treated at the Hand and Microsurgery outpatient clinic of a public hospital from March 2020 to March 2022. They were assessed by the modified Heidelberg questionnaire. Results: The overall average of satisfaction totaled 3.27 (maximum value 4, SD 0.52, p-value 0.04), representing a good result. Patients' profile characteristics showed no statistically significant differences. Conclusion: The efficiency of WALANT technique stemmed from the high satisfaction rate of patients undergoing minor surgeries, justifying its use as a routine option in outpatient surgeries in the public system. ***Level of evidence III, Retrospective comparative study.***

Keywords: WALANT. Carpal Tunnel Syndrome. Trigger Finger Disorder. De Quervain Disease. Heidelberg Questionnaire. Surgical Treatment.

RESUMO

Objetivo: Analisar o grau de satisfação dos pacientes submetidos ao tratamento cirúrgico de afecções na mão com anestesia pela técnica de WALANT. Métodos: Estudo transversal sobre o grau de satisfação dos pacientes submetidos ao tratamento cirúrgico de afecções na mão com anestesia pela técnica de WALANT (Wide Awake Local Anesthesia No Tourniquet), no ambulatório de Mão e Microcirurgia de um hospital público, durante os meses de março de 2020 a março de 2022, através da aplicação do questionário modificado de Heidelberg. Resultados: A média geral de satisfação foi de 3,27 (valor máximo 4, DP 0,52, p-valor 0,04), representando um bom resultado; não houve diferenças estatisticamente significantes em relação as características do perfil dos pacientes. Conclusão: Demonstrou-se a eficiência do uso da técnica de WALANT através do alto índice de satisfação dos pacientes submetidos a cirurgias de pequeno porte, justificando seu emprego como opção de rotina em cirurgias ambulatoriais no sistema público. ***Nível de evidência III, Estudo retrospectivo comparativo.***

Descritores: *WALANT. Síndrome do Túnel do Carpo. Dedo em Gatilho. Tenossinovite de De Quervain. Questionário Heidelberg. Tratamento Cirúrgico.*

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

The wide-awake local anesthesia on the tourniquet (WALANT) technique has been gaining popularity in hand surgery due to its various benefits: lower cost, shorter length of hospital stay, and greater ease and safety. It also enables the intraoperative evaluation if active movements.[1,2] The technique administers lidocaine, epinephrine, and sodium bicarbonate at the site to be operated, causing less bleeding and risk than the well-known Bier block and less discomfort by dispensing with tourniquets.[3,4] Moreover, WALANT causes no side effects such as nausea, vomiting, and urinary retention.[3,5]

Minor hand surgeries with the WALANT technique have a lower risk of anesthesia-related postoperative complications and offer greater safety for patients with comorbidities.[1,5] Also, surgical procedures with local anesthesia cost less than those using sedation, enabling a greater number of procedures in public services.[1,3] Several authors have evaluated hand surgeries by comparing anesthesia with sedation and the WALANT technique. Despite similar results,[6] WALANT showed a shorter post-anesthetic recovery of up to 60%.[7]

In view of the difficulties scheduling this type of surgery in the Brazilian Unified Health System, the WALANT technique is an interesting option, allowing these procedures to be performed in a day hospital regime; especially in high-complexity hospitals, in which emergencies suspend elective surgeries and occupy beds for a long time.

Most of the literature has only informed the cost, efficacy, and fewer complications of the WALANT anesthetic technique, ignoring patients' experiences. The complete evaluation of surgeries should include their satisfaction, to be determined based on the congruence between expected and obtained results.[8,9] This evaluation is difficult to obtain,[9] and several questionnaires and scores have been developed. Schiff et al.[10] developed and validated a multidimensional questionnaire — "The Heidelberg Peri-anaesthetic Questionnaire" — so anesthesiologists can find the causes of patients' dissatisfaction. In turn, Moura et al.[11] validated this questionnaire for the Portuguese language, enabling the application of its questions and the evaluation of patients' satisfaction toward the anesthetic procedures.

This study applied a modified Heidelberg questionnaire to evaluate the degree of satisfaction of patients who had been subjected to surgical treatment for minor hand surgeries by the WALANT technique to reiterate and encourage its use as a routine option in outpatient surgeries at the Brazilian Unified Health System.

MATERIALS AND METHODS

A cross-sectional study was carried out with the modified Heidelberg questionnaire in patients undergoing minor surgical treatment for hand conditions under the WALANT technique who had been followed at the Hand and Microsurgery Outpatient Clinic of a public hospital in São Paulo from March 2020 to March 2022. The questionnaire was applied by three resident physicians at the service during the consultations following the surgeries. This study was approved by the Ethics and Research Committee of the service under CAAE no. 58634822.5.0000.5479.

Surgical treatments for carpal tunnel syndrome (open decompression of the carpal tunnel), trigger finger (open A1 pulley release), and De Quervain tenosynovitis (opening of the first extensor compartment) were included as minor surgeries. A total of 63 patients were selected, of which, 30 answered the questionnaire and were included in this study.

The questionnaire is shown in Annex 1. The answers followed a scale of agreement scored in 4 items (4, totally agree; 3, agree; 2, disagree; 1, totally disagree). Characteristics of patients' profile (such as age, gender and level of education) and their history of previous surgeries and type of anesthesia were also identified. Participants were also asked about details of their surgeries, fear of the procedure, waiting time, pain, surgery environment, and medical team availability.

Inclusion criteria

- Patients of any gender aged over 18 years;
- Patients with trigger finger on any finger or hand, regardless of degree according to Green's classification,[2] underwent A1 open pulley release under anesthesia by the WALANT technique without sedation;
- Patients with carpal tunnel syndrome of any laterality, regardless of the time since diagnosis, who had been subjected to open surgical treatment under anesthesia by the WALANT technique without sedation;
- Patients with De Quervain tenosynovitis of any laterality, regardless of the time since diagnosis, who had been subjected to open surgical treatment under anesthesia by the WALANT technique without sedation;
- Adequate post-surgical follow-up.

Exclusion criteria

- Patients undergoing surgery with a technique other than WALANT;
- Patients undergoing surgery under sedation;
- Patients with diagnoses other than carpal tunnel syndrome, De Quervain tenosynovitis, or trigger finger;
- Refusal to participate in this study or unwillingness to answer the questionnaire.

Data analysis

The collected data were organized into tables on Microsoft Excel Office 2016®, and statistically correlated by the Mann-Whitney and two-proportion equality tests and by the Spearman's correlation on SPSS V20, Minitab 16, and Excel Office 2010. Statistical significance was set at $p < 0.05$.

To facilitate statistical analysis, the scores of negative answers were reversed (the answer scored at "1" was converted to "4," "2" to "3," and so on) and marked with an "X." Positive answers kept their score as the original given by the interviewee. The following questions had their scores reversed: 2, 3, 4, 6, 7, 10, 11, 12, 13, 14, 15, and 16 (Annex 1).

RESULTS

Participants' mean age totaled 57.6 years (SD 13.7 years, range 20-82), with 26 female and four male patients; 16 of which received a diagnosis of trigger finger; 12, of carpal tunnel syndrome; and two, of De Quervain tenosynovitis (Table 1).

Asked about previous anesthesia, most patients (28 out of 30) had undergone a procedure with anesthesia, 21 reported lumbar plexus block (or spinal anesthesia); 18, having undergone general anesthesia and only seven, local anesthesia without sedation (Table 1).

More than 50% had an educational level below complete elementary school (19) and only seven had higher education. The performed Spearman's correlation found no statistically significant differences regarding participants' answers (Table 2). It ranges from −1 to 1. A positive correlation would mean that as the value an analyzed variable increases, so does that of the other and vice versa. Thus, no answer to the questions show a positive or negative correlation with education.

Each question enables the evaluation of the average of the obtained answers, obtaining the degree of satisfaction; for which the closer the value to four, the greater the patient satisfaction.

