UNIVERSITE DE LAUSANNE - FACULTE DE BIOLOGIE ET DE MEDECINE

Département de l'appareil locomoteur

Service d'orthopédie et traumatologie

Critical Evaluation of Outcome Scales Assessment of Lateral Ankle Ligament Reconstruction

THESE

préparée sous la direction du Docteur Xavier Crevoisier

et présentée à la Faculté de biologie et de médecine de l'Université de Lausanne pour l'obtention du grade de

DOCTEUR EN MEDECINE

par

Alexandre BURN

Médecin diplômé de la Confédération Suisse
Originaire d' Adelboden

Lausanne

2013

UNIL | Université de Lausanne
Faculté de biologie
et de médecine

Ecole Doctorale
Doctorat en médecine

Imprimatur

Vu le rapport présenté par le jury d'examen, composé de

Directeur de thèse	*Monsieur le Docteur* **Xavier Crevoisier**
Co-Directeur de thèse	
Expert	
Directrice de l'Ecole doctorale	*Madame le Professeur* **Stephanie Clarke**

la Commission MD de l'Ecole doctorale autorise l'impression de la thèse de

Monsieur Alexandre Burn

intitulée

Critical Evaluation of Outcome Scales Assessment of Lateral Ankle Ligament Reconstruction

Lausanne, le 26 novembre 2013

pour Le Doyen
de la Faculté de Biologie et de Médecine

Madame le Professeur Stephanie Clarke
Directrice de l'Ecole doctorale

Résumé:

Introduction:

Les résultats d'une chirurgie du pied et de la cheville peuvent être évalués par des scores spécifiques à la région anatomique ainsi que par des scores spécifiques à la pathologie. Beaucoup de scores existent rendant la comparaison entre les études difficile. La présente étude se focalise sur une pathologie fréquente du pied et de la cheville et compare les résultats obtenu par deux scores spécifiques à la région et deux scores spécifiques à la pathologie.

Méthode:

Nous avons revu 41 patients ayant bénéficié d'une plastie ligamentaire externe de la cheville. Quatre scores ont été administrés simultanément: the Cumberland Ankle Instability Tool (CAIT) et the Chronic Ankle Instability Scale (CAIS), spécifiques à la pathologie, the American Orthopedic Foot & Ankle Society (AOFAS) hindfoot scale et the Foot and Ankle Ability Measure comprenant deux parties (FAAM1 et FAAM2), spécifiques à la région anatomique. Le degré de corrélation entre les scores a été évalué par le coefficient de corrélation de Pearson. L'analyse graphique des variances a été utilisée pour le choix de tests paramétriques versus non paramétriques. Des tests non paramétriques, le Kruskal-Wallis pour éliminer l'hypothèse nulle et le Mann-Whitney pour la comparaison entre les scores deux à deux, ont été utilisés.

Résultats:

Une différence significative ($p<.005$) a été démontrée entre le CAIS et l'AOFAS ($p=.0002$), entre le CAIS et le FAAM1 ($p=.0001$) et entre le CAIT et l'AOFAS ($p=.0003$)

Conclusions:

Cette étude compare les performances de quatre scores dont deux spécifiques à la région anatomique et deux spécifiques à la pathologie. Nous avons démontré une bonne corrélation entre les scores ainsi que des différences significatives entre les résultats obtenus par chacun d'eux. Les résultats obtenus par les scores spécifiques à la pathologie semblent être plus précis que ceux obtenus par les scores spécifiques à la région anatomique. De plus, nous avons mis en évidence une forte corrélation entre l'AOFAS et les autres scores. Le FAAM semble être un bon compromis car il offre la possibilité, du fait de ses deux parties, d'évaluer le résultat en fonction de la demande fonctionnelle du patient.

Perspectives:

Un algorithme est proposé qui permet d'évaluer la littérature spécifique de manière plus critique et peut s'adapter également à la recherche et à la clinique relative à d'autres pathologies du pied et de la cheville

Critical Evaluation of Outcome Scales Assessment of Lateral Ankle Ligament Reconstruction

Alexandre Burn, Yannick Buerer, Swati Chopra, Michaela Winkler and Xavier Crevoisier

Foot Ankle Int 2013 34: 995 originally published online 11 March 2013
DOI: 10.1177/1071100713481669

AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY

Foot & Ankle International
34(7) 995–1005
©The Author(s) 2013
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1071100713481669
fai.sagepub.com

Critical Evaluation of Outcome Scales Assessment of Lateral Ankle Ligament Reconstruction

Alexandre Burn, MD[1], Yannick Buerer, MD[1], Swati Chopra, PT, MSc[1], Michaela Winkler, MD[1], and Xavier Crevoisier, MD, PD[1]

Abstract

Background: Outcome following foot and ankle surgery can be assessed by disease- and region-specific scores. Many scoring systems exist, making comparison among studies difficult. The present study focused on outcome measures for a common foot and ankle abnormality and compared the results obtained by 2 disease-specific and 2 body region-specific scores.

