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Abstract

Purpose: The treatment of proximal 5th metatarsal fractures is based on location and displacement, but surgery is often recommended in adult feet due to the watershed location and poor vascularity of the bone. The purpose of this study was to evaluate the outcomes of children treated without surgery for their proximal 5th metatarsal fractures.

Methods: A retrospective review was performed on all children identified by ICD-9 code to have sustained a 5th metatarsal fracture between 2006 – 2007 with initial non-operative management and immobilization. Demongraphics and radiographic parameters were then recorded. All children meeting criteria were then invited to participate in a telephone interview in order to obtain outcome measures, including: AOFAS midfoot scores, FAOS scores, and SF-8 scores.

Results: 124 children were identified, but only seventy-six patients (mean age 12.6± 2 yrs) had available radiographs. Mean duration of radiographic follow-up was 5.0 weeks in those with union and 8.3 weeks in those without union (p=0.033). There was a trend (p=0.068) for greater displacement in the non-union factures. Thirty children (24%) agreed to participate in the phone interview at a mean 6.6±0.5 years after injury. Overall, the outcome scores were: AOFAS 98.5±37, FAOS Pain 95±12, FAOS Symptoms 96±8, FAOS ADL 97±7, FAOS Sports 93.5±13, FAOS QOL 89.8±20. Of this cohort, 6 were lost to follow-up prior to radiographic union, and this subset actually scored better, then the known union cohort for FAOS Pain (p=0.05) and Sports (p=0.04) domains.

Conclusion: With intermediate-term follow-up (mean 7 years) children treated without surgery for their 5th metatarsal fractures score very well on functional outcome measures, including those that did not have a complete union at final follow-up visit. Childhood proximal 5th metatarsal fractures may be treated with cast immobilization for 4 to 6 weeks with success.

Introduction

The most common fractures of the foot in children involve the metatarsal bones, accounting for 61% of all foot fractures.[1] Moreover, fractures of the proximal fifth metatarsal are the most common metatarsal fracture.[5] The proximal fifth metatarsal fracture is usually caused by an inversion/rotational mechanism or a direct adduction force on a plantarflexed foot.[2]

Fractures to the proximal fifth metatarsal are split into three main categories: Zone I or apophyseal fractures, Zone II or metaphyseal/Jones' fractures[3], and Zone III or proximal shaft/dancer's fractures. Conservative treatment is recommended for minimally displaced breaks (defined as less than 2mm) in all three zones.[4] Although, the management of these fractures is based almost entirely on adult literature.[1] Current recommendations, based on adult studies and a single study on children, is non-weight bearing ambulation in a short leg cast for 6-8 weeks for minimally displaced fractures, but any displacement greater than 2mm indicates surgery.[1]

In children, Zone 1 fractures can include avulsion fractures, as well as intra-articular fractures. Sometimes avulsion fractures can be confused with the normal apophysis in children because they both occur along a parallel line to the metatarsal shaft. The apophysis usually first shows in radiographs at around eight years old and fusion with the fifth metatarsal base should be complete by age twelve in girls and age fifteen in boys.[3]

Zone II is in the "watershed" zone between two arteries, so it will receive less blood supply during the healing process. This area is of particular concern when

treating without surgery because there is a higher likelihood, with the reduced blood supply, that the area will not reach proper union. This could result in long term functional difficulties for the patient.

To our knowledge, there has not been a previous report on patient-centered outcomes regarding the treatment of these fractures in children. The purpose of this study was to evaluate whether children with proximal fifth metatarsal fractures (regardless of amount of displacement) in Zones I and II who were initially managed conservatively had poor long term functional outcomes, or required subsequent surgery.

Materials and Methods:

A retrospective chart review was performed after Institutional Review Board approval of all children identified by ICD-9 code to have sustained a 5th metatarsal fracture treated during 2006 and 2007. Inclusion criterion was initial non-operative management and immobilization.

Clinical notes were reviewed for demographic information, such as age and gender. Initial treatment, duration of immobilization, conversion of management (especially conversion to surgical intervention) and any complications were noted. Radiographs at the time of initial visit, as well as interval plain films up to and including the final radiograph were reviewed. All measurements were made directly from the digital images with use of radiographic measuring software AMICAS PACS (AMICAS, Inc. Brighton, MA) (Figure 1). Amount of displacement was measured, and the parameter was defined as the greatest amount recorded on any

image (including, anteroposterior (AP), lateral, or oblique images). Angulation was also measured, and this parameter was defined by 3 points (one at the most proximal aspect of the distal fragment laterally, one at the most distal aspect of the proximal fragment laterally, and the third as a point on the medial side of the converging fragments. This measure was only obtained for all, but only utilized for analysis if maximal displacement measured near zero millimeters but there was clear angular deformity. Finally, union of the fracture, defined as consolidation of the fracture lucency with or without reformation of the cortex, was assessed and recorded.