Overall mean satisfaction totaled 3.27, with a 0.52 SD (p-value = 0.04). Of all analyzed questions, only question 9 stayed below the mean (evincing a lower satisfaction index), the mean of which equaled 1.47 and SD, 0.81. (Figure 1)

Table 1. Patient profile

Patient profile (n = 30)	
Variables	**Values**
Age (years) (mean±SD)	57.6 ± 13.7
Women	26 (86.7%)
Escolaridade	
Illiterate or Incomplete Elementary Education	15(50%)
Complete elementary school	4 (13.3%)
Complete secondary education	4 (13.3%)
Complete or incomplete higher education	7 (23.3%)
Prior anesthesia (yes)	28 (93.3%)
Previous anaesthesia (n = 28)	
Type of anesthesia	
General	18 (60%)
Spinal anesthesia	21 (70%)
Local	7 (23.3%)
Indication for surgical treatment	
Diagnosis	
Trigger finger	16 (53.3%)
Carpal tunnel syndrome	12 (40%)
De Quervain tenosynovitis	2 (6.7%)

Absolute values (n) and respective percentages (%).
Source: Medical archives of the institution

Questions 11 and 15 had their overall mean below the mean minus one standard deviation but obtained a satisfaction variance within the range of the overall mean. Question 11 refers to the waiting on the day of surgery (between hospitalization and referral to the operating room). This item obtained a 2.67 mean satisfaction and a 0.91 SD. Question 15 refers to patients shivering or feeling cold, showing a 2.63 mean satisfaction and a 1.08 SD.

Table 2. Spearman's correlation and patients' education

Correlation between education and obtained answers		
Question	**Correlation**	**p-value**
1	0.002	0.992
2	0.23	0.222
3	0.123	0.517
4	0.049	0.797
5	0.023	0.905
6	0.273	0.144
7	0.08	0.674
8	0.011	0.955
9	−0.232	0.217
10	−0.077	0.686
11	0.306	0.101
12	0.253	0.178
13	0.083	0.662
14	0.208	0.27
15	0.053	0.781
16	0.226	0.23
17	0.096	0.616
18	0.084	0.659
19	−0.136	0.473
20	0.03	0.873
21	0.018	0.926
22	0.04	0.832

Source: Medical archives of the institution

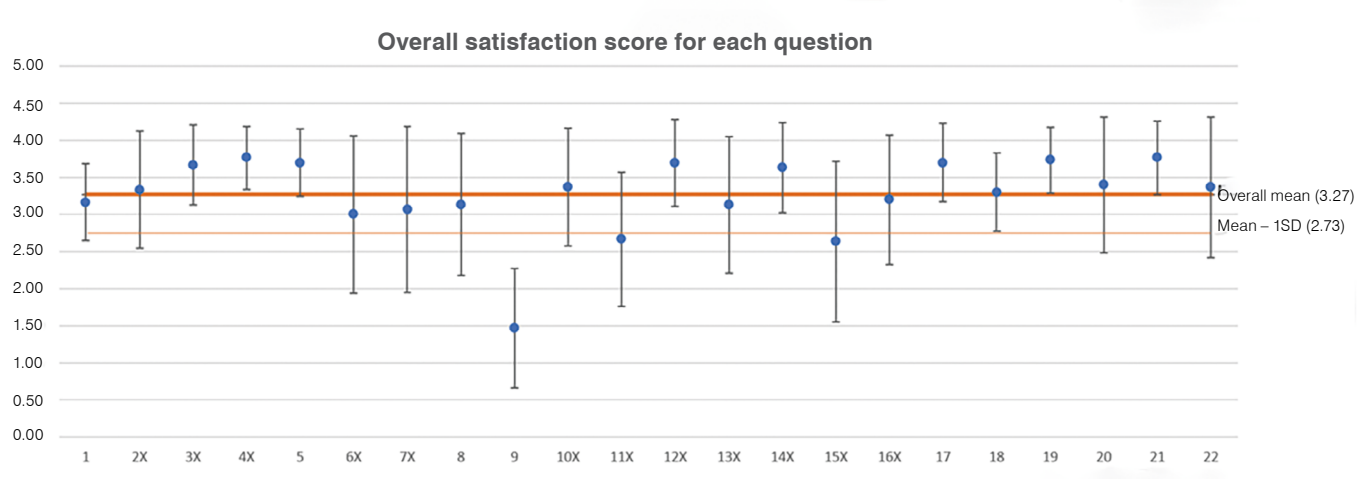

Figure 1. Mean, standard deviation, confidence interval in each question.

SD = standard deviation

DISCUSSION

The complex evaluation of patients' satisfaction involves several socioeconomic and cultural factors, previous personal experiences, and the surgical and anesthetic act itself. The literature currently considers satisfaction as a new indicator of health care quality, correlating it with treatment adherence and successful outcomes.[9,12,13] Thus, this study applied a modified "Heidelberg Peri-anaesthetic Questionnaire" that has been validated and translated into Portuguese.[10,11] The original Heidelberg questionnaire was adapted for performance by surgeons rather than anesthesiologists, excluding questions that could become repetitive.

Furthermore, the original model Schiff[10] proposed distributed the questionnaire for filling by patients. This study applied this questionnaire by interviews to reduce biases in filling out the questionnaire and lack of answers and increase research adherence.[8,14] However, interviews could suffer the influence of the interviewer's (the surgeon) presence as a bias, even if involuntary.[8] To minimize this, the interviewer differed from the physician who performed the patient's surgery in this study.

Schiff et al.[10] found higher levels of satisfaction in older patients and in lower levels of education. Myles et al.[15] and Heidegger et al.[16] reported lower satisfaction in younger interviewees. Moura et al.[11] and Lemos[8] reported lower satisfaction rates the higher the level of education. In total, 43% of the patients in this study were aged over 60 years, with a mean age of 57.6 years; 50% of whom had poor education (incomplete elementary school, below nine years of schooling). Overall average satisfaction was high — 3.27 (p-value 0.04), as in other studies, despite no statistically significant correlation between satisfaction indices and education or age.

Previous studies reported lower satisfaction rates regarding fear of anesthesia; anxiety waiting for surgery; and pain, thirst, and drowsiness.[8,10,14] In this study, question 11 ("the waiting time on the day of surgery was long") showed a mean satisfaction below the general average, with an index of 2.67 (SD 0.91) versus 3.27 (SD 0.52; p-value 0.04), which, although not as high as in other studies, proved to be a parameter with the worst evaluation. Several authors have shown that the organization of a health system also influences satisfaction indices as prolonged waiting increases anxiety, agitation, and discontent.[8,17,18] Thus, organizational systems should undergo reforms to reduce waiting and thus anxiety and improve the quality of the provided services.

Question 15 also showed a lower index than the other parameters, with a mean of 2.63 (SD 1.08). Other studies have mentioned no unsatisfactory evaluations.[8,10,11,14] This item asked if patients "felt cold or shivered in the room in which they were anesthetized." Thus, better temperature control in operating rooms can improve patient comfort during procedures.

On the other hand, analyzing fear of anesthesia or surgery (questions 6 and 7) obtained no dissatisfaction rates, showing high averages — 3.0 (SD 1.06) and 3.07 (SD 1.12), respectively —, unlike previous studies. Thus, the WALANT technique can be considered comfortable. Pain, thirst, or drowsiness also obtained no dissatisfaction rates in this study, receiving mentions in previous studies.[8,10,11,14] The exclusive application of the WALANT technique dispensed with sedation or any other anesthesia, prolonged fasting, or sedatives. Thus, patients showed no such complaints, reinforcing the comfort that the WALANT technique provides in minor procedures.

Moura et al.[11] found higher rates of dissatisfaction in women. The 86.7% prevalence of female patients in this study (p-value< 0,001) showed no correlation with worse indices. The predominance of females in this study stems from the fact that the main diseases the WALANT technique treat occur more prevalently in women, who encompass 80% of the cases of carpal tunnel syndrome[19] and up to 95% of those of De Quervain tenosynovitis.[20] Other analyzed factors that could have negatively influenced outcomes included previous anesthesia and local anesthesia. In total, 93.3% of patients (p-value < 0.001) reported previous anesthesia and 76.7%, (p-value < 0.001) local anesthesia. However, despite most patients having previous knowledge, this failed to obtain an unsatisfactory evaluation of the WALANT technique. On the contrary, the overall average showed satisfaction and approved its use.

The lowest positive index this study obtained refers to question 9 — "the surgery was postponed to another day", with a mean of 1.47 (SD 0.81). Since the surgery of most patients showed no postponement, this question steered away from the final agreement standard, differing from the general satisfaction average. Rather than reflecting negatively on the service, it exemplifies its commitment and organization. Moreover, the low rate of postponement of surgeries evinces the ease, greater applicability, and lower risks related to anesthesia despite comorbidities.[3,5,21]

The questions 4,5,12,17,19, and 21 showed the highest satisfaction rates. Questions 4 and 5 refer to explanations given in the consultation prior to surgery, showing satisfaction rates of 3.77 (SD 0.42) and 3.70 (SD 0.46), respectively. Question 17 — "anesthesia took place exactly as the physician had explained" — had a 3.70 satisfaction index (SD 0.53), i.e., patients easily understood the entire process of anesthesia with WALANT. Questions 19 and 21 show patient satisfaction toward the care and assistance from the surgical team, with indices equal to 3.70 (SD 0.44) and 3.77 (SD 0.50), showing that the satisfactory result of the entire process also involves the intraoperative care offered to patients. Thus, providing clear and easy-to-understand information and good care during surgery will influence good results and satisfaction.