Methods: We reviewed 41 patients who underwent lateral ankle ligament reconstruction. Four outcome scales were administered simultaneously: the Cumberland Ankle Instability Tool (CAIT) and the Chronic Ankle Instability Scale (CAIS), which are disease specific, and the American Orthopedic Foot & Ankle Society (AOFAS) hindfoot scale and the Foot and Ankle Ability Measure (FAAM), which are both body region-specific. The degree of correlation between scores was assessed by Pearson's correlation coefficient. Nonparametric tests, the Kruskal-Wallis and the Mann-Whitney test for pairwise comparison of the scores, were performed.

Results: A significant difference ($P < .005$) was observed between the CAIS and the AOFAS score ($P = .0002$), between the CAIS and the FAAM I ($P = .0001$), and between the CAIT and the AOFAS score ($P = .0003$).

Conclusions: This study compared the performances of 4 disease- and body region-specific scoring systems. We demonstrated a correlation between the 4 administered scoring systems and notable differences between the results given by each of them. Disease-specific scores appeared more accurate than body region-specific scores. A strong correlation between the AOFAS score and the other scales was observed. The FAAM seemed a good compromise because it offered the possibility to evaluate the patient according to his or her own functional demand.

Clinical Relevance: The present study contributes to the development of more critical and accurate outcome assesment methods in foot and ankle surgery.

Keywords: outcome score, ankle instability, Broström-Gould, lateral ankle ligament repair

The current evaluation systems for foot and ankle surgeries involve a number of outcome scores that are both disease and body region-specific.[3,5,11,12] According to evidence-based medicine, the results produced by these scores can be used to establish guidelines for clinical practice. However, a disparity frequently exists in the literature regarding the methods applied to evaluate the results of different treatment options for the same disease. Moreover, several scores are not valid because they lack accuracy, specificity, and sensitivity in assessing outcome, but unfortunately they are still used frequently.

Hence, comparison among studies focusing on similar problems remains difficult, and determining guidelines is even more challenging.[3,5,11,12] The question still exists regarding the relative value of both the disease- and body region-specific scores in foot and ankle surgery. Therefore, in the present study we evaluated selected foot and ankle scores in order to identify the best available outcome measure for the assessment of lateral ankle ligament repair.

The goal of the present study was to evaluate outcome measures for the treatment of a common foot and ankle abnormality—lateral ankle instability—and to compare the results obtained by 2 disease-specific and 2 body region-specific scores. The study aimed to explore 3 hypotheses: (1) A correlation exists between the 4 proposed scores, (2) it is possible

[1]Centre Hospitalier Universitaire Vaudois (CHUV) and University of Lausanne (UNIL), Department of Orthopedic Surgery and Traumatology, Switzerland

Corresponding Author:
Xavier Crevoisier, MD, PD, Centre Hospitalier Universitaire Vaudois (CHUV) and University of Lausanne (UNIL), Department of Orthopedic Surgery and Traumatology, 1011 Lausanne, Switzerland.
Email: xavier.crevoisier@chuv.ch

to compare results obtained by these scores and evaluate how they compare with each other, and (3) a notable difference exists between the results produced by these scores.

Methods

Patients

We reviewed a consecutive series of 41 patients who underwent a modified Broström-Gould procedure for chronic lateral instability of the ankle in our hospital from 2005 to 2010. Patients were operated on by a single surgeon (X.C.) and followed the same rehabilitation protocol. Patients who were affected by other concomitant abnormalities of the lower extremity, who had additional surgery, or who did not give informed consent were excluded. The cohort was followed retrospectively for a minimum of 1 year (13-72 months) and evaluated by an independent examiner (Y.B.) who administered the scores described below. Approval of the ethics commission of our institution was obtained.

Forty-seven patients were identified as eligible for the study. Six patients were excluded, leaving 41 patients for examination. Of the excluded patients, 3 had had additional surgery and 3 didn't respond to repeated queries. The mean age of the 41 remaining patients was 33.7 years (18-60 years). There were 25 women and 16 men, with a total of 23 right and 18 left procedures.

Surgical Technique and Rehabilitation

The surgical procedure consisted of a modification of the Broström-Gould procedure as described previously.[2] After surgery, the patients were immobilized in a walking cast for 4 weeks, were given low-molecular-weight heparin (Fragmin, Pfizer, AG, 8052 Zürich, Switzerland) as prophylaxis for deep vein thrombosis, and were encouraged to bear weight as tolerated. Further immobilization included a day and night ankle splint (ASO, Allenspach, Medical AG, 4710 Balsthal, Switzerland) for 4 weeks and only a night splint for 2 weeks. At 5 weeks after surgery, ankle exercises were started in the sagittal plane. At 7 weeks the patients were taught exercises for coordination and proprioception and were allowed to resume sports in one plane, like biking, skiing, and running. Pivot sports (tennis, football) were allowed at the 13th week.

Outcome Scales

Four outcome scales were administered simultaneously at the last follow-up. The CAIT (Cumberland Ankle Instability Tool) (Appendix 1)[6] and the CAIS (Chronic Ankle Instability Scale) (Appendix 2)[4] were disease specific, and the AOFAS (American Orthopedic Foot & Ankle Society) hindfoot scale (Appendix 3)[8] and the FAAM (Foot and Ankle Ability Measure) (Appendix 4)[1,10] were body region-specific.

