Comparison of cast versus crepe bandage for tuberosity fractures of the proximal fifth metatarsal.

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ABSTRACT:

INTRODUCTION: Tuberosity avulsion fractures of the base of the fifth metatarsal are common fore foot injuries and are found following indirect trauma. These injuries have to be clearly distinguished from the "true" Jones fracture, which is located at the junction between the proximal diaphysis and the metaphysis of the fifth metatarsal involving the 4th to 5th intermetatarsal articulation and from the proximal diaphyseal fracture, which is located distally to the 4th to 5th intermetatarsal articulation. Tuberosity fractures of the proximal fifth metatarsal are common injuries, but with few comparisons of conservative treatment options. The objective of the study was to evaluate functional outcomes of two commonly used conservative treatment methods; short-leg cast and crepe bandage, for the tuberosity avulsion fractures.

METHOD: Thirty-nine (n=39) patients with acute undisplaced or minimally displaced avulsion fracture of the fifth metatarsal base were allocated to treatment in either a short leg plaster cast (n= 21) or crepe bandage (n= 18) for a period of 4 weeks. Patients were assessed at 1, 4, 6, 8 and 12 weeks after injury using a modified American Orthopaedics Foot and Ankle Society (AOFAS) mid-foot score, Visual Analogue Scale (VAS) pain score, time to independent mobility, mid-foot circumference, clinical and radiological analogue. A Mann–Whitney U test was chosen to compare the primary outcome measures between the groups (p-value of 0.05 or less was deemed significant).

RESULT: Patients treated in short leg cast had significantly lower VAS pain score at 1st week (p=0.008) but the score was comparable to crepe bandage at 4 weeks (p=0.091). Patients treated with crepe bandage had significantly higher AOFAS mid-foot scores at 8 weeks and 12 weeks follow-up (p=0.049 and p= 0.015) and had earlier time to independent mobility (p=0.0014).

But, there was no significant difference between the two groups in mid-foot circumference, clinical and radiological union time. Two patients in cast group had complications; one had tight cast which needed bivalving and the other had Chronic Regional Pain Syndrome (CRPS) type 1.

CONCLUSION: We conclude that a crepe bandage allows patients to return to independent levels of activity faster than when treated in a short leg cast without compromising clinical or radiographic union.

KEY WORDS: tuberosity avulsion fractures, common foot injuries, conservative treatment, functional outcome, modified AOFAS mid-foot score

INTRODUCTION:

Of all foot fractures, the fifth metatarsal fracture is the most common. Much has been discussed about it since Sir Robert Jones first drew attention to this fracture when he incurred the injury while dancing around a maypole at a military garden party in 1896. In 1902, Jones described the location of the fracture as the three-quarter–inch (1.5 cm) segment of the shaft on the fifth metatarsal bone distal to the styloid.1 Since then, virtually all fractures of the proximal fifth metatarsal have been labelled as ‘Jones fractures’. The continued use of this imprecise term, however, has perpetuated the confusion and controversy regarding the classification, pathomechanics, and the choice of treatment for this type of fracture.2

The intraosseous blood supply to the fifth metatarsal tuberosity arose from numerous metaphyseal vessels penetrating the nonarticular surfaces of the tuberosity in a random, radiate pattern.3 Injuries to the proximal diaphysis of the metatarsal are likely to injure the proximal branch of the intraosseous nutrient vessel and to impair the blood supply to the distal portion

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of the proximal fragment of the bone. This watershed area creates an avascular zone, which can increase the risk of delayed union or nonunion. The proximal fifth metatarsal has been classified into three zones as proposed by Quill in 1995 (Fig.1). Zone 1, the most proximal zone, is the cancellous tuberosity which usually extend into the fifth metatarsocuboid joint. Zone 2 includes the more distal tuberosity. Fractures of this zone extend into the area of articulation of the fifth metatarsal with the fourth metatarsal. Zone 3 begins just distal to these ligamentous structures and extends distally into the tubular portion of the diaphysis for approximately 1.5 cm.

The mechanism of injury can be correlated to fracture type. Type I fracture (tuberosity) is caused by traction-type forces exerted on the peroneus brevis tendon and/or the lateral band of the plantar fascia with inversion of the foot. Fractures in zone 1 usually begin laterally on the tuberosity and extend proximally into the metatarsocuboid joint. They course through the cancellous bone, which has an excellent blood supply.