Item 12 — "feeling alone bothered you" — obtained a good satisfaction index of 3.70 (SD 0.59), differing from the results in Schiff et al.[10] as the patients in this study reported no such discomfort. The service of this study performed the surgeries in a day hospital, in which patients stayed with their companion up to the moment of entering the operating room, reuniting with them soon after the procedure. The positivity of this evaluation reiterates good indicators for the WALANT technique.

Some limitations in this study stem from its relatively small (n=30) and predominantly female and poorly educated sample and the application of the questionnaire by interview. Moreover, standardization only included surgeries to treat the three chosen conditions, limiting the demonstration of the WALANT technique. This study also ignored cost-benefit since previous studies had shown it.[1,7,22] A future alternative would include expanding research by analyzing more patients with other diagnoses and hospital costs from the WALANT technique without sedation in comparison to other anesthestic methods.

However, the modified questionnaire usefully assessed the satisfaction of patients subjected to the WALANT technique, with satisfactory results in favor of its use.

CONCLUSION

Several countries perform minor hand surgeries with the WALANT technique (the patient awake and without sedation) increasingly more often. It shows proven safety, efficacy, and accessibility.

This study complemented the efficiency of the WALANT technique by showing the high level of satisfaction of patients operated with this anesthetic technique, justifying its use in outpatient surgeries within the public system.

Moreover, evaluating patient satisfaction goes beyond analyzing surgical results: analgesia, welcoming, and perception of the quality of service and care should also receive prioritization.

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ANNEX 1. QUESTIONÁRIO DE HEIDELBERG MODIFICADO

A. Identificação do paciente:

- Sexo
- Idade
- Escolaridade
  - Analfabeto ou fundamental incompleto
  - Fundamental completo
  - Ensino médio completo
  - Superior incompleto ou completo
- Anestesias anteriores

B. Questionário:

(Avaliação: 1- Discordo totalmente; 2 – discordo; 3- concordo; 4- concordo totalmente)

1. Antes da cirurgia, o contato com o médico foi efetuado num ambiente agradável
2. O médico, que o contactou antes da cirurgia, deveria ser mais simpático
3. O médico, que o contactou antes da cirurgia, parecia estar com pressa
4. O médico, que o contactou antes da cirurgia, não deu informação suficiente
5. A informação dada pelo médico, que o contactou antes da cirurgia, foi fácil de entender
6. O medo da anestesia foi importante para si
7. O medo da cirurgia foi importante para si
8. Na noite antes da cirurgia sentiu-se calmo
9. A cirurgia foi adiada para outro dia
10. Antes da cirurgia sentiu um medo incontrolável
11. O tempo de espera no dia da cirurgia foi longo
12. Sentir-se sozinho/a incomodou-o/a.
13. O medo ou agitação no momento antes da anestesia foi importante
14. A sede antes da anestesia foi um problema para si
15. Sentiu frio ou tremor na sala onde foi anestesiado/a.
16. Dor antes da anestesia causou-lhe ansiedade.
17. A anestesia decorreu exatamente como o médico tinha explicado.
18. O ambiente na sala onde foi anestesiado/a era agradável.
19. Os membros da equipe cuidaram bem de si e foram prestáveis enquanto era anestesiado/a
20. Não teve dor nenhuma ou quase nenhuma noutras áreas do corpo após a cirurgia (por exemplo, cabeça).
21. Os membros da equipa mostraram que estavam verdadeiramente preocupados com a sua dor.
22. Os membros da equipe rapidamente aliviaram a sua dor.

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W-SITTING IN CHILDHOOD: A SYSTEMATIC REVIEW

SENTAR EM W NA INFÂNCIA: UMA REVISÃO SISTEMÁTICA

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ABSTRACT

Objective: Despite the lack of science-based evidence, many specialists and non-specialists consider W-sitting detrimental to children. This systematic review aims to find evidence on W-sitting. Methods: This review was registered on PROSPERO under the number CRD42022313341. During January 2023, the term "W-sitting" and its variations were searched on the following databases: PubMed, Medline, Embase, PEDro, and Cochrane. Duplicate articles and those that addressed themes other than W-sitting were removed. Results: This review found 3641 articles, removed 614 duplicates, and excluded 3021 for focusing on subjects other than W-sitting. It included seven studies for analysis, one of which was a narrative review and two were methodologically inadequate cross-sectional to evaluate the causal effect in W-sitting. Another article evaluated muscular activation in adults according to sitting position. The last article found no causal relation between W-sitting and developmental dysplasia of the hip. Conclusion: This review found no scientific evidence advise against W-sitting in children and no association with hip dysplasia. Moreover, muscular activation remains the same, regardless of the position chosen for sitting. ***Level of evidence III, review article.***

Keywords: Child Development Deviation. Sitting Position. Systematic Review. W-sitting.

RESUMO

Objetivos: Apesar da falta de evidências científicas, muitos especialistas e não-especialistas consideram danoso para a criança sentar-se em W. Esta revisão sistemática tem o objetivo de encontrar evidências científicas sobre o tema. Métodos: esta revisão está registrada no PROSPERO sob o número CRD42022313341. Durante o mês de janeiro/2023, o termo "W-sitting" e suas variações foram buscadas nas seguintes bases de dados: PubMed, Medline, Embase, PEDro e Cochrane. Artigos duplicados e sem relação com o tema foram removidos. Resultados: 3641 artigos foram encontrados, 614 duplicados foram removidos, e 3021 foram excluídos por não terem relação com o tema. Sete foram incluídos para análise. Um artigo era uma revisão narrativa. Dois artigos eram transversais, metodologicamente inadequados para avaliar os efeitos causais de sentar em W. Outro artigo avaliou a ativação muscular em adultos de acordo com a posição em que se senta. O artigo final concluiu que não há relação causal entre se sentar em W e displasia do desenvolvimento do quadril. Conclusão: não foi encontrada evidência científica para se recomendar evitar que uma criança se sente em W; não há associação com displasia do quadril; a ativação muscular é a mesma, independentemente da posição de sentar. ***Nível de evidência III, artigo de revisão.***

Descritores: *Desvios do Desenvolvimento Infantil. Posição de Sentar. Revisão Sistemática. Sentar em W.*

INTRODUCTION

W-sitting or "television sitting" is a position in which children perform flexion, adduction, and maximal internal rotation at the hip when sitting on the floor. From above, their legs make the shape of a W. Children aged from three to six years usually prefer it as it offers more comfort for those with increased joint mobility and anteversion of the proximal femur (the degree the femoral neck and head point transversally forward), which occurs physiologically at this age.[1,2] In contrast, sitting in a cross-legged position is more natural for those with decreased femoral anteversion or for whom sitting in a W shape would be painful or impossible.[1,2]

Despite the lack of science-based evidence against this sitting position, most physical therapists, occupational therapists, teachers, and several other healthcare and education professionals advise against it; a sentiment present across multiple internet sources.[3-6] This systematic review aims to identify any evidence for or against W-sitting that warrants consideration when advising for or against this sitting position.

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This study was conducted at Instituto de Ortopedia e Traumatologia do Hospital das Clinicas at Universidade de Sao Paulo.
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<< SUMÁRIO

METHODS

This review is registered on PROSPERO under the number CRD42022313341.

During January 2023, two independent researchers (DN and CP) performed a search on the PubMed, Medline, Cochrane Library, Embase, and PEDro databases by using the terms "W-sitting," "W sitting," "Television sitting," and "W-shape sitting." The results according to those keywords are shown in Table 1 and Figure 1. A third reviewer (PM) reviewed the articles considered for inclusion.

Table 1. Findings according to keywords.

