Nonoperative Treatment of Bimalleolar Equivalent Ankle Fractures: A Retrospective Review of 51 Patients

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The purpose of this retrospective study was to determine the outcome of bimalleolar equivalent ankle fractures in patients who were treated nonoperatively. The charts of 214 patients with isolated Weber B (supination-external rotation pattern) fibula fractures were reviewed. Fifty-one patients met the inclusion criteria and were administered the American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey by telephone or personal interview. The average medial clear space was 5.09 mm; the average American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey score was 84.22. A medial clear space of 4, 5, 6, and 7 mm resulted in American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey scores of 90.22, 89.4, 72.0 and 63.17, respectively. Further analysis showed significant differences in American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey scores between the 4 mm medial clear space group and the 6 mm and 7 mm medial clear space groups; the 5 mm medial clear space group and the 6 mm and 7 mm groups. Our results suggest that medial tenderness and ecchymosis alone are not sufficient to meet operative criteria, a higher medial clear space on stress gravity views correlates with a lower American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey score, and that there are significant differences in American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional Survey scores between groups with medial clear space 4 to 7 mm. ACFAS Level of Clinical Evidence: 2b. (The Journal of Foot & Ankle Surgery 47(1):40–45, 2008)

Key Words: supination-external rotation, fibula fracture, deltoid ligament injury, medial clear space

Ankle fractures remain one of the most common orthopedic injuries encountered by foot and ankle surgeons. Isolated fibular fractures account for a high percentage of these injuries. Classification systems exist to help describe the injury and guide providers in treatment (1–3). In 1954, Lauge-Hansen published a classification system that correlates mechanism of injury with a specific fracture pattern (1, 2). A few years later, Weber modified the Danis classification by focusing on the anatomic location of the distal fibula fracture (3). Both systems provide surgeons with both diagnostic and treatment information.

Lauge-Hansen's classification describes the position of the foot (ie, supination) and motion of the leg (ie, external rotation) at the time of injury (1). This study focuses solely on the supination-external rotation (SER) mechanism. There are 4 stages of the supination-external rotation pattern. As the pattern progresses from SER I to SER IV, the severity of injury advances and the Lauge-Hansen classification suggests that treatment increases in complexity. Supination-external rotation I involves a rupture of the anterior inferior tibio-fibular ligament, while SER II implies a short oblique fracture of the fibula or rupture of the lateral ligaments. The majority of nondisplaced SER I and SER II injuries are considered stable and treated nonoperatively (4–10). SER III patterns proceed posteriorly to include a rupture of the posterior inferior tibio-fibular ligament or fracture of the posterior malleolus. The terminal stage, SER IV, involves either a fracture of the medial malleolus or a rupture of the deltoid ligament complex.

In conjunction with injuries sustained, medial disruption implies ankle instability. The literature is replete with evidence to support operative treatment of SER IV injuries (11–23). In SER IV injuries, determining ankle instability and the need for operative repair is simple when the medial malleolus is fractured. However, if the deltoid ligament complex is disrupted, identification of the injury is less obvious, while the degree of instability is thought to be the

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same (11, 15, 18, 21–29). Medial tenderness, medial ecchymosis, and swelling have been reported to imply deltoid ligament disturbance. In turn, these soft tissue indicators may be used to assume medial ankle instability. Recent literature has challenged the reliability of the aforementioned soft tissue signs (23, 30). Schuberth et al (30) evaluated deltoid competence arthroscopically in patients with similar physical findings and found a high false positive percentage for incompetence. In short, many patients who were thought to have unstable ankle injuries by soft tissue signs showed no evidence of deep deltoid disruption by arthroscopy. McConnell et al (23) had similar findings when these soft tissue factors alone are used as operative guidelines. His results suggest that medial stress gravity radiographs should be used to more accurately determine ankle instability. This study will evaluate patients who had documented medial tenderness, medial ecchymosis, swelling, and stress positive (medial clear space 4 mm or greater) radiographs, but were treated nonoperatively. Reasons for nonoperative treatment include failure to consent to surgical intervention, failure to keep preoperative medical evaluation appointments, and/or financial reasons. The purpose of this study is to determine if the measurement of the medial clear space (MCS) on stress gravity view was a factor in predicting functional outcome.

