CHAPTER 21

RETROSPECTIVE REVIEW OF ANKLE FRACTURES: Biomechanical Comparison of the Contralateral Limb

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INTRODUCTION

The goal of ankle fracture treatment is to bring the patient as close to pre-fracture state as possible. When patients undergo open reduction with internal fixation for an ankle fracture the goals of the Association for the Study of Problems of Internal Fixation (AO/ASIF) group are also added.[1-4] With this in mind and considering the large body of literature concerning ankle fractures, we compare quantitative ankle fracture outcomes based on biomechanical examination of the foot and ankle.

It is clear that anatomic reduction, severity of fracture, early mobilization and many other factors contribute to the long-term outcome.[1,5-9] What is unclear is what if any biomechanical parameters are useful in predicting ankle fracture outcome and whether a return to a "normal" biomechanical state is a key to avoiding long-term ankle fracture morbidity.

PATIENTS AND METHODS

A retrospective study was conducted to correlate clinical biomechanical data relative to function and pain postoperatively in ankle fractures treated with open reduction with internal fixation (ORIF). The selected patients were skeletally mature with closed fracture of the ankle in non-neuropathic joints. The patients were treated between July 1994 and June 1998 at Scripps Mercy Hospital/Trauma Center, San Diego, California. All patients had a single limb affected, and all surgeries were participated in by podiatry residents. There were 208 successive ankle fracture cases that were included. All of the patients included in the study had radiographic review and were found to have adequate reduction by AO/ASIF standards.[1-4]

All 208 patients were sent a questionnaire which was modified from the (AOFAS) American Orthopedic Foot & Ankle Society, Hind Foot & Ankle Scale.[10](Fig. 1) Each patient that returned the questionnaire was brought back for a clinical biomechanical examination of the foot and ankle, according to the method described by Root, Orien and Weed.[11] Data was collected comparing the affected to the unaffected limb which was referred to as the theoretical normal. All patients were examined at least two years postoperatively (range: 2 to 6 years). Scores describing pain, function and biomechanics were recorded using data collected. Each fracture was classified according to the Lauge-Hansen system. Comparisons were made regarding the type and severity of fracture, as well as the pain, function and biomechanical parameters. Other data such as age, previous ankle injuries, length of immobilization and physical therapy were also included.

RESULTS/DATA

Fifty-one of the 208 patients (25%) returned the questionnaire and were available for clinical examination. The average age of the patient was 53-years-old (range was 22 to 81 years) and there were 32 females and 19 males. There were 38 (74%) supination external rotation, 9 (18%) pronation external rotation, 3 (6%) supination adduction, and 1 (2%) pronation abduction fractures.

All postoperative patients had an ankle-hindfoot score of at least 77 with a mean of 88.6 and an average of 94.3. When comparing fracture type, those patients with advanced types of supination external rotation (SER) and pronation external rotation (PER) injuries did slightly worse overall, which could be predicted. Comparing biomechanical exams, many (35 of 51) had decreased ankle joint range of motion (ROM). Patients averaged 3.1 degrees of decreased dorsiflexion of the ankle compared to the unaffected side (Fig. 2); with the knee flexed an average of 2.7 degrees decrease was noted.

Figure 1.

ANKLE-HINDFOOT SCALE (100 POINTS TOTAL)

Pain (40 points)	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always	0
Function (50 Points)	
Activity, limitations, support required	
No limitations, no support	10
No limitation of activities, limitation of recreational activity, no support	7
Limited daily and recreational activities, cane	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 (Dorsiflexion)	
10 degrees or more	8
6-9 degrees	4
less than 6 degrees past perpendicular	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
Alignment (10 points)	
Good, plantigrade foot, ankle-hindfoot well-aligned	10
Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms	5
Poor, non plantigrade foot, severe malalignment, symptoms	0
Total	100

