Consecutive Ankle Sprain Classification and Injury Systematization (CASCaIS), A New Lateral Ankle Sprain Classification Based on the Pivot Test: A Prospective Cohort Study

Consecutive Ankle Sprain Classification and Injury Systematization (CASCaIS), Uma Nova Classificação de Entorse Lateral do Tornozelo Baseada no Teste de Pivot: Estudo Prospetivo de Coorte

Francisco GUERRA-PINTO✉[1,2,3], João CAETANO[4], Rita ALÇADA[4], António BRITO CAMACHO[4], Jácome PACHECO[1], Diogo LACERDA[1], Teresa ALVES DA SILVA[4], Nuno CÔRTE-REAL[4], José GUIMARÃES CONSCIÊNCIA[3,5]
Acta Med Port 2022 Jul-Aug;35(7-8):566-577 ▪ https://doi.org/10.20344/amp.13804

ABSTRACT

Introduction: The biggest challenge in the treatment of acute ankle sprain is the uncertainty of the prognosis. The traditional classifications have several interpretations and little correlation with prognosis. In this study we propose a new classification for acute ankle sprain only based on clinical criteria.

Material and Methods: We prospectively evaluated all patients with an ankle sprain, aged between 18 and 45 years, admitted to a hospital during a 24 month period. The minimum follow-up period was 12 months. The sprains were classified, in the first few days (CASCaIS-Initial), according to autonomous gait capacity, inspection and palpation. After a few weeks (CASCaIS-Deferred), it was complemented with the mechanical evaluation of ligaments through the ankle pivot test.

Results: Among the 49 patients who completed the follow-up, none of those who had a pivot-negative test progressed to chronic ankle instability (CAI). Nine of the 33 patients (27%) with a positive pivot progressed to CAI ($p = 0.022$). The evaluation of CASCaIS-Deferred demonstrated an association with CAI ($p = 0.018$).

Conclusion: This classification proved to be a simple, inexpensive, and reliable tool that clinicians can use to determine the prognosis of the sprain.

Keywords: Ankle Injuries; Ankle Lateral Ligament; Prognosis

RESUMO

Introdução: O maior desafio no tratamento da entorse aguda do tornozelo é a indefinição do prognóstico. As classificações clássicas têm várias interpretações e pouca correlação com o prognóstico. Com este trabalho propomos uma nova classificação baseada apenas em critérios clínicos.

Material e Métodos: Foram prospectivamente avaliados doentes entre os 18 e os 45 anos com entorse aguda do tornozelo, admitidos numa instituição durante 24 meses. O seguimento mínimo teve uma duração de 12 meses. Estes doentes foram classificados nos primeiros dias após a entorse (CASCaIS-Inicial) com base na valorização da capacidade de marcha autónoma, inspeção do quadro inflamatório e palpação. Passadas algumas semanas (CASCaIS-Diferida) complementou-se com a avaliação ligamentar pelo teste de *pivot* do tornozelo.

Resultados: Dos 49 doentes que completaram o seguimento, nenhum dos que tinha um teste *pivot*-negativo evoluiu para instabilidade crónica do tornozelo (ICT). Nove dos 33 doentes (27%) com um *pivot*-positivo evoluíram para ICT ($p = 0,022$). A avaliação da CASCaIS-Diferida demonstrou uma associação com a ICT ($p = 0,018$).

Conclusão: Esta classificação demonstrou ser uma ferramenta simples, não dispendiosa e fiável que os clínicos poderão usar para determinar o prognóstico da entorse.

Palavras-chave: Lesões do Tornozelo; Ligamentos Laterais do Tornozelo; Prognóstico

INTRODUCTION

Acute ankle sprains are considered as the most frequent injuries of the ankle, with a significant incidence rate in major team sports,[1] corresponding to around 20% of all sport injuries,[2,3] not exclusively managed by orthopaedic surgeons or physiatrists.[4]

Three different groups of ankle ligaments can be injured: lateral, medial (deltoid) and syndesmotic. Acute sprains are mostly (85%) related to supination,[2,5] leading to an injury of the lateral ligament complex (Fig. 1). Due to this predominance, lateral sprains are often referred to as 'sprains', whereas deltoid and syndesmotic ligament injuries are described as 'medial sprains' and 'high sprains', respectively.

1. Serviço de Ortopedia. Hospital de Sant'Ana. Parede. Portugal.
2. Serviço de Ortopedia. Hospital da Cruz Vermelha. Lisboa. Portugal.
3. NOVA Medical School. Lisboa. Portugal.
4. Serviço de Ortopedia. Hospital Dr. José de Almeida. Cascais. Portugal.
5. Serviço de Ortopedia. Hospital de São Francisco Xavier. Centro Hospitalar Lisboa Ocidental. Lisboa. Portugal.
✉ **Autor correspondente:** Francisco Guerra-Pinto. fguerrapinto@gmail.com
Recebido/*Received*: 28/03/2020 - **Aceite/*Accepted*:** 08/11/2021 - **Publicado *Online*/*Published Online*:** 21/03/2022 - **Publicado/*Published*:** 01/07/2022

Figure 1 – Dissection of the lateral surface of the ankle (left), showing ATFL and CFL

Most injuries progress to full functional recovery,[2,5] even though around 35% of the cases are associated with chronic symptoms and limitations. This has a relevant socio-economic impact and has changed the paradigm of this condition to 'there are no simple ankle sprains'.[5]

Chronic ankle instability (CAI) will be defined as persistent functional limitation following an injury due to pain, repetitive sprains, objective instability.[6-8] Chronic pain is a criterion for CAI.[6,9]

Considering the high incidence of sprains and the significant rate of non-recovered cases, the unpredicted outcome certainly is the major issue associated with acute ankle sprains. The progression to CAI is also unpredictable within the first few days following the injury.