Methods

The purpose and methods of this study were approved by our hospital institutional review board. All patients sustained injuries between 1997 and 2004. Inclusion criteria were Weber B fibula fracture, documented (by attending physician or resident under supervision) medial tenderness, ecchymosis, swelling, and stress positive ankle mortise radiographs on initial examination in the emergency department (Figure 1). If, during the chart review, the above descriptions were not reflected in the documentation, the subject was excluded. A stress positive radiograph was defined as MCS greater than 4 mm or an MCS 1 mm greater than the superior tibiotalar articular space. The later condition was established to avoid false-positive measurements in patients of larger stature. In each case, fibular displacement was less than 2 mm. A single author (J.R.C.) confirmed these measurements on radiographs at the time of review. The original stress gravity radiograph was measured 3 times to minimize discrepancy. Exclusion criteria were surgical treatment of the fracture, documented narcotic dependence, poor documentation, or workers compensation injuries. Two hundred fourteen patient charts from our hospital were reviewed, but only 51 met the inclusion criteria. Patients were grouped by width of the MCS: 4.00 to 5.00 mm, 5.01 to 6.00 mm, 6.01 to 7.00 mm, and greater than 7.00 mm for comparison. All patients were contacted by telephone. The

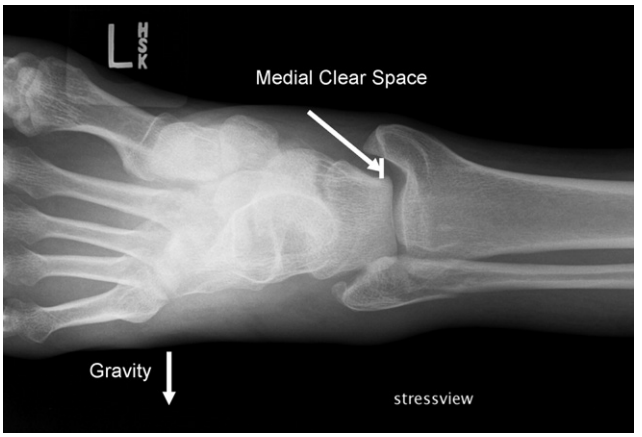

FIGURE 1 Positive stress gravity view showing medial clear space >4 mm.

subjective portion (Figure 2) of the American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional survey (AOFAS) questionnaire (31, 32) was administered during the initial telephone contact. All subjects were then evaluated in the clinic to answer objective portions of the AOFAS survey. If the investigator (J.R.C.) was concerned by language barriers or the interpretation of respondent's answer, the subjective portion of the AOFAS survey was administered again during the clinical assessment. The data were evaluated with attention directed toward distribution, and both descriptive and inferential statistical analyses, including linear regression and analysis of variance (ANOVA), were undertaken.

Results

Fifty-one patients between 1997 and 2004 sustained bimalleolar equivalent ankle fractures (SER IV) and were treated nonoperatively. The median time from injury to administration of the AOFAS survey was 26 months (range 14 to 60 months). For all subjects, the mean functional score was 84.22. The mean MCS at time of injury was 5.094 mm. Patients with MCS values of 4 mm had a mean AOFAS score of 90.22; 5 mm, 89.4; 6 mm, 72.0; and greater than 7 mm, 63.17. Linear regression analysis model (Table 1) showed a strong relationship between the response variable (AOFAS score) and the predictor variable (MCS) with a negative slope showing that an increase in MCS leads to a decrease in AOFAS scores ($R^2 = 0.7874$ with a negative slope $\beta_1 = -9.11009$). This negative slope indicates that as MCS values increase, AOFAS scores decrease. ANOVA was used to evaluate the difference between groups. Results of ANOVA showed significant difference between groups: $F = 280.88$ and $P < .05$ (Table 2). Further multiple comparisons between groups by the Tukey method (33) showed significant differences in AOFAS scores between the 4-mm