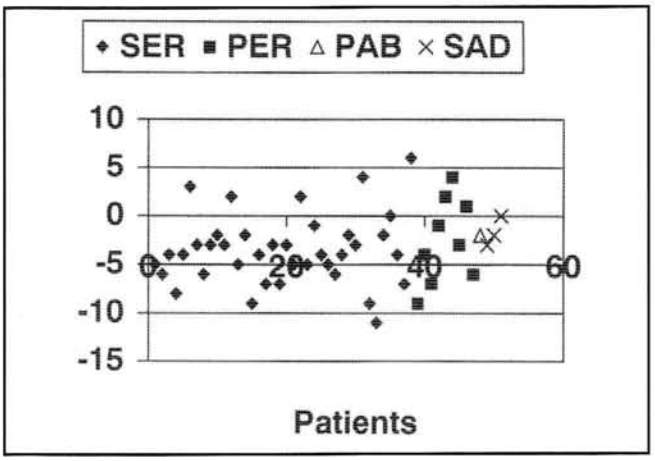

Figure 2. Ankle Joint Dorsiflexion Compared to Unaffected Limb.

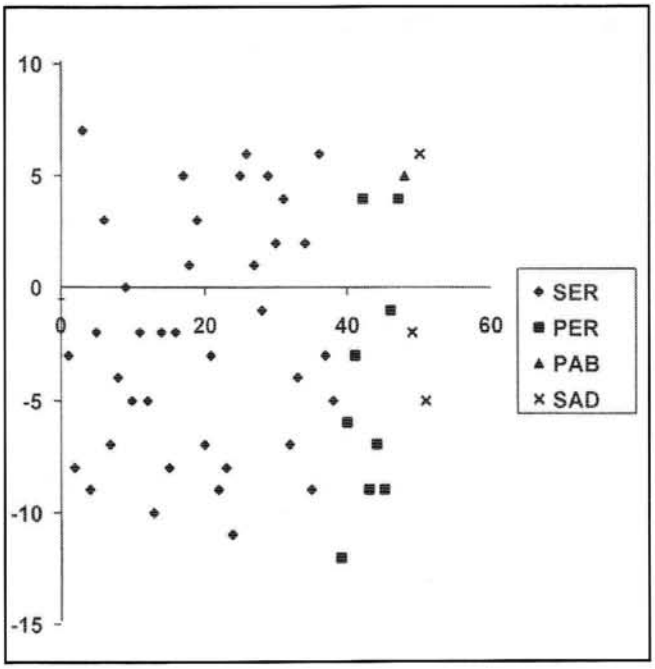

Figure 3. Difference in Subtalar Joint ROM.

The subtalar joint ROM and clinical exam revealed no relationship to type of fracture and limited range of subtalar joint motion unless a Volkmann's fracture was involved. It should be noted that overall there was an average 2.5 degree decrease in subtalar joint ROM compared to the contralateral limb. However, the decrease in ROM was not universal. Only 9 patients (17%) had clinically elicited pain with ankle ROM, however 10 patients (20%) had clinically apparent pain with subtalar joint ROM. (Fig. 3)

Collected data was further analyzed for correlation between first ray range of motion, forefoot to rearfoot position, and foot position both resting and neutral. No correlation was found between these biomechanical parameters and any fracture types. Additional data recorded noted that two patients were wearing orthotics. A syndesmotic screw was used in all but one PER fracture. Some or all of the hardware was removed in 17 patients (33%). Mild swelling of the ankle joint, not related to fracture severity or pain was reported in 10 patients (20%). Forty-two of the patients (82%) were in a cast for 8 weeks or more, but the duration of time did not relate to eventual ROM or overall outcome. Although physical therapy was a part of 80% of all patient care, there was no correlation between physical therapy and outcome or ROM.

There was a correlation between range of motion and outcome when related to the presence of a Volkmann's fracture which was present in 9 (18%) patients. Overall the Volkmann's fracture group had an average decrease of 6.1 degrees of ankle dorsiflexion and 5.1 degrees decrease of subtalar joint ROM. A trend towards a decrease in dorsiflexion and subtalar joint ROM in the patients with Volkmann's posterior malleolar fractures was found. Patients with a posterior fracture had an average AOFAS score of 89.4 points compared to 95.4 points average for all other fractures without a Volkmann's fracture.

