Correlation between patient-reported and functional outcome measures following ankle injury

Zinnia M. Rocha[a], Sean R. Lyons[a], Gurvikram Boparai[a], Brian Derner[a], Trevor Klinkner[a], Christine Palma[a], Kevin Perry[a], Anthony Samaan[a]

[a]Student members, Temple University School of Podiatric Medicine ACFAS club, Philadelphia, Pennsylvania

Statement of Purpose and Literature Review

Across all fields of medicine there has been a contemporary push for the utilization of functional outcome measures in order to better assess the efficacy of treatment modalities, objectify the recovery process following injury and surgical intervention, and evaluate patient satisfaction. These include measurement of both patient subjective symptoms and more dynamic and objective physical function. Although this has yet to be standardized, it is clear that US health care centers, hospitals and third party payers are working towards value-based and outcome-based reimbursement strategies using these measures.

Acute injuries to the ankle complex are quite common. In a systematic review conducted by Fong et al., the ankle was found to be the most common site of injury in 24 of 70 evaluated sports, and 22% of sports injuries presenting to emergency rooms were ankle injuries [1]. Furthermore, history of ankle sprain is the most common predisposing factor to the occurrence of another ankle sprain [2]. These might also represent chronic injuries. Patients who have sustained an ankle fracture may experience continued symptoms such as pain and stiffness, and it is common to suffer from chronic instability following a sprain [3]. These sequelae highlight the importance of not only effective treatment, but also having a reliable, validated outcome measure to track patient progress.

Shibuya et al. found a significant correlation between the rearfoot component (Module 3) of the ACFAS Scoring Scale and other validated self-reported outcome measures in patients with a low arch foot type [4]. Other investigators have attempted to validate Modules 1 and 2 of the ACFAS Scoring Scale, but stated that Modules 3 and 4 cannot be endorsed as they have not undergone evaluations regarding validity, reliability, and sensitivity to change [5]. We are unaware of any investigation that correlates the ankle component (Module 4) of the ACFAS Scoring Scale with another validated self-reported outcome measure such as the Foot Function Index (FFI), nor any investigation that correlates it with an accepted dynamic functional outcome measure. The Star Excursion Balance Test (SEBT) quantifies dynamic balance, and has been shown to be effective in demonstrating objective functional deficits in patients with ankle instability [6-8]. It may also be used to help physicians assess return to activity following injury.

The objective of this investigation was to evaluate the correlation between the Foot Function Index (primarily a patient-reported outcome measure), the Star Excursion Balance Test (primarily a dynamic functional outcome measure), and the ACFAS Scoring Scale (combines both patient-reported and dynamic functional components).

Methodology

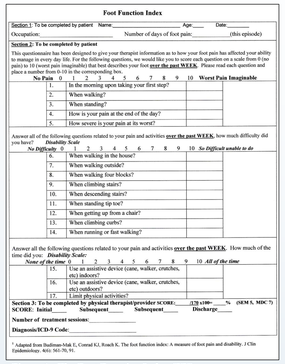
Following approval by our Institutional Review Board (Temple University Hospital Protocol #24075), twenty patients treated at the Temple University Foot and Ankle Institute for an acute ankle injury (sprain or fracture) or chronic ankle instability were prospectively enrolled. Following enrollment, they were evaluated by study authors under the supervision of faculty advisors with the FFI, ACFAS Scoring Scale Module 4, and anterior reach component of the SEBT. Inclusion criteria required that patients were able to ambulate without an immobilization device.

The Foot Function Index (Figure 1) is a self-administered tool which was developed to quantify the impact of foot pathology on function as it relates to pain, disability, and activity limitations [9]. The survey is comprised of 23 graded questions, divided into three sub-scales. Both total and sub-scale scores are produced, and the total is divided by 170 possible points to yield a percentage. Higher scores are indicative of higher levels of pain and disability.