The injury of the anterior talofibular ligament (ATFL) is the most important prognostic factor in a sprain[10], in which the ankle supination occurs. A favourable progression is expected within a few weeks when there is no ligament tear or whenever only a strain has occurred.[11]

Instead, there is a severe sprain when a complete tear of the ATFL (Fig. 1) occurs, leading to several other ligament, tendon, bone and cartilage impairments.[12] Prospective studies have described a complete tear of the ATFL in 60-75% of sprains, but there may be a selection bias related to the preferential referral of patients with complete tear.[13,14] Patients with mild sprains have mild, self-limiting complaints and no need for medical follow-up.

A classification system to guide the approach to severe ankle sprains would be useful. A classification is only relevant when it guides treatment and prognosis, and no classification allows us to establish any prognosis within the first few days.[7]

The traditional grading into three grades is itself ambiguous. Some authors use an 'anatomical' classification,[15] while others apply a 'functional' classification.[16]

In the latter, sprains are ranked as grade I when mild, grade II when moderate and grade III with the presence of a severe inflammatory condition. This classification has a questionable usefulness, as grades I and II are associated with the same prognosis and different outcomes are included in grade III. Therefore, the prognosis of patients with grade II sprains remains dubious, presumed to be severe.[17] Adherence to this traditional grading system results from the ranking of clinical cases into mild, moderate and severe, even if this distinction has no confirmed prognostic impact.

This study was aimed at suggesting a new classification of acute ankle sprains, based on clinical criteria alone, allowing a prognostic correlation, based on different previous studies, namely deferred patient assessment, walking ability and assessment of lateral ankle ligament laxity.[3,18-21]

This system seeks to diagnose a tear of the ATFL through the pivot-shift test[21] (Fig. 2 and Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/13804/Apendice_01.mov) and to infer other concomitant injuries using two successive clinical assessments, possibly confirmed by diagnostic tests. Injuries resulting from ankle sprains are therefore included in a comprehensive model assisting physicians. Finally, it seeks to relate the patient's complaints and limitations to the degree of tissue damage within this joint.[22,27]

The hypotheses put forward are that the positive pivot-shift test and the classification into four progressive degrees of severity allow predicting a poorer progression towards chronic instability.

Figure 2 – A: Pivot-shift test, initial position. The distal tibia is stabilised with one hand while the hindfoot is handled with the other hand, in a position with a hanging foot in mild plantar flexion; B: Pivot-shift test, final position. While a rotating force is applied to the calcaneus, an internal rotation is applied to the mid and forefoot, with a centre on the medial malleolus. The test should be always carried out with the healthy limb first, to prevent the patient from feeling any apprehension, in addition to assess the patient's physiologic laxity. (image capture from Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/13804/Apendice_01.mov)

MATERIAL AND METHODS

This study is based on a prospective observational cohort study approved by the Ethics Committee of Hospital Dr José de Almeida, Cascais, complying with the STROBE guidelines (STrengthening the Reporting of OBservational studies in Epidemiology, in Appendix 2 (Appendix 2: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/13804/Apendice_02.pdf).

A specific ankle sprain outpatient clinic was developed, in response to referrals of patients from the emergency department of the same hospital over a 24-month period (between 1 January 2017 and 31 December 2018). A convenience sample including all patients referred during this period was considered. This outpatient clinic was available twice a week so that all sprains could be reassessed less than five days upon admission to emergency.

Referral and inclusion criteria included:

- first ankle sprain occurring within 48 hours;
- no comorbidities affecting the same limb;
- patients aged 18-45;
- consent to follow-up for at least 12 months.

Exclusion criteria included:

- diagnosis other than acute lateral ankle sprain;
- syndesmosis sprain (positive external rotation stress tests);
- previous surgery in either ankle;
- current or recent (within six months) fracture in either lower limb segment;
- possible chronic instability:
  - previous sprain with significant oedema or recovery beyond two weeks;
  - previous history of repetitive sprains, pain or feeling of instability;
- rheumatoid pathology, corticosteroid or immunomodulatory therapy.

In the first consultation, after confirmation of the inclusion and exclusion criteria, a detailed record of the clinical examination was made and the Initial *Consecutive Ankle Sprain Classification and Injury Systematization* (CASCaIS) was applied (Table 1). This variant was specifically focused on the patient's walking ability, inspection - description of any oedema, haematoma and their location - and palpation of the ankle, with description of pain trigger points. For example: patients able to load-bear but describing severe pain over the whole lateral aspect of the ankle joint will be graded as C; when there is pain over the anteromedial aspect of the ankle (suggesting cartilage damage at the time of the sprain) this will be graded as C2.

The follow-up consultations took place between three and six weeks later, and the 'Deferred' classification was applied (Table 2), focused on gait, inspection, palpation and mechanical instability tests (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/13804/Apendice_01.mov). For example: patients able to walk independently a few weeks later, with limiting pain and complaints behind the lateral malleolus (over the peroneal tendons) would be graded as B2, while those presenting with normal gait, with pain only over the ATFL and with a positive pivot-shift test would be graded as B1.