The validity of the FAAM,[1,10] the CAIT,[6] and the CAIS[4] has been demonstrated. The AOFAS score has not been validated; however, it is the most frequently used score in the foot and ankle literature.[7,9,13]

The CAIT is used to evaluate pain and instability, especially during sports activities that are demanding in terms of ankle control. The scale includes 9 items resulting in a maximum of 30 points, with a higher score indicating a better result.

The CAIS includes similar characteristics as the CAIT. In addition, it evaluates the need for assistive devices, the difficulty of participating in demanding physical activities, apprehension about experiencing a new sprain, and the activities that are avoided because of instability. The CAIS also assesses the consequences of a new ankle sprain. The CAIS consists of 14 items for a maximum of 56 points. A higher score indicates a better result.

The AOFAS hindfoot score was designed to assess pain, subjective and objective function, and alignment of the hindfoot. Subjective function assessment includes limitation of activities, walking distance, and ability to walk depending upon walking surfaces. Objective function is evaluated by observing gait abnormalities and measuring hindfoot mobility and laxity. The scale includes 9 items scoring a maximum of 100 points. A high score indicates a good result.

The FAAM contains 2 parts, which are scored separately. The first part, called FAAM 1 in the present study, evaluates difficulties encountered in activities of daily living, like walking, home responsibilities, personal care, work, and recreational activities. This first part includes 21 items giving a possible maximum of 84 points. The second part, called FAAM 2 in the present study, focuses on the ability to perform general and patient-specific sports activities. This second part includes 8 items giving a possible maximum of 32 points. Both of these scores are then converted into a percentage. For both parts, a higher score represents a higher physical capacity. This construction in 2 parts allows customized outcome evaluation depending upon the functional demand of each patient.

Statistics

CAIT, CAIS, and AOFAS scores were normalized to 100% to allow comparison between all 4 scores. Scatter plots were used to demonstrate linear relationships between the results obtained by each score. To evaluate the degree of correlation between scores, we used the Pearson's correlation coefficient. The graphic analysis of variance was performed to orientate the decision regarding the use of parametric or nonparametric tests. Finally, nonparametric tests were performed: the Kruskal-Wallis 1-way analysis of variance to confirm the null hypothesis and the Mann-Whitney test for the pairwise comparison of the scores. We defined $P < .005$ as significant, as opposed to the more commonly used $P < .05$, because of the multiplicity of comparisons, which enhanced the risk for errors. This

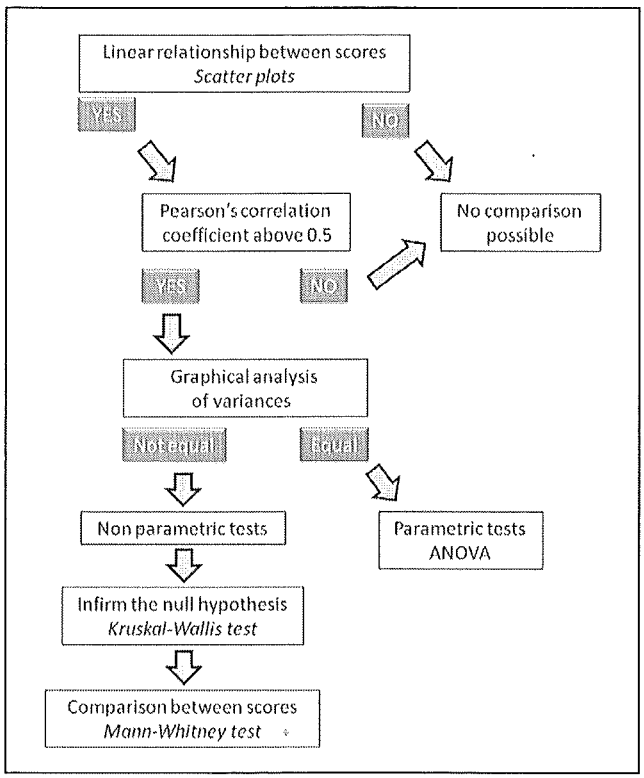

Figure 1. Algorithm for comparison between scores.

Table 1. Descriptive Statistics: Number of Questionnaires Completed (No.), With Mean Value and Standard Deviation (SD) for Each Score.

Score	No.	Mean	SD	Min	p25	p50	p75	Max
CAIS	41	74.15	20.02	27	59	77	93	100
CAIT	40	67.68	25.93	17	45	70	98.5	100
AOFAS	41	88.95	12.87	37	82	91	100	100
FAAM 1	41	89.93	13.33	42	88	94	100	100
FAAM 2	41	80.73	21.40	28	66	88	100	100

Abbreviations: Max, maximal score obtained; Min, minimal score obtained; p25, 1st quartile; p50, 2nd quartile (median); p75, 3rd quartile.

increased severity aimed to yield reliable results. The algorithm for comparison between scores is presented in Figure 1.