DISCUSSION

It is clear that in any traumatic event, the more severe the injury, the greater the long-term morbidity. Our results indicate a clinically significant decrease in ankle dorsiflexion in the majority of the repaired ankles compared to the unaffected side. What might be questioned is whether previously described ROM values for ankle dorsiflexion in normal ambulation are indeed accurate as only one of the patients had a clinically notable early heel-off.[1,11-13] It must be said that although many of the patients had limited ankle dorsiflexion, this only related directly to outcome when a posterior malleolar fracture was involved. In 9 Volkmann's fractures, only one involved over 25% of the joint surface and was fixated. One might also question the direct effects of other relevant factors such as the position of the foot when casted, and the duration of the initial casting. These were not clearly defined in this study. Although it has been assumed that physical therapy has a role in ankle fracture management, there is no clear evidence based on the data in this study that physical therapy changes either long-term outcome or biomechanical parameters. This observation is supported by previous studies.[7,14]

When looking at longer term sequella in patients with ankle dorsiflexion of less than 10 degrees past perpendicular, one might question the consistency of any long-term development of other foot deformities such as hammertoes and increased forefoot plantar pressures. As previously described, none of these were noted to be significant when compared to the opposite extremity.[15,16] This might be especially pertinent in patients that already have plantarflexed metatarsal deformities and patients that have or may develop diabetic neuropathy.

Looking at the subtalar joint, it appears that this area is often overlooked due to the larger, more grossly deformed ankle joint. Patients evaluated in this study had a significant decrease in subtalar joint ROM when compared to the contralateral limb. Many patients also had clinically reproducible pain in the subtalar joint, however it was mild in all but one patient and not statistically related to ROM.

There is a growing body of literature suggesting that in many cases, the talocalcaneal interosseous ligament is affected with moderate and severe ankle fractures and sprains.[1,13,17,18] It is not clear what morbidity relating to long-term osteoarthritis or physical limitation this represents. None of the patients had a notable gait or gross abnormality of the foot relating to the decreased subtalar joint ROM. There have also been reports of osteochondral lesions of the subtalar joint after severe ankle injuries.[18,19] It is questionable whether one might consider in cases of high grade PER or SER fractures doing initial arthroscopic joint inspection. This data also suggest that if one is doing an ankle arthroscopy after an ankle fracture and subtalar joint

pain also exists, then it may be beneficial to also scope the subtalar joint verses other diagnostic imaging. This makes subtalar joint clinical evaluation of every patient who has had a previous ankle fracture a necessary part of each examination. Since both the STJ and ankle joint may be involved alone or together it may also mandate a diagnostic injection of one or both joints when long-term pain persists.

It is apparent that when dealing with the subtalar and ankle joint, a clinically decreased range of motion is generally not directly correlated to STJ or ankle joint pain. As only one of our patients with a Volkmann's fracture (posterior malleolar) was fixated, it might be proposed that these be treated more aggressively with fixation. In general, the more severe fractures have more morbidity. The question remains as to whether more of these should be fixated when less than 25% of the joint is involved, or whether Vassels rule is enough to maintain reduction of these fractures.

CONCLUSION

Although the patient response was less than 25%, it is important to realize that this data is not conclusive by any means. There is value in this study in making clinicians aware of what ROM values to look for when seeing patients at long-term follow-up after ankle fractures. It is also important to recognize that the subtalar joint morbidity related to ankle fractures is a more significant issue than described in the literature. The study further suggests that fixation of a posterior malleolar fracture through less than 25% of the ankle joint surface may need to be looked at more closely when fixating trimalleolar ankle fractures.

It is clear that many of the patients in this study had a decrease in dorsiflexion ROM of the ankle joint compared to the contralateral limb, however, the decrease does not appear to directly correlate to long term pain or dysfunction in most patients. Again the question should be raised of just how much ankle dorsiflexion is needed for normal ambulation and function, and whether a small unilateral decease in range of motion has any real long term morbidity not appreciated in this study.

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