All children identified in the retrospective review were then contacted and invited to participate in a telephone interview. For those agreeing to participate, outcome measures were obtained, including: (American Orthopedic Foot and Ankle Society) AOFAS midfoot scores, (Foot and Ankle Outcome Score) FAOS scores, and SF-8 scores. AOFAS scores had to be modified because the final measurement requires an in person measurement of the final alignment of the foot. We excluded the final question and made the survey out of a total of 85 points instead of 100. We still recorded the final AOFAS score out of 100 (for consistency sake) by converting to a percentage of the total 85 points. FAOS scores were completed in full, and each section was scored out of 100 points, including: Pain score, Symptoms score, Activities of Daily Living (ADL) score, Sports score and Quality of Life (QOL) scores. SF-8 scores, measures of overall mental and physical health, were included as a control for the outcomes recorded.

Descriptive statistics were calculated for the entire cohort. Patients who were recorded as achieving union were compared to those that did not achieve union in terms of length of follow-up and radiographic displacement utilizing nonparametric Mann Whitney U test. Spearman correlation coefficient was used to evaluate relationships between outcomes scores (AOFAS and FAOS with SF-8) as well as fracture severity (displacement and angulation) and outcome scores. Outcome scores for patients who were healed at last follow-up versus those who did not have evidence of healing at their last available follow-up were compared utilizing nonparametric Mann Whitney U test. Alpha was set at $p<0.05$ to declare significance and all analyses were performed with SPSS v. 12 (SPSS Inc, Chicago, IL).

Results:

124 children were identified with a 5th metatarsal fracture during the treatment period. There were 73 (59%) males and 51 (41%) females with an average age of 12 ± 2 years at time of presenation. All but one patient were treated conservatively. Maximum displacement and angulation for the cohort were 1.6 ± 1 mm (range 0 to 4.7) and 7 ± 6° (range 0 to 30). Average follow-up was 2 months (range 0.2 -25 months).

Retrospective analysis

Seventy-six patients (mean age 12.6± 2 yrs) had a minimum of 4 weeks of follow-up or union confirmed on final radiograph. There were 46% girls and 54% boys in the cohort. One child was subsequently treated with open reduction and internal

fixation after an initial attempt of conservative treatment failed to achieve satisfactory relief of symptoms, his fracture was in Zone 1.

Of the 75 children ultimately managed without surgery, most were treated with short-leg casting (70), but three were treated with a splint, and two were treated with a hard-soled shoe. The duration of immobilization varied, but the majority were casted for 4 weeks (Figure 2).

Out of the children that had radiographs available to study there were only 5 without union, and 70 with confirmed radiographic union, at the time of final radiograph. Children with confirmed union were followed a mean 4.99 weeks, while those without confirmed union were followed a mean 8.25 weeks (p=0.033). These 5 children either were lost to follow-up or released to full activity with resolution of symptoms.

The maximum displacement and angulation measures for the entire 75 patient cohort were 1.6 ± 1 mm (range 0 to 4.7) and 7 ± 6° (range 0 to 24). There was a trend (p=0.068) for greater maximum displacement in the factures that did not achieve union, mean displacement 2.4 mm (range 1.6 to 3.5) compared to the fractures that achieved union with final radiographs 1.6mm (range 0to 4.7).

Telephone Interview

Thirty of the initial 124 children (24%) agreed to participate in the phone interview at a mean 6.6±0.5 years after injury. Of the children in the callback group, 3 were in zone II and 26 were zone I (with one unknown). Regardless of initial displacement or union on final radiograph, the mean AOFAS score was 98.5 ± 37. The FAOS scores were equally high: Pain score 95 ± 12, Symptoms score 96 ± 8, ADL

score 97 ± 7, Sports score 93.5 ± 13, and QOL score 89.8 ± 20. The SF-8 score for the entire cohort was 53± 7 (range 32 to 60) for the physical domain and 54± 8 (range 28 to 61) for the mental domain. When assessing the children that scored "poorly" (less than 100%) with the foot and ankle outcome scores were then compared to their respective SF-8 score (Physical mean 50, range 38 to 57; Mental mean 57, range 52 to 61) demonstrating an association of low outcome scores with low SF-8 scores. The SF-8 physical domain score was significantly correlated with all domains of the FAOS; pain (rho=0.54, p=0.002), symptoms (rho=0.66, p≤0.001), activities of daily living (rho=0.65, p≤0.001), sports (rho=0.42, p=0.02), and quality of life (rho=0.54, p=0.002). The AOFAS score did not correlate with the SF-8 physical domain score (rho=0.31, p=0.09). The SF-8 mental domain did not correlate with any of the FAOS domains or the AOFAS score (p>0.05).