Results

Descriptive statistics are shown in Table 1. All 41 patients completed the scores except for the CAIT, where only 40 completed questionnaires were obtained. Mean (standard deviation) values obtained were, in decreasing order, 89.9 (13.3) for the FAAM 1, 89.0 (12.9) for the AOFAS score, 80.7 (21.4) for the FAAM 2, 74.2 (20.0) for the CAIS, and 67.7 (25.9) for the CAIT.

The scatter plots (Figure 2) showed a linear relationship between the scores compared 2 by 2. The Pearson's correlation coefficient was greater than 0.5 between each score except between the CAIT and the FAAM 1 (0.39) (Figure 3). According to our algorithm, further comparison between the CAIT and the FAAM 1 was not allowed.

Variance analysis was then performed for all the remaining scores and demonstrated inequalities, prompting the use of nonparametric tests for further analysis. The Kruskal-Wallis 1-way analysis of variance allowed rejection of null hypothesis, with a significant P value at .0001 ($P < .01$). This demonstrated the absence of differences between scores and made comparison between groups substantial.

Finally, scores were compared pairwise using the Mann-Whitney test to determine the significant differences between the results obtained by the scores. A significant difference ($P < .005$) was observed between the CAIS and the AOFAS score ($P = .0002$), between the CAIS and the FAAM 1 ($P = .0001$), and between the CAIT and the AOFAS score ($P = .0003$) (Table 2).

Discussion

The scores administered in the present study were chosen in order to (1) compare scores that have already been used several times in the literature; (2) incorporate valid or widely used scores; and (3) include both body region- and disease-specific foot and ankle scores, for an increased precision in outcome. All the selected scores in the study fit in the given criteria. The absence of valid scores focusing on the quality of life, like the SF-36 or the EQ-5D, may appear to be a limitation of the present study. However, even if the use of such a score had brought additional interesting elements, it would not have been critical to achieving the aims of the study.

Our cohort was too small to allow for comparison between the results of patients at 1, 2, 3, 4, and 5 years and to make any statement regarding differences based on time from surgery. However, our clinical experience shows that our patients usually stabilize by 1 year post surgery so we considered it adequate to accept a 1- to 5-year range for administration of the questionnaires.

To the best of our knowledge, this is the first study specifically comparing the performances of these 4 disease- and body region-specific scores. An algorithm was developed to compare the outcome of these 4 scores (Figure 1) that was easy to use and could be applied to other foot and ankle diseases and different foot and ankle scores. The established linear relationship and the Pearson's coefficient results demonstrated a good correlation between the scores. This shows that the patients tended to express their outcome consistently, independent of the score used. The Kruskal-Wallis test showed the existence of a strongly significant difference between the scores and, therefore, justified their comparison using the Mann-Whitney test.