At both time points, patients were classified into four severity grades (A, B, C or D) and the interpretation of the injury was followed according to the Consecutive Ankle Sprain Classification and Injury Systematisation. Classification into subtypes aids the clinical recording of associated injuries, highlighting the initial severity and other findings.

Patients subsequently attended follow-up consultations every six weeks including an objective assessment using the Cumberland Ankle Instability Tool (CAIT) and Foot and Ankle Ability Measure (FAAM) scores.[23,24]

The final assessment of each patient was used for statistical analysis.

The primary outcome was the incidence of chronic ankle instability. Secondary outcomes included CAIT, FAAM and FAAM Sport classifications.

The initial two consultations, where the Initial and Deferred CASCaIS ratings were applied, were always performed by the first author, to minimise inter-observer variance bias. The remaining assessments, as well as scoring, were performed by five co-authors. The final telephone assessment was carried out within Dec 2019.

Statistical analysis

Data analysis was performed using STATA v13.1 (StataCorp, College Station, USA). Initially, continuous variables were assessed for symmetry and kurtosis using histograms and for normality using the Shapiro-Wilk test. Non-parametric tests (Mann-Whitney and Kruskal-Wallis) were used for the association of continuous variables with nominal variables, with two groups and more than two groups, respectively. Fisher's exact test was used to analyse the association between categorical variables. Agreement between the results of the Initial and Deferred CASCaIS classification was assessed using Cohen's kappa coefficient. A 5% significance level was used for decisions on the null hypothesis.

RESULTS

Sixty-seven patients were initially referred, 49 (73%) of which have completed follow-up and were included in our group of patients [mean age 27.7 (SD 8.5)]. Progression to chronic ankle instability was found in 18% of the patients. All data were statistically analysed according to the association with the primary outcome, i.e., the presence of CAI. The results are shown in Table 3.

Inflammatory signs, gait and pain location on palpation were assessed on the first consultation, in which 39 patients could walk with pain and eight patients could not walk. The progression to CAI was found in twenty-five per cent of the patients who could not walk and 17% of the patients who were able to walk (normal gait or able to walk) within the first days after the injury.

On initial inspection, no patients presented with ecchymosis or haematoma, 41 patients presented with mild to moderate oedema or haematoma, while eight patients presented with severe haematoma.

Table 1 – Initial Consecutive Ankle Sprain Classification and Injury Systematization

CASCaIS Inicial (First days):	**Type A**		**Type B**		**Type C**		**Type D**
Gait	Possible, almost normal		Difficult, although possible; Weight bearing possible		Very difficult		
Inspection: haematoma or oedema?	Mild or absent		Present, anterolateral		Significant, anterolateral, or lateral		
Ankle joint palpation	AL pain	AL pain and affecting other structures*	Severe AL pain	Severe AL pain and affecting other structures*	Severe AL pain and under the tip of the lateral malleolus	... and affecting other structures*	Severe AL pain and under the tip of the lateral malleolus, in addition to other injuries High-energy injuries Luxations
Tests to ascertain ankle stability (pivot-shift, for instance)	Normal and not painful		These should not be applied within day 1, avoiding painful manipulation				
Which is the probable lesion?	Partial tear or sprain of the ATFL	Partial tear or sprain of the ATFL and other minor injuries	Complete tear of the ATFL	Complete tear of the ATFL and other injuries	Complete tear of the ATFL and partial tear of the CFL, possible subtalar injury	… and other injuries	Complete tear of the ATFL and CFL, with associated injuries
Subtypes:	**Type A1**	**Type A2**	**Type B1**	**Type B2**	**Type C1**	**Type C2**	**Type D**
Traditional grading system	**Grade I or II**		**Grade III**				
Clinical interpretation	Mild sprain	Mild sprain, focus on other injuries	Severe sprain	Severe sprain With other relevant injuries	Severe sprain with subtalar injury	Severe sprain with subtalar injury With other relevant injuries	Very severe sprain with subtalar injury. Significant associated injuries
Suggested testing	None**		Ultrasound on the first or second weeks**				
Proposed treatment	**RICE**	**RICE; Functional rehabilitation / orthosis**		**RICE; Immobilisation for a short period, for pain and inflammation control**			
Next evaluation	Within 4-6 weeks		Within 1-2 weeks				
Follow-up	Check for a favourable outcome as soon as sprain and bruising recover		Severe sprain, complete all the clinical tests within the following weeks	Remove the immobilisation and complete all the clinical tests within the following weeks Low threshold for MRI			
Clinical risks	-	Overlooking associated injuries	Lost to follow-up or overlook associated injuries	Complicated, combined ligament tears, with other associated injuries Probable injury of the cartilage			

ATFL: anterior talofibular ligament; CFL: calcaneofibular ligament; AL: anterolateral surface; RICE: rest, ice, compression, and elevation
*: other structures prone to be affected during an ankle sprain: cartilage; peroneal tendons; deltoid ligament; syndesmosis.
**: X-ray imaging according to the Ottawa criteria.

All patients presented with pain on palpation of the ATFL, and 20% of patients developed CAI, while this progression was found in 17% of the patients presenting with pain in other locations as well.