The ACFAS Scoring Scale (Figure 2) is a clinical assessment instrument that measures both subjective and objective parameters [7]. There are four distinct modules to the ACFAS Scoring Scale. Each module consists of a total of 100 potential points (50 subjective, 50 objective), with higher values correlating to improved functionality and decreased pain. For the purposes of this study, we focused on the ankle module. The subjective parameters are broken down into sections on pain, appearance, and functional capacities, while the objective parameters include radiographic findings and measures of function. We modified the radiographic portion to align with our facility's standard practices, which typically do not include the long leg calcaneal axial view nor rotational axis of the ankle measurements following acute ankle injury. This modification effectively decreases the possible objective points from 50 to 44, and the total maximum overall ACFAS score from 100 to 94.

The Star Excursion Balance Test measures single leg balance, strength, and mobility by means of a commercial measurement system (Figure 3). Plisky et al. observed that a difference in anterior reach between the right and left legs is indicative of instability and predictive of future ankle injury [11,12]. Participants were instructed on the SEBT and given an opportunity to practice five trial runs on each leg prior to study data collection.

A comparison between each measurement was performed with frequency scatter plots derived and a Pearson correlation coefficient calculated for each comparison [13].



Foot Function Index

Section 1: To be completed by patient Name:_____ Age:_____ Date:_____
Occupation:_____ Number of days of foot pain:_____(this episode)

Section 2: To be completed by patient

This questionnaire has been designed to give your therapist information as to how your foot pain has affected your ability to manage in every day life. For the following questions, we would like you to score each question on a scale from 0 (no pain) to 10 (worst pain imaginable) that best describes your foot **over the past WEEK**. Please read each question and place a number from 0-10 in the corresponding box.

No Pain	0	1	2	3	4	5	6	7	8	9	10 **Worst Pain Imaginable**

1.	In the morning upon taking your first step?	
2.	When walking?	
3.	When standing?	
4.	How is your pain at the end of the day?	
5.	How severe is your pain at its worst?	

Answer all of the following questions related to your pain and activities **over the past WEEK**, how much difficulty did you have? ***Disability Scale***

No Difficulty	0	1	2	3	4	5	6	7	8	9	10 ***So difficult unable to do***

6.	When walking in the home?	
7.	When walking outside?	
8.	When walking four blocks?	
9.	When climbing stairs?	
10.	When descending stairs?	
11.	When standing tip toe?	
12.	When getting up from a chair?	
13.	When climbing curbs?	
14.	When running or fast walking?	

Answer all the following questions related to your pain and activities **over the past WEEK**. How much of the time did your ***Disability Scale:***

None of the time	0	1	2	3	4	5	6	7	8	9	10 ***All of the time***

15.	Use an assistive device (cane, walker, crutches, etc) indoors?	
16.	Use an assistive device (cane, walker, crutches, etc) outdoors?	
17.	Limit physical activities?	

Section 3: To be completed by physical therapist/provider SCORE:_____ /170 x100= _____% (SEM 3, MDC 7)
SCORE: Initial_____ Subsequent_____ Discharge_____
Number of treatment sessions:_____
Diagnosis/ICD-9 Code:_____

[a] Adapted from Budiman-Mak E, Conrad KJ, Roach K. The foot function index: A measure of foot pain and disability. J Clin Epidemiology. 44(6): 561-70, 91.

Figure 1: The Foot Function Index (FFI)
The FFI is a validated patient-reported outcome measure which provides subjective information from the patient with respect to their perceived pain, disability, and activity restriction.

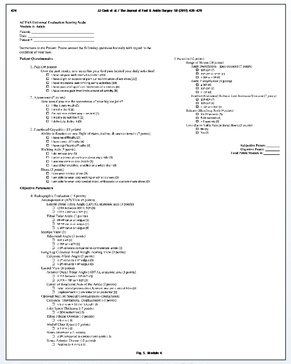


Figure 2: ACFAS Scoring Scale – Module 4
The ACFAS Scoring Scale combines a subjective analysis of patient perception and an objective analysis of radiographic abnormality and functional capacities.

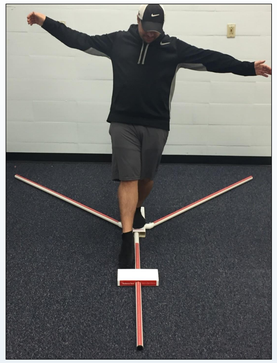


Figure 3: Star Excursion Balance Test (SEBT)
The SEBT is a purely objective validated measure of lower extremity balance, strength, and mobility. It has been used to guide patient return to activity.