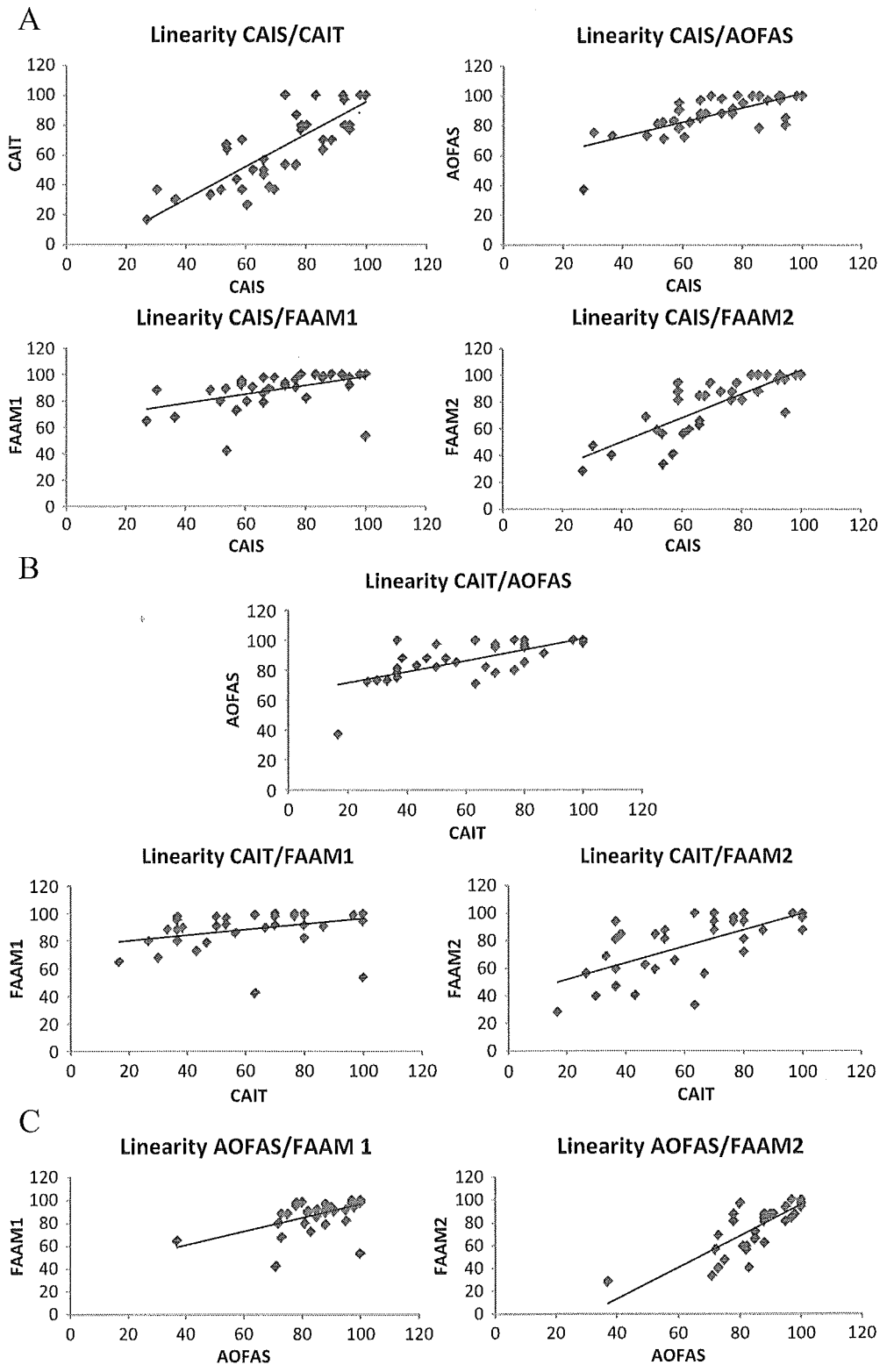

Figure 2. Relationships between scores: (A) relationship between the CAIS and the other scores, (B) relationship between the CAIT and the other scores, and (C) the 2 last possible combinations. The linear relationship between the scores showed that the patients tended to express their outcome consistently independent of the score used.

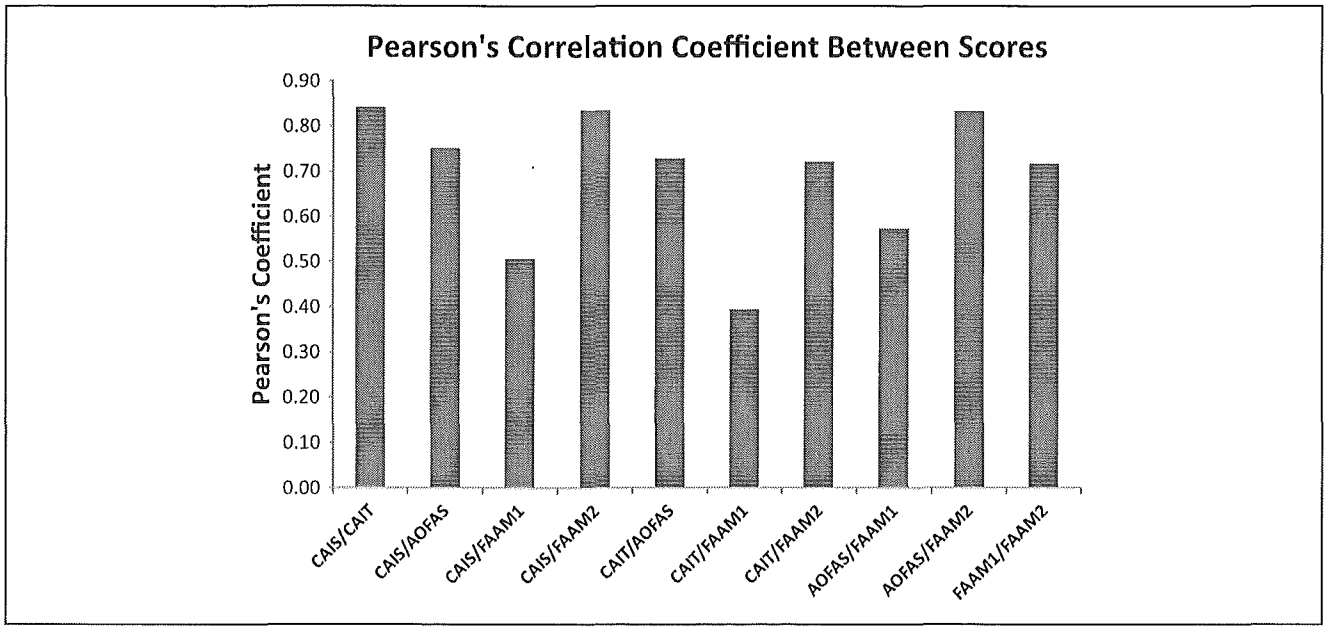

Figure 3. Distribution of Pearson's correlation coefficients. There was a >0.5 correlation between each score except between the CAIT and the FAAM 1 (0.39).

Table 2. Mann-Whitney Test ($P < .005$).[a]

Score	P
CAIS/CAIT	.4151
CAIS/AOFAS	**.0002**
CAIS/FAAM 1	**.0001**
CAIS/FAAM 2	.0659
CAIT/AOFAS	**.0003**
CAIT/FAAM 1	NA
CAIT/FAAM 2	.0268
AOFAS/FAAM 1	.703
AOFAS/FAAM 2	.1641
FAAM 1/FAAM 2	.1117

[a]A significant difference (boldface) was observed between the results of the body region-specific (AOFAS and FAAM) and the disease-specific (CAIT and CAIS) scores except for the FAAM 2, which showed no significant difference with the other scores. Because of the low Pearson's correlation coefficient (0.39), CAIT/FAAM 1 were not eligible for further steps of comparison (NA).