The Initial Consecutive Ankle Sprain Classification and Injury Systematisation assessment showed a statistical trend towards CAI (p = 0.088).

Inflammatory signs, gait, pain location and stability were assessed by the pivot-shift test on the follow-up consultation, in which half of the patients could walk normally.

On inspection, 22 patients presented with no evidence of oedema or haematoma. Four of these 22 patients (18%) progressed to CAI. Five of the 26 patients (19%) in whom these inflammatory signs persisted progressed to CAI.

As regards tenderness upon palpation, 18 patients were already asymptomatic on the follow-up consultation, 11%

Table 2 – Deferred - Consecutive Ankle Sprain Classification and Injury Systematization

Deferred CASCaIS	**Type A**		**Type B**		**Type C**		**Type D**
Gait	Normal		Walking unassisted with mild symptoms		Mild improvement within the first weeks, still in need for walking aids		
Inspection: haematoma or oedema?	Absent or recovered		Recovered or mild oedema, frequently with haematoma		Haematoma and oedema still in recovery		
Palpation of the ankle	Mild pain or no pain	Mild AL pain or no pain Possible pain affecting other structures*	Pain on the AL surface	Pain over the AL surface and pain affecting other structures*	Pain over the AL surface or under the tip of the lateral malleolus	... and pain affecting other structures*	Pain on the lateral surface of the ankle and affecting other structures
Ankle stability tests (pivot-shift test, for instance)	Normal and not painful		Positive pivot-shift test, with 5 - 10 mm laxity		Gross instability. Positive pivot-shift test, with a lack of a solid end point		
Which is the probable lesion?	Partial tear or sprain of the ATFL	Partial tear or sprain of the ATFL and other minor injuries	Complete tear of the ATFL	Complete tear of the ATFL and other injuries	Complete tear of the ATFL and partial tear of the CFL, possible subtalar injury	… and other injuries	Complete tear of the ATFL and CFL, with associated injuries
Subtypes:	**Type A1**	**Type A2**	**Type B1**	**Type B2**	**Type C1**	**Type C2**	**Type D**
Traditional grading system	**Grade I or II**		**Grade III**				
Clinical interpretation	Recovered mild sprain	Favourable outcome, depending on the associated injuries	Severe sprain, 30% chance of chronic pathology	… apart from the outcome of associated injuries	Poorer outcome, due to the combined injuries		
Suggested testing	None	According to the associated injuries	Ultrasound	MRI The presence of joint effusion in ultrasound corresponds to a high rate of combined injury or injury to the cartilage			
Proposed treatment			Functional rehabilitation with orthosis and support of rehabilitation medicine		Remove immobilisation. Orthosis. Early rehab. Possible surgical indication.		
Next evaluation	Required according to some residual symptoms		Each 4 - 6 weeks				
Follow-up			Serial observations aimed at monitorising the response to rehab, check ligament healing with stability tests and follow-up of the associated injuries				
Clinical risks	-	Outlooking associated injuries	Outlooking a clear instability or the absence of a favourable clinical progression A diagnosis of ankle chronic instability should always be considered				

ATFL: anterior talofibular ligament; CFL: calcaneofibular ligament; AL: anterolateral surface

*: other structures prone to become injured during a sprain: cartilage, peroneal tendons, deltoid ligament, syndesmosis.

Table 3 – Data obtained in the first and second specific clinical examinations, grouped according to the outcome regarding at least 12-month follow-up

n = 49	Outcome: Good outcome	Outcome: Ankle chronic instability	(Sum)	*p-value*
Gender				0.868
Female	19 (47.5%)	4 (44.4%)	23	
Male	21 (52.5%)	5 (55.6%)	26	
Age				0.486+
Median	25.9	30.9		
IQR	13.1	15.9		
First consultation				
Gait				0.760
Normal gait	2 (5.0%)	0 (0.0%)	2	
Able to walk	32 (80.0%)	7 (77.8%)	39	
Unable to walk	6 (15.0%)	2 (22.2%)	8	
Oedema / haematoma				0.322
Absent	0 (0.0%)	0 (0.0%)	0	
Present	32 (80.0%)	9 (100.0%)	41	
Severe	8 (20.0%)	0 (0.0%)	8	
Pain over the ATFL				> 0.990
No pain	0 (0.0%)	0 (0.0%)	0	
Pain over the ATFL	28 (70.0%)	7 (77.8%)	35	
... and beyond	12 (30.0%)	2 (22.2%)	14	
Initial CASCaIS				0.088
A	14 (35.0%)	0 (0.0%)	14	
B	17 (42.5%)	7 (77.8%)	24	
C	6 (15.0%)	1 (11.1%)	7	
D	3 (7.5%)	1 (11.1%)	4	
Second consultation				0.289
Gait				
Normal gait	22 (55.0%)	3 (33.3%)	25	
Able to walk	18 (45.0%)	6 (66.7%)	24	
Unable to walk	0 (0.0%)	0 (0.0%)	0	
Oedema / haematoma				> 0.990
Absent	18 (45.0%)	4 (44.4%)	22	
Present	21 (52.5%)	5 (55.6%)	26	
Severe	1 (2.5%)	0 (0.0%)	1	
Pain over the ATFL				0.340
No pain	16 (40.0%)	2 (22.2%)	18	
Pain over the ATFL	15 (37.5%)	3 (33.3%)	18	
... and beyond	9 (22.5%)	4 (44.5%)	13	
Pivot-shift test				**0.022**
Negative	16 (40.0%)	0 (0.0%)	16	
Positive	24 (60.0%)	9 (100.0%)	33	
Deferred CASCaIS				**0.018**
A	18 (45.0%)	0 (0.0%)	18	
B	12 (30.0%)	7 (77.8%)	19	
C	6 (15.0%)	1 (11.1%)	7	
D	4 (10.0%)	1 (11.1%)	5	
Ligament tear found in tests				0.094
Absent	10 (25.0%)	0 (0.0%)	10	
Partial tear	5 (12.5%)	0 (0.0%)	5	
Complete tear	8 (20.0%)	4 (44.4%)	12	
(no tests)	17 (42.5%)	5 (55.6%)	22	