The AOFAS score demonstrated a correlation with initial severity of the fracture (rho = -0.49, p=0.009) (Figure 3). None of the FAOS outcome scores demonstrated a correlation with fracture severity.

Of the 30 children with outcome scores, 18 were confirmed as having evidence of radiographic healing at their final follow-up and 12 did not have evidence of healing at their final follow-up (only one was confirmed as a nonunion, 11 were lost to follow-up prior to 4 weeks post injury). A comparison was made in the outcome scores between these two cohorts and found no statistical difference, except in the FAOS Pain and Sports scores. The mean FAOS Pain score in the union cohort was 93, range 47 to 100, and in the not healed group it was better with a mean 99, range 86 to 100 (p=0.05). Similarly, the mean FAOS Sports score in the

union cohort was 91, range 65 to 100, and in the nonunion group it was again better with a mean 97, range 60 to 100 (p=0.04).

Discussion:

Even though children will commonly present with pain at the base of the 5th metatarsal from a fracture, the treatment of these injuries has not been fully studied. The only literature we have suggests that these fractures (regardless of child age) will behave like adult versions and should be treated similarly.[1] Our longer-term outcomes (at nearly 7 years) suggests that this may be overly aggressive in the treatment of these children.

Herrera-Soto and colleagues retrospectively evaluated children with 5th metatarsal fractures,[1] and categorized them into 5 different fracture patterns and treatment recommendations. Regarding the fractures of interest to this current study, the apophyseal fractures required a short-leg walking cast for 3 to 6 weeks, the displaced intra-articular fractures had slow union, and the Jones fractures required surgery. They recommended non-weightbearing casts for fractures with angulation or displacement, particularly when it involved the proximal joint. Our current study mirrored the concept that most children could be treated with walking-casts; and further, indicated that displaced and articular fractures were slower to develop a union. However, the patient-centered outcomes were excellent in all the groups despite this delay in healing, suggesting that no change in weightbearing status was necessary beyond “as tolerated.”

Moreover, only one of the children in our series required a conversion to open reduction and internal fixation for displacement and delayed union of his Type 1 apophyseal avulsion. None of the Type II Jones fractures required conversion, nor any of the Type III fractures. Therefore, it seems that these children have quite different outcomes than there adult counterparts. At least for fractures with less than 5mm displacement (as all were in our cohort), surgery does not appear to be indicated without other clinical indications beyond fracture displacement. It should be noted that our cohort did not truly include teenage patients (the oldest child being 14 years old) and that the conclusions of this current study should reflect the treatment of children, not high school students. Perhaps the conclusions of the previous study, by Herrera-Soto and colleagues, more accurately represents this older population of children (as it was their oldest cohort, mean age 14.2 years) and they recommended considering surgery to prevent re-fracture (not seen in our younger cohort) and to speed return to activity.

For the most part, our entire cohort of callback patients scored very well; but there were a few low sets of scores that brought the mean down. The patients that scored poorly on foot/ankle outcomes also scored poorly on their SF-8 questions. The low SF-8 scores indicate a lower overall physical and mental well-being, which could translate to higher patient perception of lingering disability from the fifth metatarsal fracture, or an overall attitude that life is going poorly, so why not the outcomes of the foot. This is difficult to distinguish.

A major limitation to this study includes the ratio of children initially treated for their 5th metatarsal fracture (75 children) and the number available to complete

the outcome scores at 7 years (30 children, 40%). However, children treated at a mean age 12 years would now be in college, or at least out of the home, and they are a difficult population to find for these longer term outcome studies. Not knowing the radiographic state of the proximal 5th metatarsal fracture is also limiting; however, we believe that the data obtained from further x-rays may not out-weight the risks of additional radiation exposure to the young adult.

We conclude that children who sustain base of the 5th metatarsal fractures have good functional outcomes, at intermediate-term follow-up (mean of almost 7 years) and experience minimal residual disability with conservative treatment. Additionally, radiographic union at last documented follow-up does not appear to be associated with enhanced function in the long term.

The majority of children with proximal 5th metatarsal fractures treated with cast immobilization for 4 to 6 weeks achieved satisfactory union with high functional outcome scores after six to seven years. Those who do not achieve satisfactory union at final follow-up also trended to have a high functional status with minimal disability suggesting that continued radiographic monitoring until complete union may not be necessary in this age group and that surgery is rarely indicated in children.