Regarding the results obtained by the descriptive statistics and the Mann-Whitney test (Table 2), a notable difference was observed between the body region-specific scores, which gave the highest values (ie, the AOFAS score and the FAAM 1), and the disease-specific scores, which gave the lowest values (ie, the CAIT and the CAIS). No notable difference was seen between the AOFAS score and the FAAM 1 or between the CAIT and the CAIS. This signifies that the outcome is measured more accurately by the disease-specific scores than by the body region-specific scores. The FAAM 2, however, showed no notable difference with any of the 4 scores. The mean value of the FAAM 2 score was in the middle of the values obtained by all scores, so we can conclude that the accuracy of the FAAM 2 is intermediate.

In accordance with the results of the present study, it can be concluded that the FAAM is an appropriate score for clinical practice. First, it is a valid score. Second, because it consists of 2 sections, the first one about activities of daily living and the second one about sports activities, it allows a nuanced evaluation of the outcome depending on the patient's functional demand. The FAAM 1 is probably well adapted for patients with a lower functional demand and the FAAM 2 for patients with an active lifestyle who perform sports and highly demanding activities. Finally, since the score obtained by administration of the FAAM 2 showed no notable differences with the other scores and also since its accuracy was demonstrated to be intermediate, our results suggest that the FAAM 2 could have been used alone to evaluate outcome following lateral ankle ligament repair.

The present study did not aim to validate the AOFAS hindfoot score and did not include the complex methodology to do so. However, for the specific evaluation of outcome following lateral ankle ligament repair, we demonstrated a strong correlation between the AOFAS score and the other validated scales used here. This is important considering that the AOFAS is by far the most frequently used score in the foot and ankle literature.

Conclusion

Our study aimed to compare the results obtained by 2 body region-specific and 2-disease specific scores in evaluating treatment outcome of a frequent condition of the foot and

ankle. We demonstrated a correlation between the 4 administered scores, the ability to compare them, and notable differences between the results given by each of them. We further demonstrated that for the same patients, disease-specific scores were more accurate than body region-specific scores for outcome evaluation. A strong correlation between the AOFAS score for hindfoot and the other scales was observed. Our results also suggest that the FAAM is a good compromise because it allows the clinician to evaluate patients according to their own functional demand. An algorithm is proposed that could be used in other foot and ankle abnormalities and for comparison of other scores.

Appendix I

The CAIT Questionnaire

Please tick the one statement in each question that best describes your ankles.

		LEFT	RIGHT	SCORE
1.	**I have pain in my ankle**			
	Never	□	□	5
	During sport	□	□	4
	Running on uneven surfaces	□	□	3
	Running on level surfaces	□	□	2
	Walking on uneven surfaces	□	□	1
	Walking on level surfaces	□	□	0
2.	**My ankle feels unstable**			
	Never	□	□	4
	Sometimes during sport (not every time)	□	□	3
	Frequently during sport (every time)	□	□	2
	Sometimes during daily activity	□	□	1
	Frequently during daily activity	□	□	0
3.	**When I make sharp turns, my ankle feels unstable**			
	Never	□	□	3
	Sometimes when running	□	□	2
	Often when running	□	□	1
	When walking	□	□	0
4.	**When I am going down the stairs, my ankle feels unstable**			
	Never	□	□	3
	If I go fast	□	□	2
	Occasionally	□	□	1
	Always	□	□	0
5.	**My ankle feels unstable when I am standing on one leg**			
	Never	□	□	2
	On the ball of my foot	□	□	1
	With my foot flat	□	□	0
6.	**My ankle feels unstable when**			
	Never	□	□	3
	I hop from side to side	□	□	2
	I hop on the spot	□	□	1
	I jump	□	□	0
7.	**My ankle feels unstable when**			
	Never	□	□	4
	I run on uneven surfaces	□	□	3
	I jog on uneven surfaces	□	□	2
	I walk on uneven surfaces	□	□	1
	I walk on a flat surface	□	□	0
8.	**Typically, when I start to roll over (or "twist") on my ankle I can stop it**			
	Immediately	□	□	3
	Often	□	□	2

Sometimes	□	□	1
Never	□	□	0
I have never rolled over on my ankle	□	□	3
9. After a typical incident of my ankle rolling over, my ankle returns to "normal"			
Almost immediately	□	□	3
Less than 1 day	□	□	2
1 or 2 days	□	□	1
More than 2 days	□	□	0
I have never rolled over my ankle	□	□	3

Adapted from Hiller et al.[6]

Appendix 2

The CAIS Questionnaire

With this questionnaire, we would like to document the possible implications of your ankle instability problem. The questions below refer to complaints and difficulties/problems you may have while performing activities as a result of your ankle instability. Read every question carefully. Please rate every question by checking *only one* of the possible boxes that best describes your present condition (compared with your preinjury level). If a question does not apply to you or because it relates to something else than your ankle instability, please mark not applicable (NA). Try not to reflect too long on a question, and do not leave questions unanswered. This questionnaire is personal, so please do not consult with others. If you have doubts about the meaning of a word or question, please use your own interpretation.