IQR: interquartile range; +: Mann-Whitney's test; n: total number of patients
The pivot-shift test was only carried out on the second medical appointment and an association with the presence of CAI was found ($p = 0.022$).

progressed to CAI. Among patients with persistent complaints, 16% also progressed to CAI, as did 30% of those presenting with pain in the ATFL and elsewhere, showing a non-statistically significant difference ($p = 0.34$).

As regards the pivot-shift test, none of the patients presenting with a negative test progressed to CAI. Nine of the 33 patients (27%) presenting with a positive pivot-shift test progressed to CAI. A relationship between the pivot-shift test and subsequent progression to CAI was found ($p = 0.022$).

A statistically significant difference in the frequency of progression to CAI between the different groups of this classification (p = 0.018) has been found when assessing the relationship between Deferred CASCaIS and progression to CAI (Table 3).

The agreement between Initial and Deferred classifications was analysed; three of the 24 patients graded as type B in the Initial CASCaIS were reclassified as type A after the pivot-shift test, showing ligament integrity, while a positive pivot-shift test was found in the remaining 21 and these were classified as B, C or D according to the clinical severity and ligament laxity. A strong agreement between the Initial and Deferred CASCaIS assessments (Table 4) has been found, with 87.8% of the patients classified in agreement (Cohen's kappa coefficient 0.82, $p < 0.001$).

The results of patient assessments using the Cumberland Ankle Instability Tool (CAIT) and Foot and Ankle Ability Measure (FAAM) scoring system questionnaires are shown in Table 5.

No significant associations were found between CASCaIS and final scoring, which may be due to the low number of patients graded in the most severe categories.

Patients with type A sprains presented with a better score with any of the assessment questionnaires at one-year follow-up (Table 5), showing the reassuring predictive value of a CASCaIS – type A classification within the first few days after the injury.

The progression to CAI in patients with type A sprain was compared to all the remaining patients grouped together (B, C and D) (Table 6); a statistically significant association has been found, both in the initial assessment ($p = 0.045$) and in the delayed assessment ($p = 0.018$).

DISCUSSION

The proposed classification has prognostic capacity in identifying patients who will develop CAI upon ankle sprain, as found in our group of patients. An 18% incidence rate of CAI has been found in our study, in line with literature.[2,7,25]

A significant prognostic ability was found with the pivot-shift test in our group of patients ($p = 0.022$) and regarding the Deferred CASCaIS classification ($p = 0.018$). A statistical trend was also found between the Initial CASCaIS classification and the primary outcome ($p = 0.088$), in addition to a significant correlation between the Initial and Deferred scores ($p = 0.001$), so the clinical assessment is highly likely to be confirmed a few weeks later. This suggests that the intensity of the initial inflammatory signs may give a good insight into the presence of severe ankle ligament injury. This can be confirmed after a few weeks with the pivot-shift test.

The application of instability tests a few days after an ankle sprain has been considered a valid technique for the diagnosis of severe sprains, i.e., those with a complete ATFL tear.[13,18] The same chronological flowchart has been applied, although avoiding the instability tests in the first consultation to reduce patient discomfort; these were only applied in follow-up. A positive pivot-shift test was found in 33 (67%) patients,[21] corresponding to a complete AFTL tear, in line with the literature.[13,14]

No poor outcome was found in patients presenting with a negative pivot-shift test. Nine (27%) out of 33 patients presenting with a positive pivot-shift test progressed to CAI. According to our hypothesis, the pivot-shift test correlated with poorer outcome, showing its prognostic relevance.

The classification of patients according to different degrees of severity and outcome is extremely relevant as mild cases can save resources and severe cases can be treated more aggressively, leading to a better clinical outcome and less absenteeism from work.

Inversion sprains of the ankle are often classified into three degrees of severity.[11,17] According to the functional classification, patients suffering from grade I sprains present with pain and mild to moderate functional impairment and little oedema. Grade III refers to patients with large

Table 4 – Number of patients according to the grading on the first days (Initial CASCaIS) and within the first weeks (Deferred CASCaIS)

Agreement between Initial and Deferred CASCaIS grading						
		Deferred CASCaIS				Total
Initial CASCaIS		A	B	C	D	
	A	14 (100.0%)				14
	B	3 (12.5%)	19 (79.1%)	1 (4.2%)	1 (4.2%)	24
	C	1 (14.0%)		6 (86.0%)		7
	D				4 (100.0%)	4

Cohen's kappa coefficient 0.82, $p < 0.001$
The initial clinical assessment has a high probability of being found some weeks later.