Keyword/Database	PubMed	Medline	Cochrane	Embase	PEDro
W-sitting	6 (3 obtained)	2 (1 new article)	1 (0 obtained)	9 (4 found, 1 retrieved)	4 (0)
W sitting	487 (5, 1 new article)	2804 (no new articles)	223 (0 obtained)	9 (5 found, 2 retrieved)	4 (0, no new articles)
Television sitting	0	20 (0)	60 (0 obtained)	5 (1 found, 0 retrieved)	5 (1 new, 0 retrieved)
W-shape sitting	1 (no new articles)	0	0	1 (1 found, 0 retrieved)	0

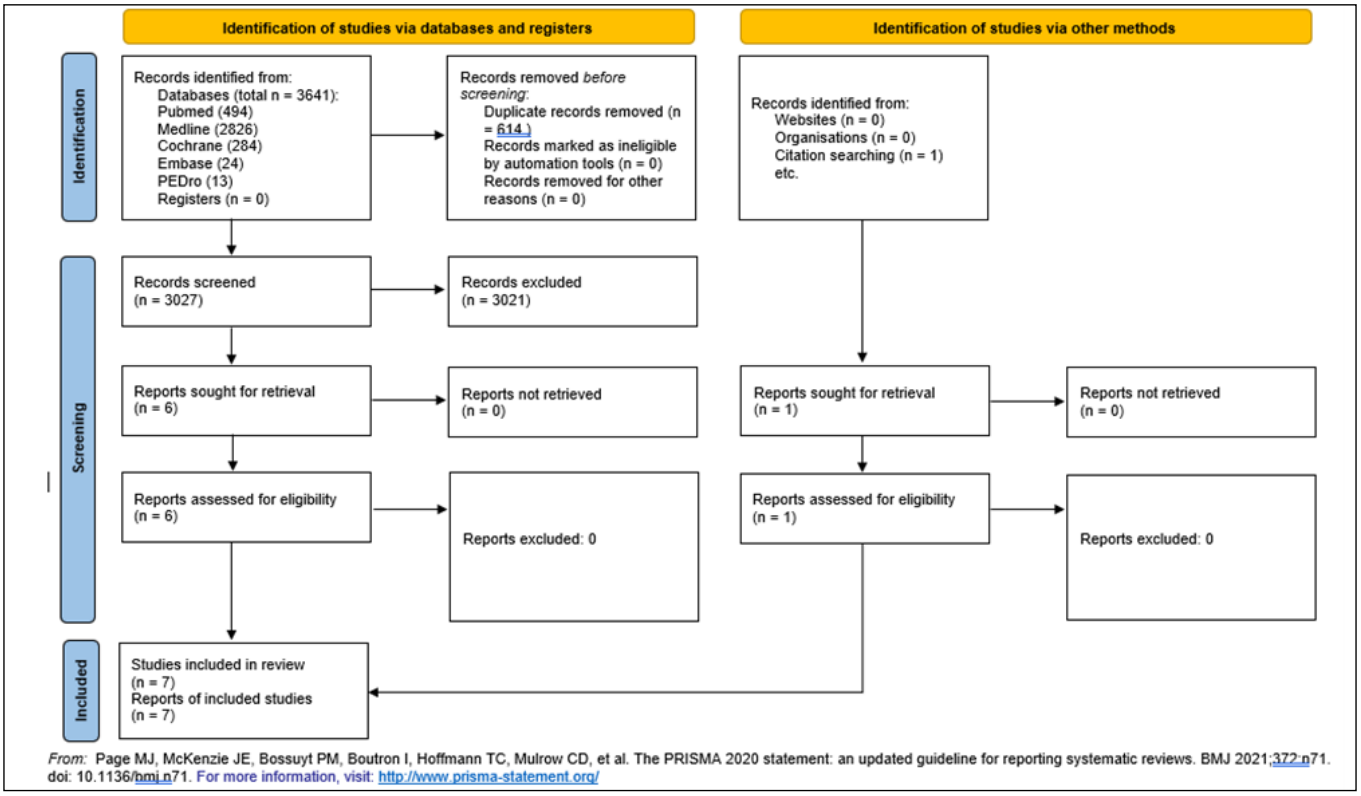

Figure 1. Flow diagram for systematic review.

A search on Google Scholar was also performed. However, most of its articles were opinion texts and content from blogs or websites — including no clinical studies other than the ones that had already been found on other platforms. Therefore, this search was ignored in the systematic review.

The following inclusion criteria were considered: the article must concern W-sitting. Clinical studies were preferred. Still, reviews, case reports, and even specialists' opinions were included. No language or date limitations were applied.

Articles were only excluded from the analysis if they ignored W-sitting in any way. For that, the researcher considered both the title and the abstract; in case of doubts, the article was obtained and thoroughly read. The reviewers showed no disagreements regarding article inclusion.

All relevant information was obtained and included on a Microsoft Excel™ spreadsheet.

After data synthesis and studies categorization as described above, the final report was prepared following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[7]

Risk of bias was described according to the ROBINS I tool for non-randomized studies.[8]

When possible, the articles in this review were also evaluated using the Bradford-Hill criteria[9] to determine causality of a medical condition: strength of association (the observed association between two variables, such as relative risk), consistency (repeating the same test obtains similar results), specificity (cause is specific to the effect, removing the cause reverses or eliminates the effect), temporality (effect comes after its cause), biological gradient (optional, but the more the patient is exposed to a specific variable, the more effect it causes), plausibility (whether the cause and the effect are biologically plausible), coherence (whether their association is coherent with current medical knowledge), experiment (causation proved by earlier experiments), and analogy (if the causative association is possible by analogy to other similar associations). Healthcare providers should use these criteria when considering whether W-sitting may cause any adverse effects.

<< SUMÁRIO

RESULTS

The first search strategy was to use the terms "W-sitting" and "W sitting" as keywords. This review selected and retrieved six articles[10-15]. A thorough reading and reference review found one more article. Altinel et al.[16] used the term "Television sitting," which was also used as a new search strategy, but it obtained no other articles. Lee et al.[11] used the term "W-shape." Thus, we performed a new search using "W-shape sitting" as a new keyword but it retrieved no other articles.

The number of findings using "W-sitting" and "W sitting" as keywords considerably differ for the search engine considers "W" and "Sitting" as two different words in the latter, thus retrieving articles that use "W' mostly as an abbreviation for "Women." Thus, using "W Sitting" as a new keyword obtained no new articles, and further research may be performed by using solely the term "W-sitting."

Table 2 shows the seven articles included for analysis:

Table 2. Characteristics and most relevant information of each article obtained for analysis.

Main author and year of publication	Methods	Results	Considerations
Altinel, 2007.[16]	Study design: Cross-sectional, observational study. Variables: Evaluation of gait, in-toeing, hip range of movement (ROM) and sitting habits. Population: 1134 children aged from three to six years.	5.9% of children showed in-toeing, and 75% were bilateral. In-toeing was 2.4 times more common in girls, and 75% were related to femoral anteversion. It is associated with increased internal rotation and decreased external rotation of the hips. 37% of the children sat in a cross-legged position, and 63% in W-shape. W-sitting was associated with in-toeing (p=0.001)	As in any cross-sectional study, it is possible to associate W-sitting with in-toeing but not to infer causality.
Chen, 2010.[10]	Study design: Cross-sectional, observational study. Variables: Evaluation of feet arches, joint laxity, and W-sitting. Population: 1538 children.	29.7% of children showed joint laxity and 17.3% W-sat. 46.7% of the children with bilateral flat feet presented with joint laxity and 41.2% of those with bilateral flatfeet W-sat.	Despite no evident causality, the authors consider W-sitting as a cause for flatfeet.
Lee, 2017.[11]	Study design: Cross-sectional, observational study. Variables: Muscular activation (external oblique, *rectus abdominis*, *latissimus dorsi*, *erector spinae*) in four sitting positions (cross-legged, side, long, W-shaped) *Population:* 8 adults.	No significant difference in muscle activation in the evaluated sitting positions: cross-legged, side, long, W-shaped.	Empirical evidence that W-sitting leads to no abnormal muscle activation and, therefore, development (by extrapolation). The authors concluded that more studies are necessary.
Goldstein, 2019.[12]	Study design: Retrospective cohort. Variables: developmental dysplasia of the hip; W-sitting status and duration; hip angles. Population: 27 children (11 W-sitters and 16 non-W-sitters).	No correlation between W-sitting and developmental dysplasia of the hip.	Meeting abstract; preliminary findings for the article below (Rethlefsen, 2020).
Rethlefsen, 2020.[13]	Study design: Retrospective cohort. Variables: developmental dysplasia of the hip; W-sitting status and duration; hip angles. Population: 104 children (18 with and 86 without hip dysplasia); 48 W-sat.	No correlation between W-sitting and developmental dysplasia of the hip.	Compatible with clinical findings in the pediatric orthopedics.
Honig, 2021.[14]	Study design: Narrative review. No specification of literature research methodology.	Considers that W-sitting should not be prohibited.	Most arguments were based on literature on normal child development and on Rethlefsen 2020.
Lamari, 2022.[15]	Study design: Retrospective cohort. Variables: psychosocial and characteristics of patients with joint hypermobility. Population: 482 children and adults with hypermobility.	Around 55% of patients with joint hypermobility are or were able to W-sit.	Authors associated W-sitting with no complications.