1. **How much fear do you have of respraining your ankle?**
   □ no □ a little bit □ moderately □ a lot □ extremely much
2. **To what extent do you have difficulties/problems with cutting or changing direction (during walking, running or jumping) because of your ankle instability problem?**
   □ none □ some □ moderate □ a lot □ unable to do
3. **How often do you use an external ankle support when performing sports or recreational activities?**
   □ never □ rarely □ sometimes □ often □ always □ NA
4. **To what extent do you avoid performing certain activities (such as walking, running, jumping, cutting) because of your ankle instability problem?**
   □ not at all □ rarely □ sometimes □ often □ constantly
5. **To what extent do you have difficulties/problems with walking on uneven ground because of your ankle instability problem?**
   □ none □ some □ moderate □ a lot □ unable to do □ NA
6. **To what extent has the overall quality of your sports or recreational activities decreased as a result of your ankle instability, when compared with your preinjury level?**
   □ not at all □ slightly □ moderately □ strongly □ extremely □ NA
7. **How unstable does your ankle feel?**
   □ not at all □ slightly □ moderately □ strongly □ extremely
8. **To what extent do you have difficulties/problems with jumping because of your ankle instability problem?**
   □ none □ some □ moderate □ a lot □ unable to do □ NA
9. **To what extent do you have difficulties/problems with running on** even **ground because of your ankle instability problem?**
   □ none □ some □ moderate □ a lot □ unable to do □ NA
10. **To what extent do you have difficulties/problems with running on** uneven **ground because of your ankle instability problem?**
    □ none □ some □ moderate □ a lot □ unable to do □ NA
11. **How frequently do you still sprain your ankle?**
    □ not anymore □ rarely □ sometimes □ often □ constantly
12. **If you sprain your ankle, how often does it cause symptoms such as pain, stiffness, or swelling?**
    □ not anymore □ rarely □ sometimes □ often □ always □ NA

13. **To what extent are you concerned about your ankle instability problem?**
□ not at all slightly □ moderately □ very □ extremely
14. **To what extent has your participation in certain sports or recreational activities decreased as a result of your ankle instability, when compared with your preinjury level?**
□ not at all □ slightly □ moderately □ much □ do not participate anymore □ NA

Adapted from Eechaute et al.[4]

Appendix 3

AOFAS Ankle-Hindfoot Scale

Pain (40 points)
- □ 40 None
- □ 30 Mild, occasional
- □ 20 Moderate, daily
- □ 0 Severe, almost always present

Function (50 points)

Activity limitations, support requirement
- □ 10 No limitations, no support
- □ 7 No limitations of daily activities, limitation of recreational activities, no support
- □ 4 Limited daily and recreational activities, cane
- □ 0 Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace

Maximum walking distance, blocks
- □ 5 >6
- □ 4 4-6
- □ 2 1-3
- □ 0 <1

Walking surfaces
- □ 5 No difficulty on any surface
- □ 3 Some difficulty on uneven terrain, stairs, inclines, ladders
- □ 0 Severe difficulty on uneven terrain, stairs, inclines, ladders

Gait abnormality
- □ 8 None, slight
- □ 4 Obvious
- □ 0 Marked

Sagittal motion (flexion plus extension)
- □ 8 Normal or mild restriction (≥30 degrees)
- □ 4 Moderate restriction (15-29 degrees)
- □ 0 Severe restriction (<15 degrees)

Hindfoot motion (inversion plus eversion)
- □ 6 Normal or mild restriction (75%-100% normal)
- □ 3 Moderate restriction (25%-74% normal)
- □ 0 Marked restriction (<25% normal)

Ankle -hindfoot stability (anteroposterior, varus-valgus)
- □ 8 Stable
- □ 0 Definitely unstable

Alignment (10 points)
- □ 10 Good, plantigrade foot, ankle-hindfoot well aligned
- □ 5 Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms
- □ 0 Poor, nonplantigrade foot, severe malalignment, symptoms

Adapted from Kitaoka et al.[8]

Appendix 4

Foot and Ankle Ability Measure (FAAM)

Activities of Daily Living Subscale

Please answer every question with *one response* that most closely describes your condition within the past week.
If the activity in question is limited by something other than your foot or ankle mark not applicable (N/A).