Figure Legend:

Figure 1: Radiograph with measurements in place demonstrating A) the measure of displacement recorded as millimeters, and B) the measure of angulation recorded as degrees.

Figure 2: Bar graph demonstrating the range of duration for immobilization and the number of children treated for that duration.

Figure 3: A scatterplot of AOFAS scores. The correlation suggests that children with greater initial displacement are less likely to have a perfect AOFAS score at final outcome.

Figure 1

Figure 2

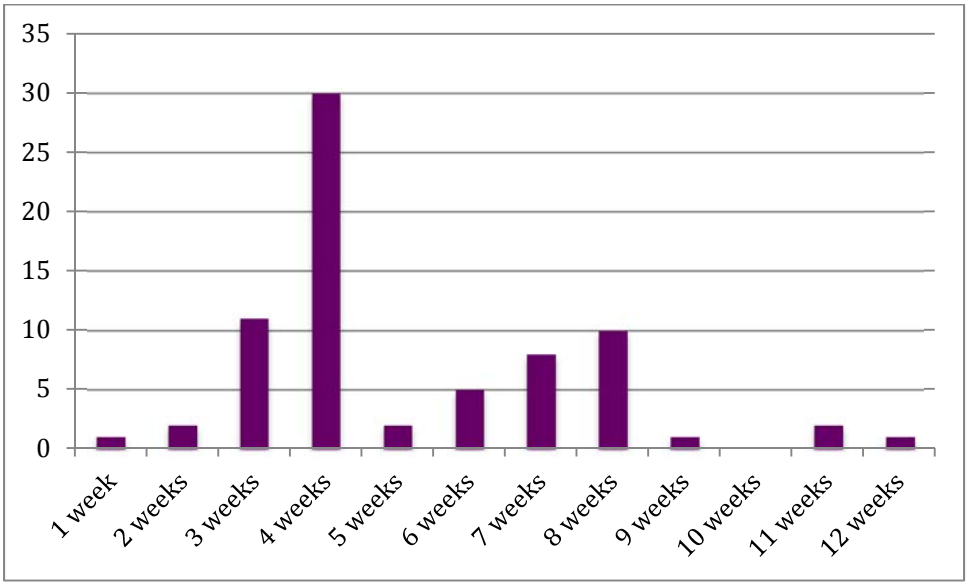
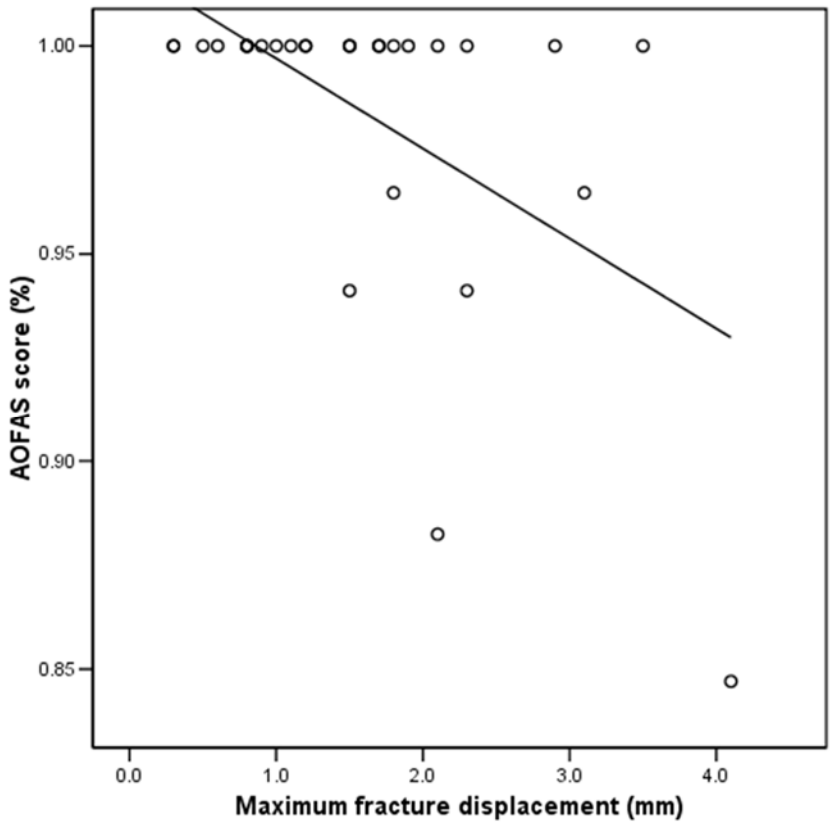


Figure 3



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