The level of evidence in the included articles — three cross-sectional observational studies, three retrospective cohort studies, and one narrative review — is considerably low. Only one (considering Goldstein[12] and Rethlefsen[13] as the same study) had an appropriate methodology to investigate causation between W-sitting and orthopedic conditions or complications. The lack of good data became more evident by evaluating the articles by the Bradford-Hill criteria (table 3).[9] This review ignored the analysis of two articles (Honig et al.[14] and Goldstein et al.)[12] by the Bradford-Hill criteria. Honig et al.[14] was unsuitable for them and Goldstein et al.[12] was only an abstract of the complete study in Rethlefsen et al.[13]

Most studies in this review inadequately proved causality between W-sitting and complications according to the Bradford Hill criteria. Finally, this review applied he ROBINS I tool[8] for assessing risk of bias in non-randomized studies to Rethlefsen[13] since it was the only suitable article for such an analysis (a retrospective cohort designed to specifically assess the association between W-sitting and developmental dysplasia of the hip [DDH]). It showed a low risk of bias.[13] (Figure 2).

Table 3. Bradford Hill Criteria applied on the articles included in this systematic review.

Criteria	Altinel, 2007[16]	Chen, 2010[10]	Lee, 2017[11]	Rethlefsen, 2020[13]	Lamari, 2022[15]
Strength	Cross-sectional studies can calculate prevalence ratios, rather than risk ratios. This type of study cannot prove causality.			Cohort studies can calculate relative risk. Strength is higher.	
Consistency	Although all these studies are reproducible, none have been reproduced in other populations yet.				
Specificity	The methodologies of the studies are insufficient for a specific association between cause and effect (factors of confusion remained uncontrolled).		The design of the chosen studies sufficiently showed specificity.		This study was not designed to evaluate W-sitting.
Temporality	Impossible to assert that cause precedes effect in time due to the observational study design.			Adequate methodology in study design (retrospective cohort).	
Biological gradient	The design of the chosen studies are inadequate for biological gradient evaluation.			Adequate methodology (current and past W-sitters).	The design of the chosen studies is inadequate for biological gradient evaluation.
Plausibility	Findings are implausible with the current medical knowledge.		Findings are plausible with current medical knowledge.		
Coherence	Association is incoherent with the current medical knowledge.		Association is coherent with current medical knowledge.		
Experiment	The methodologies of the studies prohibit causality tests.			Can test for causality, but a prospective study would be preferable	This study was not designed to evaluate causality in W-sitting.
Analogy	Analogies are incompatible with current medical knowledge.		Analogies are compatible with current medical knowledge.		

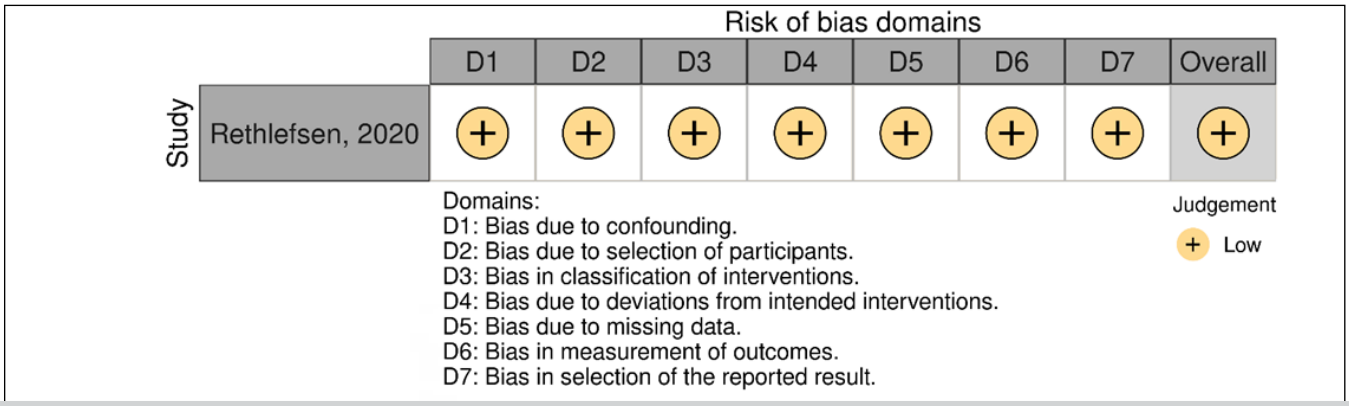

Figure 2. ROBINS I tool for non-randomized studies for W-sitting.

DISCUSSION

The discussion of W-sitting and its detrimental effects on children is old and persistent. Finding the origin of such assumptions offers a difficult task. We suspect anecdotes in which the habit of W-sitting was initially associated with muscular abnormalities in cerebral palsy patients formed the basis of a belief in the harmful effects of W-sitting. This belief was then likely extended to the neurotypical population without adequate scientific evidence. Most arguments against W-sitting lack empirical evidence or use evidence improperly, as this systematic review has shown.

Out of the six clinical studies included in this systematic review, two associated W-sitting with other orthopedic "complications" (in-toeing [walking with the feet pointed medially] in Altinel[16] and flatfeet in Chen[10]); two repudiated such an association (Goldstein[12] and Rethlefsen[13]); two ignored this relationship (Lamari[15] and Lee[11]), although the latter (Lee) may be considered as arguing against such an association.

Altinel et al.[16] considered W-sitting as a cause for in-toeing. However, not only was the study design inadequate to infer such causality, but it also implausibly considered our current knowledge of the physiological development of children's limbs. All children are born with increased femoral anteversion, which slowly decreases during life, until around 10 years of age.[1,2,17] During normal gait development, the tension of iliofemoral ligaments and muscular recruitment shape the proximal femur into a final anteversion of around 15°. Children with delayed or impaired gait have a persistent femoral anteversion, as in several studies in cerebral palsy patients.[18,19] In typical development, as children grow and femoral anteversion decreases, they tend to stop W-sitting.

Children with increased femoral anteversion enjoy greater comfort W-siting as it increases internal rotation of the hip, whereas a cross-legged position offers more comfort for those with decreased femoral anteversion.[1,2] Moreover, ligament laxity during infancy may also contribute to an increased range of motion at the hip, raising internal rotation and W-sitting, as in Lamari et al.[15] Ligament laxity may be restricted to a specific joint (or more than one) or may affect every or most tissues, thus causing a hypermobility syndrome.

Chen et al.[10] intended to correlate joint laxity, flatfeet, and W-sitting. Again, their cross-sectional study was unable to prove causality. From a biological and mechanical point of view, it is more plausible to consider that a hypermobile hip joint would enable children to more easily W-sit and increase the flexibility of their foot arches.

<< SUMÁRIO

The medical literature has described that the medial longitudinal arch of the feet starts its development by the age of two years, ending at age from seven to 10 years.[20] Up to two years of age, almost all children show flatfeet; and from then on, its prevalence gradually decreases, as does that of joint laxity.[21,22] Chen et al.[10] described the decrease in flatfeet prevalence to happen from ages three to six years by observing children of different ages, rather than by a longitudinal observation. Finally, the principle of temporality discredits Chen's theory; flatfeet occur universally, even before children begin to W-sit and progressively decrease by the time they W-sit. So, following the authors' logic, one might consider that W-sitting "cures" flatfeet.

Similarly, as in Altinel et al.,[16] biological and mechanical plausibility should be considered: is it more likely that W-sitting causes flatfeet or is it more likely that a more intense joint laxity both enable children to W-sit and predisposes them to flat feet?[16] By reviewing the data from their own study, the authors might be able to determine the answer. However, they ignored such analysis.

Lee et al.[11] evaluated muscular activation (i.e., the muscles required during a certain action) in different sitting positions. This is an important analysis since several healthcare providers state (despite lack of evidence) that W-sitting will compromise the development of trunk muscles and children's ability to turn and execute functions with crossed arms (as, for instance, picking up a toy on their left side with their right hand).[14] This study was performed on adults due to the challenge of performing electromyographic analysis in children. Therefore, their findings should not be applied to children without further considerations. Nevertheless, there should exist no reason to think that muscular activation in children would be so different as to render this study irrelevant to children (considering analogy, coherence, and plausibility).

The last study this systematic review included refers to Rethlefsen et al.[13] Goldstein et al.[12] reported the preliminary findings from Rethlefsen et al.[13] The authors performed a retrospective cohort study with 104 children who had received a pelvic X-ray. The patients' parents were asked whether their children used to W-sit and if they still W-sat, for how long they sat in such a position, and when they stopped W-sitting if they stopped. In total, 48 children W-sat. Those authors then analyzed the X-rays of the entire study population were to assessment their center edge angle and acetabular index (measures required for diagnosing DDH in children via X-ray), showing that 18 children had DDH. There was no correlation between W-sitting and DDH. This review analyzed this article by the ROBINS I tool and found its low risk of bias.