Results

Descriptive Statistics:
-Twenty participants meeting inclusion criteria were included in this analysis. The mean participant age was 35.5 years (14 female, 11 left-sided injuries). The mean ± standard deviation (range) time following injury was 80.7 ± 102.6 days (1-376).
-The mean Foot Function Index score was 40.2 ± 25.6 (%), ranging from 5.3% to 88.2%.
-The mean ACFAS Scoring Scale was 56.3 ± 17.4, ranging from 20 to 80.
-The mean Star Excursion difference between extremities was 6.7 ± 8.1 cm, ranging from -5.5 to 24.0 cm.

Comparative Statistics:
-Figure 4 shows the frequency scatter plot of the Star Excursion distance versus the Foot Function Index. A statistically significant positive relationship was observed with a corresponding Pearson correlation coefficient of 0.624. This indicates that as the Star Excursion distance increased between the affected and unaffected extremities, the Foot Function Index score clinically worsened with a "moderate-strong" correlation observed.
-Figure 5 shows the frequency scatter plot of the Star Excursion distance versus the ACFAS Scoring Scale. A statistically significant negative relationship was observed with a corresponding Pearson correlation coefficient of -0.678. This indicates that as the Star Excursion distance increased between the affected and unaffected extremities, the ACFAS Scoring Scale clinically worsened with a "moderate-strong" correlation observed.
-Figure 6 shows the frequency scatter plot of the ACFAS Scoring Scale versus the Foot Function Index. A statistically significant negative relationship was observed with a corresponding Pearson correlation coefficient of -0.798. This indicates that as the ACFAS Scoring Scale clinically improved, the Foot Function Index clinically improved with a near "strong" correlation observed.

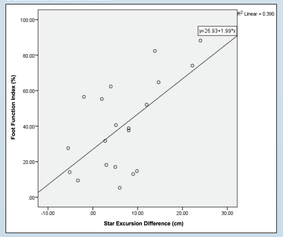


Figure 4: Star Excursion distance plotted against Foot Function Index result.

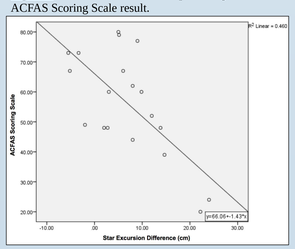


Figure 5: Star Excursion distance plotted against ACFAS Scoring Scale result.

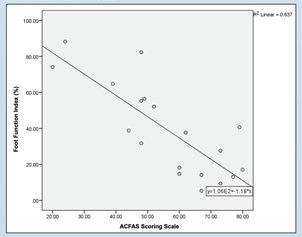


Figure 6: ACFAS Scoring Scale plotted against Foot Function Index result.

Discussion

The results of this investigation provide evidence in support of and to some degree validates the purely subjective and patient-reported FFI, the purely functional SEBT, and the ACFAS Scoring Scale, which includes both subjective and objective components, in a cohort of patients following ankle injury. Overall, our subject population demonstrated a clinically significant mean SEBT difference of 6.7 ± 8.1 cm, indicating a substantial functional deficit was present. This exceeds the 4 cm threshold difference used to gauge return to activity, and indicates that our studied participant cohort did in fact have functional ankle impairment.

When directly compared, the SEBT and FFI demonstrated a clear positive relationship. Thus, as the SEBT difference increased between limbs, the FFI score also increased. This illustrated the expected interpretation of both tests: a larger difference between reach distances in injured and uninjured limbs translating to higher values of pain and disability. When directly compared, the SEBT and ACFAS Scoring Scale demonstrated a clear negative relationship. This also aligns with what one might expect to find in a patient with ankle injury: an increased difference in anterior reach distance between limbs and a low ACFAS score. **These findings indicate that all three outcome measures might be valid in the evaluation of unilateral ankle injuries.**