Table 5 – Relationship between grading and the result of the questionnaires Cumberland Ankle Instability Tool (CAIT, in which a score of 30 corresponds to the best physical function) and Foot and Ankle Ability Measure (FAAM, in which 100% means the best physical function)

		Mean	SD		Median	IQR	Two-sided *p*-value
Initial CASCaIS	**CAIT**			**CAIT: A *versus* non-A**			
	A (n = 14)	29.4	1.3	A (n = 14)	30	0	**0.0438+**
	B (n = 24)	26.8	5.7				
	C (n = 7)	27.3	3.9	B. C. D (n = 35)	29	5	
	D (n = 4)	26.8	3.8				
	p = 0.197§						
	FAAM, in %			**FAAM: A *versus* non-A**	Median	IQR	
	A (n = 14)	99.6	1.3	A (n = 14)	100	0	**0.0446+**
	B (n = 24)	95.0	11.4				
	C (n = 7)	99.3	1.9	B. C. D (n = 35)	100	5	
	D (n = 4)	92.5	15.0				
	p = 0.724§						
		Mean	SD		Median	IQR	Two-sided *p*-value
Deferred CASCaIS	**CAIT**			**CAIT: A *versus* non-A**			
	A (n = 18)	29.5	1.2	A (n = 18)	30	0	**0.0137+**
	B (n = 19)	26.2	6.2				
	C (n = 7)	27.3	3.9	B. C. D (n = 31)	29	6	
	D (n = 5)	26.8	3.3				
	p = 0.0884§						
	FAAM in %			**FAAM: A *versus* non-A**	Median	IQR	
	A (n = 18)	99.7	1.2	A (n = 18)	100	0	**0.0362+**
	B (n = 19)	93.7	8.2				
	C (n = 7)	99.3	1.9	B. C. D (n = 31)	100	7.7	
	D (n = 5)	94.0	13.4				
	p = 0.0531§						

Mean grading results regarding the 4 different types of sprains are shown in the columns on the left. Discretization into A *versus* non-A is shown in the columns on the right.
SD: standard deviation; IQR: interquartile range; §: Kruskal-Wallis test;; +: Mann-Whitney's test

haematoma or oedema and walking disability. Grade II corresponds to an intermediate clinical event. The evidence shows that patients with grade I injury will mostly progress to a good outcome. In patients with grade III injury and complete ATFL tear, there is a more uncertain outcome. The inclusion of patients with isolated ATFL tear together with those presenting with tear of the ATFL and the calcaneofibular ligament (CFL) in the same grade III detracts from the value of this classification.

There is some evidence on the search for prognostic factors after a sprain. A short-term follow-up of 31 patients was carried out by Debie using a functional scoring system combining pain, instability, load-bearing capacity and gait pattern;[19] 21 athletes presenting with grade I or II sprains were assessed by Wilson at day 3, excluding apparently severe cases, including the measurement of mobility arc, oedema, visual analogue scale of pain and functional tasks (such as jumping on the affected limb), and reached the conclusion that initial functional disability had the best prognostic significance.[26]

Return to sport time (days) was used by Cross as primary outcome in 20 athletes, and predictive power was found in self-assessment questionnaires, but not in range-of-motion or muscle strength assessment.[27]

Magnetic resonance imaging (obtained within 48 hours of the injury) and the outcome were compared in 38 patients by Langner, and the presence of ligament tear was found in 63% of the patients. Patients with torn ligaments returned to their sporting duties later. At the end of six months only seven patients were unable to walk independently and five of these presented with a statistically significant injury of both the ATFL and CFL.[28]

The Ankle Function Score was based on pain, stability, gait and weight-bearing capacity, and was developed by Wees in a study with 33 patients; the author found that patients with severe injury were less likely to recover within two weeks and with an 86% positive predictive value for this cut-off.[29]

A study including 102 patients aged 18-60 and presenting with acute sprains, one-week follow-up, was carried out

by Van Middelkoop and no relationship was found between 12-month outcome and patient's age, gender, BMI, type of treatment or three-grade classification.[30]

The CASCaIS was aimed at discriminating benign sprains with no ligament tear (type A) from complete ATFL tears (type B). Complete ATFL tear defines a severe sprain, and clinical suspicion should exist within the first few days (Initial CASCaIS) or weeks (Deferred CASCaIS), in addition to a clinical evaluation according to a continuum of severity in which type A sprains have a good prognosis, type B sprains include severe sprains in need of follow-up, and type C or D sprains involve multi-ligament injuries in need of early referral to a specialist.

The suspicion of an ATFL tear is crucial, graded as a C-type injury, as partial tears may be associated with subtalar joint injuries. Finally, type D sprains include very severe sprains with complete ATFL and CFL tear. In addition, these patients may have significant cartilage damage in other ligaments (such as the deltoid) or peroneal tendons. These are frequently related to high-energy injuries and should not be included with other sprains.

The concept of 'moderate' sprain, or grade II, has been removed, as this is considered a grey area that should be interpreted as severe sprain (type B) until proven otherwise. Partial tears of the ATFL have a similar prognosis as sprains, as the integrity of part of the ligament will favourably guide the healing process.[31]

There is also a classification into subtypes in this system (Tables 1 and 2), according to which number 1 is added when injury to the external ligament complex is the only suspicion, while number 2 is added whenever the presence of any associated injury is suspected.