This systematic review has some limitations. Despite its comprehensive literature review, the indexed journals published only a few articles. This might lead to a publication bias by disregarding articles published in non-indexed journals. Nevertheless, indexed journals are in effect the highest level of evidence, and the inclusion of non-indexed articles might lead to yet another bias – and thus we decided to ignore them.

After conducting this systematic review and considering the lack of scientific evidence , biological and mechanical plausibility, coherence, and analogy in the studied articles, the authors of this review think that W-sitting fails to harm children's hips or development, and should thus face no restriction. W-sitting occurs commonly in children and rarely in adulthood due to the physiological development of femoral anteversion, which naturally regresses and makes it mechanically impossible to W-sit regardless of postural correction or physical therapy. However, new longitudinal studies should be conducted with adequate methodologies (prospective cohort or a clinical trial) and a large multicentric and multinational population. Furthermore, these future studies should include uniform musculoskeletal criteria for joint hypermobility, flatfeet, DDH, and muscular activation.

CONCLUSION

W-sitting shows no relation with evidence-based developmental dysplasia of the hip. No scientific evidence suggests any other orthopedic deformity. W-sitting results in no evidence-based different trunk muscle activation. More studies must be performed since the current studies show a predominantly low level of evidence and methodological inadequacies to prove harm in W-sitting. Therefore, prohibiting W-sitting in children lacks evidence.

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ENDOSCOPIC SURGERY FOR TREATING SPINAL STENOSIS: AN INTEGRATIVE REVIEW OF RANDOMIZED CLINICAL TRIALS

CIRURGIA ENDOSCÓPICA PARA O TRATAMENTO DE ESTENOSE NA COLUNA VERTEBRAL: REVISÃO INTEGRATIVA DE ENSAIOS CLÍNICOS RANDOMIZADOS

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ABSTRACT

Background: Spinal stenosis refers to the narrowing of the spinal canal which can generate clinical symptoms secondary to the spinal cord injury itself, or even root involvement. The traditional open surgical procedure to correct spinal stenosis is highly traumatic and risky, and with the development of surgical techniques, endoscopic procedures have been widely used in treating said stenosis, achieving good results with minimally invasive management. Aim: To conduct a literature review regarding endoscopic techniques for correcting spinal stenosis. Method: This is an integrative literature review that surveyed the PUBMED database using the following search strategy: spinal[title] AND stenosis[title] AND surgery[title]. Only randomized clinical trials published in the last 10 years were included in the sample. Results: A total of 13 articles were identified that met the previously established search strategy, all of which were included in the review. Conclusion: The reviewed studies showed that endoscopic surgery to correct spinal stenosis could offer adequate decompression of neural elements, resulting in shorter hospital stays, faster recovery and favorable operative results. ***Level of Evidence IV, evidence from descriptive (non-experimental) or qualitative studies.***

Keywords: Spine. Stenosis. Endoscopic Surgery. Minimally Invasive Surgery.

RESUMO

Introdução: O termo estenose na coluna vertebral se refere ao estreitamento do canal vertebral, que por sua vez pode gerar sintomas clínicos secundários à própria lesão medular, ou mesmo ao comprometimento radicular. O procedimento cirúrgico aberto tradicional para correção da estenose vertebral é altamente traumático e arriscado, e com o desenvolvimento das técnicas cirúrgicas, os procedimentos endoscópicos têm sido amplamente utilizados no tratamento da referida estenose, alcançando bons resultados com manejos minimamente invasivos. Objetivo: Realizar uma revisão da literatura a respeito das técnicas endoscópicas para correção da estenose vertebral. Método: Trata-se de uma revisão integrativa da literatura que utilizou como fonte a base de PUBMED, utilizando a seguinte estratégia de busca: spinal[title] AND stenosis[title] AND surgery[title]. Apenas ensaios clínicos randomizados publicados nos últimos 10 anos foram incluídos na amostra. Resultados: Foram identificados 13 artigos que atenderam à estratégia de busca previamente estabelecida, todos incluídos na revisão. Conclusão: Os trabalhos revisados apontaram que a cirurgia endoscópica para correção da estenose espinal poderia oferecer uma descompressão adequada dos elementos neurais, resultando em menor tempo de internação hospitalar, recuperação mais rápida e resultados operatórios favoráveis. ***Nível de Evidência IV, evidências de estudos descritivos (não-experimentais) ou com abordagem qualitativa.***

Descritores: *Coluna Vertebral. Estenose. Cirurgia Endoscópica. Cirurgia Minimamente Invasiva.*

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<< SUMÁRIO

INTRODUCTION

Spinal stenosis refers to the narrowing of the spinal canal which in turn can generate clinical symptoms secondary to the spinal cord injury or even root involvement. It can involve the cervical, thoracic (rarely), or lumbar spine, presenting as monosegmental or multisegmental (adjacent or not) and unilateral or bilateral. Cervical or thoracic spinal stenosis can cause root and spinal cord compression, resulting in pain, radiculopathy, myelopathy, or myeloradiculopathy. Lumbar spinal stenosis (LSE), the most common of the three, causes only root compression with typical complaints of neurogenic claudication or radicular leg pain.[1]

LSE incidence is four times higher than that of cervical stenosis, totaling five cases per 100,000 individuals, and both coexist in 5% of patients. Up to 14% of patients who seek specialized care for low back pain have spinal stenosis and some degree of the disease is present in up to 80% of patients over 70 years old, when evaluated by imaging techniques. Distinction between narrowing of the canal and stenotic symptoms should be emphasized, as one-fifth of asymptomatic individuals over 60 years old show stenosis on MRI.[1,2]

Spinal stenosis diagnosis is based on the patient's history and confirmed by imaging tests. However, physical examination is often not useful in recognizing LES, and neurophysiological studies can help confirm a coexisting pathology or aid in the differential diagnosis, particularly for polyneuropathies of various causes. Additionally, clinical presentation may be complex in a minority of patients with cervical and lumbar stenosis.[1,3]

Knowledge of the natural history of the disease is fundamental in determining the most appropriate course of treatment. As significant spontaneous improvement is unlikely to occur, intolerable symptoms warrant a more aggressive treatment strategy. Progressive disease is expected for both cervical and lumbar stenosis, probably more dramatically in the former, so the treatment goal should be primarily to halt progression. Nonoperative management includes: exercises, girdles, analgesics, and physical therapy. However, bed rest is no longer considered a treatment alternative. Spinal stenosis surgery is indicated for patients who have been severely symptomatic for a reasonable period of time (most authors consider at least three months). Its biomechanical goal is to relieve pressure on both the spinal cord/thecal sac and nerve roots without causing instability. The clinical goal is to provide pain relief and prevent disease progression by allowing for reversal of neurological deficits if present.[1,4]

In certain cases, and due to the specific anatomical features of the spine, surgery is the only effective treatment; however, the traditional open procedure is highly traumatic and risky, despite being considered the gold standard for treating spinal stenosis. With the development of surgical techniques, endoscopic technology (represented by the transforaminal endoscopic surgical system) has been widely used to treat vertebral diseases, achieving good results with minimally invasive management since the beginning of the last decade. Based on this, national and foreign specialists have been using endoscopic techniques to treat spinal stenosis routinely.[4,5]

Given this context, this integrative review synthesizes the results of randomized clinical trials that described spinal stenosis treatment with endoscopic surgical techniques.

MATERIAL AND METHOD

This is an exploratory study integrative literature review with evidence synthesis. Based on Souza et al.,[6] the review was divided into the following six steps: 1 - elaboration of guiding question; 2 - bibliographic search or sampling; 3 - data collection; 4 - critical analysis of included studies; 5 – discussion of results; and 6 – presentation of the integrative review. Fulfilling the first step, we formulated the following guiding question: "What are the main endoscopic methods for treating spinal stenosis?"

For the bibliographic search for sampling, we surveyed the PUBMED database using the following search strategy: *spinal[title] AND stenosis[title] AND surgery[title]*. Only clinical trials published in the last 10 years were included in the review.

RESULTS

Data collection took place in September 2023. Initial search identified 13 studies that met the previously established strategy. Continuing with the critical analysis of the included studies, the titles and abstracts were read resulting in no article excluded.

DISCUSSION

In this section we discuss the review results by presenting each of the selected articles individually, compiling their proposals, methodology, main results and conclusions. The articles are presented in chronological order based on publication year.