Category	Criteria	Points
Pain (40 points)		
	None	40
	Mild, occasional	30
	Moderate, daily	20
	Severe, almost always present	0
Function (50 points)		
Activity limitations, support requirement		
	No limitations, no support	10
	No limitation of daily activities, limitation of recreational activities, no support	7
	Limited daily and recreational activities, can	4
	Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum walking distance, blocks		
	Greater than 6	5
	4-6	4
	1-3	2
	Less than 1	0
Walking surfaces		
	No difficulty on any surface	5
	Some difficulty on uneven terrain, stairs, inclines, ladders	3
	Severe difficulty on uneven terrain, stairs, inclines, ladders	0
Gait abnormality		
	None, slight	8
	Obvious	4
	Marked	0
Sagittal motion (flexion plus extension)		
	Normal or mild restriction (30° or more)	8
	Moderate restriction (15° - 29°)	4
	Severe restriction (less than 15°)	0
Hindfoot motion (inversion plus eversion)		
	Normal or mild restriction (75%-100% normal)	6
	Moderate restriction (25-74% normal)	3
	Marked restriction (less than 25% normal)	0
Ankle-hindfoot stability (anteroposterior, varus-valgus)		
	Stable	8
	Definitely unstable	0

AOFAS Ankle-Hindfoot Scale, Subjective Portion (90 points total)

FIGURE 2 AOFAS Ankle-Hindfoot Scale, Subjective Portion (90 points total).

MCS group compared to the 6-mm and 7-mm MCS groups; the 5-mm MCS group compared to the 6-mm and 7-mm MCS groups; and the 6-mm MCS group compared to the 7-mm MCS group (Table 3).

Discussion

Traditionally, surgeons relied on medial tenderness and medial ecchymosis to determine deltoid incompetence (11, 15, 18, 21–29). Even though these findings are very sensitive, the specificity of physical exam has been somewhat devalued with recent research (23, 30) that has suggested that the less substantial superficial deltoid ligament is easily disrupted by supination–external rotation patterns. Failure of this ligament will regularly cause swelling, tenderness, and ecchymosis leading to the appearance of deltoid incompetence when, in fact, the more critical deep deltoid ligament is unimpaired.

Positive stress gravity radiographs are helpful adjuncts in determining medial ankle instability, but to our knowledge no study exists to correlate patient satisfaction and function with MCS values. One could postulate that as MCS increases, the patient's functional outcome deteriorates. Our results point out that a larger MCS could be indicative of a more severe injury. On the contrary, we also discovered that functional outcomes seem satisfactory with MCS values of 4 mm and 5 mm. This discovery lends credence to a recent study that suggests ankle position (dorsiflexion and external rotation) at the time of stress examination provides a more reliable MCS value (20). Perhaps technician error or patient positioning during stress gravity

TABLE 1 Regression analysis for monitoring relationship and strength of relationship between AOFAS scores (dependent) and MCS groups (predictor)

Root MSE	4.73278	R-Square	0.7874		
Dependent Mean	84.21569	Adj R-Sq	0.7831		
Coeff Var	5.61984				
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	129.94476	3.45858	37.57	<.0001
MCS	1	−9.11009	0.67625	−13.47	<.0001

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional survey; MCS, medial clear space; MSE, mean square equivalent.

TABLE 2 Analysis of variance for significant difference in AOFAS between MCS groups

Source	DF	Sum of squares	Mean square	F Value	Pr > F
Model	3	4889.883007	1629.961002	280.88	<.0001
Error	47	272.744444	5.803073		
Corrected Total	50	5162.627451			
Source	DF	Type I SS	Mean square	F Value	Pr > F
MCS	3	4889.883007	1629.961002	280.88	<.0001
Source	DF	Type III SS	Mean square	F Value	Pr > F
MCS	3	4889.883007	1629.961002	280.88	<.0001

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional survey; MCS, medial clear space.