We also specifically looked at the favourable predictive value of type A classification. All the patients in our group had the same classification both in the Initial and the Deferred CASCaIS (Table 4). In addition, these patients had better outcome when measured with CAIT and FAAM, and no patients classified with an A sprain progressed to CAI. From a clinical point of view, this suggests that in patients with mild functional impairment and mild (or no) inflammatory signs, a pivot-shift test could be performed a few days after an ankle sprain, which will presumably be painless and normal, given the evidence of tissue integrity. These patients have a favourable prognosis, whenever any associated injuries are clinically excluded.

The main limitations of this study include the dropout rate and the sample size.

From an initial sample of 67 patients, only 49 were followed for at least 12 months. This corresponds to a 29% dropout rate, in line with those described by Cross (32%) and Middelkoop (22%).[27,30]

A convenience sample was used for this study, including all patients attending our institution during the study period and meeting the inclusion criteria. Although the total sample size was in line with most studies on this issue, a post-hoc analysis shows that it has a statistical power of 0.406 in the relationship between the initial classification and the main outcome. Therefore, the conclusions presented are not an absolute certainty. However, collected data are the base for further studies and will help in defining the sample size.

A total of 12 patients with multi-ligament ruptures (i.e., types C and D) were found in the Deferred CASCaIS scoring, corresponding to 39% of non-A sprains. These are in line with all the literature, from the oldest to the most recent.[14,28,32] A post-hoc power analysis was obtained for the mean differences in CAIT and FAAM tests, discretising into type A versus non-A sprains. The power of this sample (true positive) for CAIT is 0.75 and for FAAM is 0.66.

The fact that all initial assessments were carried out by the same author represent another potential weakness, not allowing the assessment of inter-observer agreement. On the other hand, as mentioned, there was good agreement between the Initial and Deferred CASCaIS.

Finally, correlation with imaging tests was not performed for logistical reasons.

The design of this study did not include the presence of imaging tests on all patients, given the limitations imposed by the functional organisation of the health system in which we operate. The agreement with imaging would show the sensitivity of the clinical tests used, which does not reduce the validity of our hypotheses, rather supporting them.

The most important aspects of this study are related to development of a specific outpatient sprain clinic for the follow-up of patients suffering from an ankle sprain who attended the hospital emergency department. The prospective follow-up allowed a serial assessment of all these patients with clinical criteria and objective evaluation by means of scores. A high statistical significance was found between the Deferred CASCaIS grading and the patients' outcomes.

This type of assessment requires no logistics other than the availability of clinical observation for a few days or weeks after an acute sprain and could be easily used in primary healthcare.

CONCLUSION

This study proposes a new classification of acute ankle sprains. It is based on the identification of an ATFL tear by using the pivot-shift test and is aimed at ruling out any subsequent injuries through two successive clinical assessments, possibly supported by diagnostic tests. It was mainly aimed at assessing injuries related to ankle sprains within a comprehensive model for assisting physicians in the valuation of all the elements of potential prognostic relevance.

A statistically significant relationship was found between the Deferred CASCaIS classification and the progression to chronic ankle instability. This relationship was found in the Initial CASCaIS classification when this was reduced to only two groups (A versus non-A sprains).

There is a significant correlation between the Initial and Deferred classifications ($p = 0.001$), suggesting that a single assessment is required to guide the treatment and provide enough information for estimating a poorer outcome. The Deferred CASCaIS classification ($p = 0.018$) and pivot-shift test ($p = 0.022$) have shown the prognostic ability for the

presence of chronic ankle instability.

ACKNOWLEDGMENTS

The authors wish to acknowledge Miguel Flora, Miguel Pádua and Miguel Duarte Silva for the manuscript revision.

AUTHOR CONTRIBUTION

FGP, TAS: Study conception, planning, data acquisition and interpretation. Manuscript writing, final version approval.

JC, RA: Data acquisition and interpretation. Manuscript writing, final version approval.

ABC: Statistics, data analysis and interpretation. Manuscript writing and approval.

JP, DL: Data analysis and interpretation. Manuscript writing and final version approval.

NC-R: Study Conception, planning. Manuscript writing and final version approval.

JGC: Study conception. Manuscript writing and final version approval.

HUMAN AND ANIMAL PROTECTION

The authors declare that this project complied with the regulations that were established by the Ethics and Clinical Research Committee, according to the 2013 update of the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

FINANCIAL SUPPORT

The authors declare that there was no public or private financial support in writing this manuscript.