Usman et al.[7] evaluated the feasibility and efficacy of a new minimally invasive spinal surgery technique for LES correction involving a unilateral approach to bilateral decompression. For this purpose, they conducted a single-center cross-sectional observational study from January to December 2010. The study included 60 patients with LES who were randomized to undergo either conventional laminectomy (30 patients, Group A) or unilateral endoscopic approach (30 patients, Group B). Clinical outcomes were measured using the Finneson and Cooper scale. All data were collected using *pro forma*. Different parameters were evaluated for a minimum follow-up period of three months, and were analyzed by descriptive statistics using SPSS version 17. Adequate decompression was achieved in all patients. Compared with the subjects in the conventional laminectomy group, those who received the new procedure (unilateral approach) had a reduced average hospital stay, a faster recovery rate and most patients (88.33%) had an excellent to reasonable operative outcome, according to the Finneson and Cooper scale. Five major complications occurred in all patient groups: two had unintentional dural rupture, two had wound dehiscence, and the fifth patient had worsening symptoms. There was no mortality in the series. According to the authors, the ultimate goal of the unilateral endoscopic approach to treat LES was to achieve adequate decompression of the neural elements. An additional benefit of a minimally invasive approach was the adequate preservation of vertebral stability, as it required only minimal muscle trauma, preserved the supraspinatus/infraspinatus ligament complex and the spinous process; therefore, it allowed for early mobilization. This also shortened the length of hospital stay, reduced postoperative back pain, and led to satisfactory results.

Delitto and collaborators[8] compared surgical decompression with physical therapy (PT) for LES, also evaluating the differences between genders. They conducted a multicenter randomized controlled trial with LES surgery candidates aged 50 years or older who were randomized to endoscopic surgical decompression or PT. Primary outcome was the physical function score on the *Short Form-36 Health Survey* after two years, evaluated by masked testers. The study took place from November 2000 to September 2007 and had a total of 169 participants who were randomly assigned and stratified by surgeon and gender (87 for surgery and 82 for PT), with a 24-month follow-up completed by 74 and 73 participants in the surgery and PT groups, respectively. Mean improvement in physical function for the surgery and PT groups

was 22.4 and 19.2, respectively, and intention-to-treat analyses revealed no difference between the groups. Sensitivity analyses using causal effects methods to explain the high proportion of crossovers from PT to surgery (57%) showed no significant differences in physical function between the groups. As a limitation, the researchers stated that without a control group it was not possible to assess success attributable to any of the interventions. According to the authors, endoscopic surgical decompression produced effects similar to a PT regimen among patients with LES who were candidates for surgery. Additionally, patients and healthcare providers should participate in shared conversations for decision-making that includes full disclosure of evidence involving surgical and nonsurgical LES treatments.

Marchand et al.[9] commented that in LES, although the benefits of surgery outweighed those of conservative approaches, physical rehabilitation could be used to improve function and minimize the risk of persistent dysfunction. Within this context, the group developed a study protocol to establish the feasibility of a large-scale randomized clinical trial and to evaluate the efficacy of an active preoperative intervention program in improving clinical parameters and functional physical capacity in patients undergoing endoscopic surgery for LES. To this end, 40 patients were recruited and randomly allocated to one of two treatment arms: a six-week supervised preoperative rehabilitation program (experimental group) or standard hospital preoperative management (control group). The intervention group trained three times a week, with each session aimed at improving strength, muscular endurance, spine stabilization, and cardiovascular fitness. Exercise intensity and complexity were gradually increased throughout the sessions, depending on the individual progress of each participant. Primary outcomes were the level of lumbar disability and the level of pain. Secondary outcomes included the use of analgesics, quality of life, patient's global impression of change, endurance of the lumbar extensor muscles, maximal voluntary contraction of the lumbar flexor and extensor muscles, maximal voluntary contraction of the knee extensors, active lumbar ranges of motion, walking skills and cardiovascular capacity. Primary and secondary outcomes were measured at baseline, at the end of the training program (six weeks after baseline assessment for control participants), and at six weeks, three, and six months postoperatively. According to the authors, their study informed the design of a future large-scale trial on the topic. Additionally, improvements in patients' physical performance before undergoing endoscopic lumbar surgery could limit the functional restrictions that occurred after a surgical intervention. The results of this study would provide the opportunity to efficiently improve spine care and advance the knowledge of favorable preoperative strategies to optimize postoperative recovery.

Försth et al.[10] randomly assigned 247 patients between 50 and 80 years of age who had LES at one or two adjacent vertebral levels to undergo endoscopic decompression surgery plus fusion surgery (fusion group) or endoscopic decompression surgery (decompression group). Randomization was stratified according to the presence of preoperative degenerative spondylolisthesis (in 135 patients) or its absence. Outcomes were assessed using patient-reported outcome measures, a six-minute walk test, and an economic health assessment. Primary outcome was the score on the *Oswestry Disability Index* (ODI; ranging from 0 to 100, with higher scores indicating more severe disability) two years after surgery. Primary analysis, which was a per-protocol analysis, excluded the 14 patients who did not receive the assigned treatment and the five who were lost to follow-up. No significant difference was observed between the groups regarding the mean ODI score after two years (mean of 27 in the fusion group and 24 in the decompression group) or the six-minute walk test results (mean of 397 m in the fusion group and 405 m in the decompression group). Results were similar between patients with and without spondylolisthesis and between patients who had five years of follow-up and were eligible for inclusion in the five-year analysis. There were no significant differences between the groups in clinical outcomes. Mean length of hospital stay was 7.4 days in the fusion group and 4.1 days in the decompression group. Operation time was longer, the amount of bleeding was higher, and surgical costs were higher in the fusion group than in the decompression group. During a mean follow-up of 6.5 years, additional lumbar spine surgery was performed in 22% of patients in the fusion group and in 21% of those in the decompression group. Among patients with LES, with or without degenerative spondylolisthesis, endoscopic decompression surgery plus fusion surgery did not result in better clinical outcomes at two and five years than endoscopic decompression surgery alone.

Kesänen et al.[11] evaluated the impact of preoperative knowledge on anxiety, health-related quality of life (HRQoL), disability, and pain in patients with spinal stenosis treated via endoscopic surgery. For this purpose, 100 patients were randomized into an intervention group (IG, n = 50) or a control group (CG, n = 50). Both groups received routine preoperative education and the IG also underwent a feedback session based on a knowledge test. Primary outcome was anxiety at the time of surgery. HRQoL, disability, and pain were the secondary outcomes measured during a six-month follow-up. IG showed a significant reduction in anxiety after the intervention, whereas in the CG anxiety was reduced only after surgery. Both groups had significant improvement in HRQoL, disability, and pain at the six-month follow-up, but without statistically significant differences between the groups. According to the authors, a higher level of knowledge could reduce preoperative anxiety, but it did not seem to affect self-reported clinical surgery outcomes.

Kang and collaborators[12] evaluated the feasibility of spinal decompression using the biportal/endoscopic technique compared with microscopic surgery. To this end, 70 patients with LES who underwent laminectomy were included in this study. A numerical table was used to randomize the subjects into two groups: a biportal/endoscopic technique group (BG, n = 36) and a microscopic surgery group (OG, n = 34). A surgeon performed the biportal/endoscopic technique or microscopic decompression with a tubular retractor, depending on the group to which the patient was randomized. Perioperative data and clinical outcomes in the six-month postoperative period were collected and analyzed. Demographics and level of surgery were comparable between the two groups, with shorter operation time (mean 36 ± 11 *versus* 54 ± 9 min), lower Hemovac drain flow rate (mean 25.5 ± 15.8 *versus* 53.2 ± 32.1 ml), lower opioid use (mean 2.3 ± 0.6 *versus* 6.5 ± 2.5 T) and shorter hospital stay (mean 1.2 ± 0.3 *versus* 3.5 ± 0.8 days) shown in the BG group. However, this group did not present significant differences in clinical results compared to OG and favorable clinical results were observed six months after surgery in both groups. Lumbar decompression surgery using the biportal/endoscopic technique presented favorable clinical results, less pain, and shorter hospital stay compared with microscopic surgery in patients with LES.

Kesänen et al.[13] evaluated the effect of a specific approach to preoperative education (Knowledge Test Feedback Intervention - KTFI) in the verbal and visual comprehension of patients about endoscopic spinal surgeries. They conducted a randomized clinical trial with an intervention group (n = 50) that underwent KTFI and routine education, whereas the control group (n = 50) received only routine patient education. Written description of the surgical procedure and incision design were used as outcome measures at baseline, hospitalization, and discharge at three and six months after surgery. At baseline, half of the participants demonstrated verbal

and visual understanding of their surgery and during follow-up, comprehension improved significantly, with no statistically significant differences between the groups. According to the authors, the understanding of patients with spinal stenosis about the surgical procedure was imperfect and educators would need to ensure patient learning by evaluating their comprehension results.