Additionally, the FFI and ACFAS Scoring Scale demonstrated a very strong correlation (Pearson correlation coefficient of -0.798), despite the fact that the ACFAS Scoring Scale includes radiographic measurements and objective clinical findings in addition to measures of patient-perceived disability. **If the FFI is considered a validated outcome measure in the setting of ankle injury, then this finding provides a degree of validation of the ACFAS Scoring Scale when used for the same indication.**

One limitation of this investigation is the small sample size. A larger sample size would yield correlation data of higher power. It would also be interesting to associate these outcome measures with length of time following injury. Another factor perhaps worthy of future investigation is the effect of conservative and/or surgical intervention on patient-reported and functional outcome measures. It has been our clinical experience that patients with ankle injuries often present with little radiographic or clinical evidence of degenerative pathology or residual post-traumatic instability, yet still experience chronic pain after treatment. While this study did not set time of onset restrictions or treatment exclusions, future investigations could standardize these parameters and track outcomes at time increments throughout treatment.

The results of this investigation provide evidence in support of the use of the ACFAS Scoring Scale, FFI, and SEBT in the evaluation and treatment of patients with ankle injury. It also provides a degree of validation to the ACFAS Scoring Scale when used to evaluate patients with ankle injury, and further provides evidence of a link between objective ankle disability and subjective patient symptoms. It is our hope that this data is used by future investigations to create a better understanding of the natural history of these troubling lower extremity injuries and how to best guide our patients in their rehabilitative efforts and eventual return to activity.

Reference

[1] Fong DT, Hong Y, Chan LK, Yung PS, Chan KM. *Sports Med.* 2007; 37(1):73-94.
[2] Hiller CE, Refshauge KM, Herbert RD, Kilbreath SL. Intrinsic predictors of lateral ankle sprain in adolescent dancers: a prospective cohort study. *Clin J Sport Med. 2008 Jan; 18(1):44-8.*
[3] Lash N, Horne G, Fielden J, Devane P. Ankle fractures: functional and lifestyle outcomes at 2 years. *ANZ J Surg.* 2002 Oct; 72(10):724-30.
[4] Shibuya N, Kitterman RT, Jupiter DC. Evaluation of the rearfoot component (module 3) of the ACFAS scoring scale. *J Foot Ankle Surgery.* 2014 Sep 1; 53(5): 544-547.
[5] Cook JJ, Cook EA, Rosenblum BI, Landsman AS, Roukis TS. Validation of the American College of Foot and Ankle Surgeons scoring scales. *J Foot Ankle Surg.* 2011 Jul-Aug; 50(4): 420–429.
[6] Kinzey SJ, Armstrong CW. The reliability of the star-excursion test in assessing dynamic balance. *J Orthop Sports Phys Ther.* 1998 May 1; 27(5): 356-360.
[7] Olmsted LC, Carcia CR, Hertel J, Shultz SJ. Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. *J Athl Train.* 2002 Dec; 37(4): 501-506.
[8] Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. *N Am J Sports Phys Ther.* 2009 May; 4(2): 92-99.
[9] Budiman-mak E, Conrad KJ, Roach KE. The foot function index: a measure of foot pain and disability. *J Clin Epidemiol.* 1991; 44(6): 561-570.
[10] Thomas JL, Christensen JC, Mendicino RW, Schubert JM, Weil LS, Zlotoff HJ, Roukis TS, Vanore JV. ACFAS scoring scale user guide. *J Foot Ankle Surg.* 2005 Sep-Oct; 44(5): 316-335.
[11] Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB. Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther.* 2006 Dec; 36(12): 911-919.
[12] Gribble Pa, Hertel J, Plisky P. Using the star excursion balance test to assess dynamic postural-control deficits and outcomes in lower extremity injury: a literature and systematic review. *J Athl Train.* 2012 May-Jun; 47(3): 339-357.
[13] Guyatt G, Rennie D, Meade MO, Cook DJ. Users' Guides to the Medical Literature: *A Manual for Evidence-Based Clinical Practice*. Second Edition. New York: McGraw-Hill, 2008.

We would like to acknowledge Drs. Andy Meyr (Faculty advisor, TUSPM ACFAS student club) and Steven Pettineo (Chairman, Department of Biomechanics, Temple University School of Podiatric Medicine) for their advisory role with this project.