REFERENCES

1. Fong D, Hong Y, Chan LK, Yung P, Chan KM. A systematic review on ankle injury and ankle sprain in sports. Sports Med. 2007;37:73–94.
2. Polzer H, Kanz KG, Prall WC, Haasters F, Ockert B, Mutschler W, Grote S. Diagnosis and treatment of acute ankle injuries: development of an evidence-based algorithm. Orthop Rev. 2012;4:e5.
3. Bekerom M, Kerkhoffs G, McCollum G, Calder J, Dijk C. Management of acute lateral ankle ligament injury in the athlete. Knee Surg Sports Traumatol Arthrosc. 2012;21:1390–5.
4. Moreira V, Antunes F. Entorses do tornozelo: do diagnóstico ao tratamento perspectiva fisiátrica. Acta Med Port. 2008;21:285–92.
5. Dijk C, Vuurberg G. There is no such thing as a simple ankle sprain: clinical commentary on the 2016 International Ankle Consortium position statement. Brit J Sport Med. 2016;51:485–6.
6. Adal S, Pourkazemi F, Mackey M, Hiller C. The prevalence of pain in people with chronic ankle instability: a systematic review. J Athl Training. 2019;54:662–70.
7. Thompson JY, Byrne C, Williams MA, Keene DJ, Schlussel MM, Lamb SE. Prognostic factors for recovery following acute lateral ankle ligament sprain: a systematic review. BMC Musculoskelet Disord. 2017;18:421.
8. Konradsen L, Bech L, Ehrenbjerg M, Nickelsen T. Seven years follow-up after ankle inversion trauma. Scand J Med Sci Sports. 2002;12:129–35.
9. Cristóvão I, Reis-Pina P. O ensino da dor crónica em Portugal: as perspectivas dos estudantes de Medicina e dos internos do ano comum. Acta Med Port. 2019;32:338–47.
10. Wei F, Fong D, Chan KM, Haut R. Estimation of ligament strains and joint moments in the ankle during a supination sprain injury. Comput Method Biomec. 2013;18:243–8.
11. Kannus P, Renström P. Treatment for acute tears of the lateral ligaments of the ankle. Operation, cast, or early controlled mobilization. J Bone Jt Surg. 1991;73:305–12.
12. Dijk C, Bossuyt P, Marti R. Medial ankle pain after lateral ligament rupture. J Bone Jt Surg Br. 1996;78-B:562–7.
13. Dijk C, Mol B, Lim L, Marti R, Bossuyt P. Diagnosis of ligament rupture of the ankle joint: physical examination, arthrography, stress radiography and sonography compared in 160 patients after inversion trauma. Acta Orthop Scand. 1996;67:566–70.
14. Brostroem L. Sprained Ankles. I. Anatomic lesions in recent sprains. Acta Chir Scand. 1964;128:483–95.
15. Kaikkonen A, Kannus P, Järvinen M. A performance test protocol and scoring scale for the evaluation of ankle injuries. Am J Sports Med. 1994;22:462–9.
16. Balduini F, Vegso J, Torg J, Torg E. Management and rehabilitation of ligamentous injuries to the ankle. Sports Med. 1987;4:364–80.
17. César P, Avila E, Abreu M. Comparison of magnetic resonance imaging to physical examination for syndesmotic injury after lateral ankle sprain. Foot Ankle Int. 2011;32:1110–4.
18. Dijk C, Lim L, Bossuyt P, Marti R. Physical examination is sufficient for the diagnosis of sprained ankles. J Bone Jt Surg. 1996;78:958–62.
19. Bie R, Vet H, Wildenberg F, Lenssen T, Knipschild P. The prognosis of ankle sprains. Int J Sports Med. 1997;18:285–9.
20. Miller A, Myers S, Parks B, Guyton G. Anterolateral drawer versus anterior drawer test for ankle instability. Foot Ankle Int. 2015;37:407–10.
21. Guerra-Pinto F, Côrte-Real N, Gomes T, Silva M, Consciência J, Monzo M, et al. Rotational instability after anterior talofibular and calcaneofibular ligament section: the experimental basis for the ankle pivot test. J Foot Ankle Surg. 2018;57:1087-91.
22. Verhagen E. How fundamental knowledge aids implementation: ankle sprains as an example. Acta Med Port. 2013;26:171–4.
23. Noronha M, Refshauge K, Kilbreath S, Figueiredo V. Cross-cultural adaptation of the Brazilian-Portuguese version of the Cumberland Ankle Instability Tool (CAIT). Disabil Rehabil. 2008;30:1959–65.
24. Moreira T, Magalhães L, Silva R, Martin R, Resende M. Translation, cross-cultural adaptation and validity of the Brazilian version of the Foot and Ankle Ability Measure questionnaire. Disabil Rehabil. 2016;38:2479–90.
25. Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med Auckl N Z. 2014;44:123–40.
26. Wilson R, Gansneder B. Measures of functional limitation as predictors of disablement in athletes with acute ankle sprains. J Orthop Sport Phys. 2000;30:528–35.
27. Cross K, Worrell T, Leslie J, Khalid R. The relationship between self-reported and clinical measures and the number of days to return to sport following acute lateral ankle sprains. J Orthop Sport Phys. 2002;32:16–23.
28. Langner I, Frank M, Kuehn J, Hinz P, Ekkernkamp A, Hosten N, et al. Acute inversion injury of the ankle without radiological abnormalities: assessment with high-field MR imaging and correlation of findings with clinical outcome. Skeletal Radiol. 2010;40:423–30.
29. Wees P, Hendriks E, van Beers H, van Rijn R, Dekker J, de Bie R. Validity and responsiveness of the ankle function score after acute ankle injury. Scand J Med Sci Spor. 2010;22:170–4.
30. Middelkoop M, Rijn R, Verhaar J, Koes B, Bierma-Zeinstra S. Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study. J Physiother. 2012;58:181–8.

31. Brooks S, Potter B, Rainey J. Treatment for partial tears of the lateral ligament of the ankle: a prospective trial. BMJ. 1981;282:606–7.

32. Ent F. Surgical treatment of lateral ankle ligament ruptures. Int J Sports Med. 1984;5:S149–50.