Marchand and collaborators[14] evaluated the feasibility of conducting a preoperative intervention program with LES patients and reported on the management of the proposed intervention. Patients were allocated to a six-week supervised preoperative rehabilitation program or to a control group. The intervention included supervised exercise sessions aimed at improving the subjects' strength, muscular endurance, and spinal stabilization. Outcomes were measured at baseline, six weeks before and again six weeks after, three months, and six months after endoscopic surgery. 65% of the eligible participants agreed to participate in the study, of which 5% withdrew before the end of the intervention period. 88% of the possible training sessions were conducted without adverse events. Improvements were observed in favor of the experimental group in the preoperative assessment for active ranges of motion, leg pain intensity, lumbar extensor muscle endurance, and walking capabilities. According to the authors, the results showed that small modifications in the choice of outcome measures would increase the viability of the main study, which has already been discussed in our study. Absence of adverse events, along with positive changes observed in the outcome dependent measures, would warrant conducting a large-scale trial evaluating the efficacy of this type of intervention.

Lee et al.[15] evaluated, through a prospective randomized study, the impact of posterior epidural adipose tissue (PAT) on the postoperative outcome of lumbar endoscopic decompression surgery for LES, verifying whether PAT was removed or preserved during the surgical procedure. Of the 185 eligible patients selected for the study, 181 patients were enrolled and randomly allocated to group A (PAT removal, n = 90) or group B (PAT retention, n = 91). Primary outcome was pain intensity in the lower back and lower extremities. Secondary outcomes were functional outcomes based on ODI and distance covered, complications during the surgical procedure, and surgical outcomes. Intensity of postoperative pain in the lumbar region and lower limbs was higher in group A than in group B. Functional status in the ODI and in the distance covered was also worse in group B than in group A (64.9% in group A and 66.2% in group B). The number of patients with worsening pain intensity and deterioration of functional status in the postoperative follow-up was significantly higher in group A than in group B. There were no significant differences in surgical outcome and complications between the groups. According to the authors, retention of epidural fat could be favorable in the postoperative results of posterior endoscopic decompression surgery for LES compared with its removal.

Marchand and collaborators[16] re-evaluated the effectiveness of a preoperative exercise-based intervention program compared with usual care in improving the clinical status, physical capacities, and postoperative recovery of patients waiting for LES endoscopic surgeries. To this end, 68 participants were randomized to receive a six-week supervised exercise-based pre-habilitation program or usual hospital care. Results included clinical and physical measures and data collection occurred at the post-intervention and at six weeks, three and six months after surgery. Significant but small improvements were found in favor of the experimental group in the post-intervention assessment for pain intensity, LES-related disability, lumbar strength in flexion, lumbar extensor muscle endurance, total ambulation time, and sit-to-stand performance. A significant difference in favor of the intervention group was found from the three-month postoperative follow-up for lumbar region-related disability and no adverse events were reported. According to the authors, exercise-based pre-habilitation did not improve the short-term postoperative recovery of patients with LES.

Yüce et al.[17] compared epidural hemostasis in minimally invasive surgeries for spinal stenosis by fat grafting *versus* gelatin sponge. They conducted an *in vivo* prospective randomized controlled trial in humans, with 24 operated levels of LES being evaluated in two groups: Group A (control group: gelatin sponge) and Group B (experimental group: fat graft). International Normalized Ratio and Prothrombin Time were evaluated in the preoperative period, and the number of hemostatic cotton forceps and systolic and diastolic blood pressure were evaluated intraoperatively. The epidural hemorrhage area, spinal cord size, and the ratio of epidural hemorrhage area to spinal cord size were assessed by an early postoperative lumbar MRI. Mean area of epidural hemorrhage in groups A and B was 1.3 ± 0.5 and 1.2 ± 0.6 cm^2, respectively, and the mean size of the spinal cord was 1.2 ± 0.6 and 1.8 ± 0.6 cm^2 on postoperative lumbar axial magnetic resonance imaging. The two groups did not differ significantly regarding the ratio of epidural hemorrhage/spinal cord size or number of intraoperative hemostatic forceps. According to the authors, autologous fat grafting ensured sufficient and safe epidural hemostasis without serious adverse events in minimally invasive spinal surgery, and was preferable because the autologous tissue was harvested easily and quickly. Additionally, the participating surgeons felt safe with this technique and did not require external hemostatic agents.

Yagi and collaborators[18] developed and validated a machine learning model to predict the postoperative outcome of endoscopic decompression surgeries for patients with LES. They conducted a retrospective multicenter study with 848 patients who underwent decompression surgery for LES at three different medical centers, assessing their HRQoL at the beginning of the study and two years after surgery. Subjects were randomly assigned in a 7:3 ratio to a model-building cohort and a test cohort to assess the accuracy of the models. Twelve predictive algorithms using 68 preoperative factors were used to predict each domain of the Japanese Orthopaedic Association Back Pain Assessment Questionnaire (QADC) and visual analogue scale (VAS) scores at two years postoperatively. The final predictive values were generated using a set of the top five algorithms in prediction accuracy. Correlation coefficients of the main algorithms for each domain established using the preoperative factors were excellent (correlation coefficient: 0.95-0.97 [relative error: 0.06-0.14]) and the performance assessment of each QADC domain and VAS score by the set of five main algorithms in the test cohort was favorable (mean absolute error [MAE] 8.9-17.4, median difference [MD] 8.1-15.6/100 points), with the highest accuracy for mental status (MAE 8.9, MD 8.1) and the lowest for numbness in the glutes and legs (MAE 1.7, MD 1.6/10 points). A strong linear correlation was observed between predicted and measured values (linear correlation 0.82-0.89), while 4% to 6% of individuals had predicted values greater than ±3 standard deviations from the MAE. According to the authors, a machine learning model was successfully developed to predict the postoperative outcomes of endoscopic decompression surgeries for patients with LES using subject data from three different institutions. They also stated that thorough analyses for subjects with deviations from the actual measured values could further improve the predictive probability of this model.

Finally, Minetama et al.[19] evaluated whether branched-chain amino acids (BCAAs) plus vitamin D supplementation could attenuate loss of muscle mass and strength, accelerate the return of functional mobility, and improve clinical outcomes after endoscopic lumbar surgery for LES. A randomized, blinded, single-center clinical trial

was conducted with eighty patients who underwent endoscopic lumbar surgery for LES. Primary outcome was the Zurich claudication questionnaire (ZCQ), and secondary outcomes included knee muscle strength, muscle mass measured by bioelectrical impedance analysis, gait speed, and timed up-and-go test (TUG) at 12 weeks postoperatively. Follow-up assessment was performed for the ZCQ at 52 weeks postoperatively. Patients ingested supplementation (BCAA group: BCAA plus vitamin D and amino acid-free group) twice daily for three weeks from the day after surgery, and received two hours of postoperative inpatient rehabilitation five times a week. No significant differences were observed regarding mean changes in ZCQ between the two groups at 12 weeks and 52 weeks postoperatively. Two weeks after surgery, the group without amino acids showed significant deterioration in knee extensor and flexor strength compared with the BCAA group. At 12 weeks, the BCAA group showed significant improvements in knee extensor strength and knee flexor strength compared with the group without amino acids. There were no significant differences in mean changes in muscle mass, maximum gait speed, and TUG after 12 weeks postoperatively between the two groups. According to the authors, BCAA supplementation with vitamin D did not improve clinical outcomes related to LES after endoscopic lumbar surgery, but muscle strength increased. They stated that future studies should focus on long-term outcomes for muscle mass and physical function, including the development of sarcopenia and frailty.

CONCLUSION

Our integrative review revealed that endoscopic surgery to correct spinal stenosis can offer adequate decompression of neural elements, resulting in shorter hospital stays, faster recovery, and favorable operative results. Additionally, the reviewed studies suggest that exercise-based pre-habilitation may be beneficial for some patients but does not have a significant impact on short-term recovery. Decision between endoscopic surgery and other treatment options, such as physical therapy, should be carefully discussed between patients and healthcare professionals considering the available evidence and individual needs. Finally, the use of nutritional supplements such as BCAAs and vitamin D does not seem to have a substantial impact on clinical outcomes after endoscopic lumbar surgery, although patients' muscle strength increased with the procedure.

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