	No difficulty	Slight difficulty	Moderate difficulty	Extreme difficulty	Unable to do	N/A
Standing	☐	☐	☐	☐	☐	☐
Walking on even ground	☐	☐	☐	☐	☐	☐
Walking on even ground without shoes	☐	☐	☐	☐	☐	☐
Walking up hills	☐	☐	☐	☐	☐	☐
Walking down hills	☐	☐	☐	☐	☐	☐
Going up stairs	☐	☐	☐	☐	☐	☐
Going down stairs	☐	☐	☐	☐	☐	☐
Walking on uneven ground	☐	☐	☐	☐	☐	☐
Stepping up and down curbs	☐	☐	☐	☐	☐	☐
Squatting	☐	☐	☐	☐	☐	☐
Coming up on your toes	☐	☐	☐	☐	☐	☐
Walking initially	☐	☐	☐	☐	☐	☐
Walking 5 minutes or less	☐	☐	☐	☐	☐	☐
Walking approximately 10 minutes	☐	☐	☐	☐	☐	☐
Walking 15 minutes or greater	☐	☐	☐	☐	☐	☐

Because of your foot and ankle, how much difficulty do you have with:

	No difficulty at all	Slight difficulty	Mode-rate difficulty	Extreme difficulty	Unable to do	N/A
Home responsibilities	☐	☐	☐	☐	☐	☐
Activities of daily living	☐	☐	☐	☐	☐	☐
Personal care	☐	☐	☐	☐	☐	☐
Light to moderate work (standing, walking)	☐	☐	☐	☐	☐	☐
Heavy work (pushing/pulling, climbing, carrying)	☐	☐	☐	☐	☐	☐
Recreational activities	☐	☐	☐	☐	☐	☐

How would you rate your current level of function during your usual activities of daily living from 0 to 100, with 100 being your level of function prior to your foot and ankle problem and 0 being the inability to perform any of your usual daily activities?

☐☐☐.0 %

Foot and Ankle Ability Measure (FAAM)

Sports Subscale

Because of your foot and ankle, how much difficulty do you have with:

	No difficulty at all	Slight difficulty	Mode-rate difficulty	Extreme difficulty	Unable to do	N/A
Running	☐	☐	☐	☐	☐	☐
Jumping	☐	☐	☐	☐	☐	☐
Landing	☐	☐	☐	☐	☐	☐
Starting and stopping quickly	☐	☐	☐	☐	☐	☐
Cutting/lateral movements	☐	☐	☐	☐	☐	☐
Low impact activities	☐	☐	☐	☐	☐	☐
Ability to perform activity with your normal technique	☐	☐	☐	☐	☐	☐
Ability to participate in your desired sport as long as you would like	☐	☐	☐	☐	☐	☐

How would you rate your current level of function during your sports related activities from 0 to 100, with 100 being your level of function prior to your foot and ankle problem and 0 being the inability to perform any of your usual sports activities ?

☐☐☐.0 %

Overall, how would you rate your current level of function ?

☐	Normal	☐	Nearly normal	☐	Abnormal	☐	Severely abnormal

Adapted from Martin et al.[10]

Acknowledgments

The authors thank Pierluigi Ballabeni for his advice and expertise in statistics.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Borloz S, Crevoisier X, Deriaz O, et al. Evidence for validity and reliability of a French version of the FAAM. *BMC Musculoskelet Disord.* 2011;12:40.
2. Buerer Y, Winkler M, Burn A, Chopra S, Crevoisier X. Evaluation of a modified Broström–Gould procedure for treatment of chronic lateral ankle instability: a retrospective study with critical analysis of outcome scoring. *Foot Ankle Surg.* 2013;19(1):36-41.
3. Button G, Pinney S. A meta-analysis of outcome rating scales in foot and ankle surgery: is there a valid, reliable, and responsive system? *Foot Ankle Int.* 2004;25: 521-525.
4. Eechaute C, Vaes P, Duquet W. The chronic ankle instability scale: clinimetric properties of a multidimensional, patient-assessed instrument. *Phys Ther Sport.* 2008;9:57-66.
5. Farrugia P, Goldstein C, Petrisor BA. Measuring foot and ankle injury outcomes: common scales and checklists. *Injury.* 2010;42:276-280.
6. Hiller CE, Refshauge KM, Bundy AC, Herbert RD, Kilbreath SL. The Cumberland ankle instability tool: a report of validity and reliability testing. *Arch Phys Med Rehabil.* 2006;87:1235-1241.
7. Ibrahim T, Beiri A, Azzabi M, et al. Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales. *J Foot Ankle Surg.* 2006;46:65-74.
8. Kitaoka HB, Alexander IJ, Adelaar RS, et al. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int.* 1994;15:349-353.
9. Madeley NJ, Wing KJ, Topliss C, et al. Responsiveness and validity of the SF-36, Ankle Osteoarthritis Scale, AOFAS Ankle Hindfoot Score, and Foot Function Index in end stage ankle arthritis. *Foot Ankle Int.* 2012;33:57-63.

10. Martin RL, Irrgang JJ, Burdett RG, Conti SF, Van Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). *Foot Ankle Int.* 2005;26: 968-983.
11. Martin RL, Irrgang JJ, Lalonde KA, Conti S. Current concepts review: foot and ankle outcome instruments. *Foot Ankle Int.* 2006;27:383-390.
12. Parker J, Nester CJ, Long AF, Barrie J. The problem with measuring patient perceptions of outcome with existing outcome measures in foot and ankle surgery. *Foot Ankle Int.* 2003;24:56-60.
13. SooHoo NF, Shuler M, Fleming LL. Evaluation of the validity of the AOFAS Clinical Rating Systems by correlation to the SF-36. *Foot Ankle Int.* 2003;24:50-55.