TABLE 3 Multiple Comparisons of AOFAS scores between MCS groups determined using analysis of variance with Tukey's method

MCS Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
4 mm–5 mm	0.8222	−1.2623	2.9067	
4 mm–6 mm	18.2222	15.3643	21.0801	***
4 mm–7 mm	27.0556	24.0310	30.0801	***
5 mm–4 mm	−0.8222	−2.9067	1.2623	
5 mm–6 mm	17.4000	14.5824	20.2176	***
5 mm–7 mm	26.2333	23.2469	29.2198	***
6 mm–4 mm	−18.2222	−21.0801	−15.3643	***
6 mm–5 mm	−17.4000	−20.2176	−14.5824	***
6 mm–7 mm	8.8333	5.2638	12.4029	***
7 mm–4 mm	−27.0556	−30.0801	−24.0310	***
7 mm–5 mm	−26.2333	−29.2198	−23.2469	***
7 mm–6 mm	−8.8333	−12.4029	−5.2638	***

Comparisons significant at the .05 level are indicated by ***
Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Functional survey; MCS, medial clear space.

image produced an artifactual increase in MCS value. In a cadaveric study, Park et al (20) reported an MCS of 5 mm or greater was the most reliable predictor of deep deltoid ligament competence; however, these authors point out the importance of ankle position at time of radiographic examination. Since positional changes of the ankle affect the MCS value, it places immense challenge on the surgeon to determine deltoid competence and thus decision for operative care. More specific modalities such as ankle arthroscopy, ultrasound, and magnetic resonance imaging have been used to more accurately access the deep deltoid complex. However, ankle arthroscopy and magnetic resonance imaging are very costly, and the accuracy of these modalities can be doubted also.

Stress gravity radiographs, done properly, provide the most efficient means of evaluating the deep deltoid ligament competence (20, 23). The results from this study support the recent findings of other researchers and confirm that medial tenderness, medial ecchymosis, and patients with MCS values of 4 to 5 mm can be treated nonoperatively while maintaining a satisfactory AOFAS score. Our conclusions adduce the need for careful or perhaps more detailed evaluation of deltoid competence. Our results also confirm that larger MCS values produce a more severe injury; to our knowledge, this has always been conjecture. Because patients with MCS values of 6 to 7 mm did statistically worse than those with values of 4 to 5 mm, the need for operative intervention of the former group is sup-

ported while the smaller MCS values (4 to 5 mm) seem amenable to nonoperative treatment

The major limitation to this study is the lack of a control cohort. A functional satisfaction survey of patients with distal fibula fractures and comparable MCS values (4, 5, 6, and greater than 7 mm) would provide a powerful comparison. The retrospective study design and subjective nature of the AOFAS Ankle and Hindfoot Functional satisfaction survey are also limiting factors. Another limitation is that the same technician did not perform each of the stress gravity exams. This could have created discrepancy in MCS values due to inconsistent technique or position. Finally, some bias is unavoidable in the subjective nature of questions of the AOFAS Ankle and Hindfoot Functional survey when administered by phone.

Conclusion

Several experts in ankle trauma and surgery (4–18, 22, 28, 29) have published articles on proper examination and operative indications for isolated fibular fractures. Medial malleolar fractures allow for swift and reliable identification of medial ankle instability. Before recent research, physical examination alone was used to determine instability and, thus, surgical repair. Our results confirm that medial tenderness and ecchymosis alone are not sufficient to meet operative criteria, a higher MCS on stress gravity views correlates with a lower AOFAS score, and that there are significant differences in AOFAS scores between groups with MCS of 4 to 7 mm. Based on our results, further investigation into medial clear space values should be considered. In this study, patients with medial clear space values of 4 mm on stress radiographs reported good functional outcomes.

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