Type II (Jones) fracture is caused by an indirect large adduction force applied to the forefoot with the ankle in plantar flexion. The ligaments at the base of the fourth and fifth metatarsals are resistant to displacement, and type II fracture occurs in the direction of the joint between the fourth and fifth metatarsals.

Type III fracture (diaphyseal stress), which occurs distal to the metaphyseal-diaphyseal juncture, is caused by overuse or overload.

The most common fracture of the proximal fifth metatarsal is the tuberosity avulsion fracture. They constitute two-thirds of all fifth metatarsal fractures and are usually low energy injuries sustained after a fall or twist. The mechanism of injury as implicated by Richli and Rosenthal, in a cadaveric study, is the lateral band of the plantar aponeurosis as the structure more likely to cause tuberosity avulsion fractures. This fracture is typically extra-articular, and fracture displacement is uncommon. Were the peroneus brevis the cause of the avulsion, muscular contraction and spasm would cause displacement in the patient who was not immobilized; however, this rarely occurs. Occasionally, a larger piece of bone is avulsed, and the fracture line may extend into the cuboid-metatarsal joint. Successful treatment of avulsion fractures of the base of the fifth metatarsal has been achieved using both short leg casts and elastic crepe bandage.

Anatomic variations that may be confused with fractures of the proximal fifth metatarsal include the secondary center of ossification, the os peroneus (an ossicle in the peroneus longus tendon) and the os vesalianum (an ossicle in the peroneus brevis tendon).

**METHOD**

A prospective comparative interventional study was conducted in Bir Hospital among fifty patients for one year. Inclusion criteria were; isolated tuberosity fracture to the base of the fifth metatarsal (Zone I fractures), displacement ≤ 2 mm, less than 30% of the cubometatarsal joint involvement, ages more than 16 years. Exclusion Criteria were; open fractures, polytrauma with major organ disruption and/or life threatening injuries, associated concurrent fractures or dislocations in the ipsilateral lower limb, pathological fractures, non-ambulatory patients, patients unable to provide informed consent.

Approval was taken from the IRB (Institutional Review Board). This study was conducted as a clinical research for the faculty of Orthopedics and Trauma Surgery, NAMS. The patients were randomized to one of the two treatment groups by the sealed envelope method. Consecutive patients meeting criteria for a diagnosis of tuberosity fracture of base of 5th metatarsal were enrolled after we obtained informed consent. Half of the patients were treated by elastic crepe bandage, and the other half of the patients were treated by short leg cast.
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INTERVENTIONAL PROCEDURE

Group A patients received short below-knee weight-bearing cast made up of lightweight synthetic material. This cast included the distal third of leg with ankle and foot.

Group B patients received elasticated crepe bandage of appropriate size including ankle and foot. The bandage was applied in a reverse way from the traditional fashion that is the wrapping from medial aspect of foot then rolling it laterally so as to evert the foot. The bandage encircled the foot and ankle progressively. It is applied firmly and the foot was in mild eversion at the completion. These patients were advised to walk in a hard sole shoe.

FOLLOW UP

Both groups were advised to use elbow crutches or cane for support and to mobilize as tolerated from the time of injury. The patients were seen in the Out Patient Department at 1 week, 4 weeks, 6 weeks, 8 weeks and 12 weeks to assess the various outcome parameters. An adequate supply of oral analgesic medication was provided along with written instructions about maintaining a daily analgesic intake. A standard dorso-plantar, oblique and lateral radiograph of the affected foot were obtained at 4 weeks, 8 weeks and 12 weeks to assess the radiological union.

Statistical data analysis will be done using the Statistical Package for the Social Sciences (SPSS) software package (SPSS Inc. Chicago, IL). The descriptive statistics was used to calculate mean and the median values. Because of the relatively small sample size and possible deviations from normality,
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Median values are used instead of means in statistical analyses. A Mann–Whitney U (non-parametric) test compared the two groups with respect to the time to clinical and radiological union, the time returning to normal activity, AOFAS Mid-foot scores and VAS pain score between the two treatment groups. A p-value of 0.05 or less was taken to be significant. Various other statistical tools were used where ever applicable.

RESULT

Table: Patient Demographics

<table>
<thead>
<tr>
<th></th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number recruited</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Number analyzed</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Female</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Left Foot</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Right Foot</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Mean Age</td>
<td>35.67 (18-60)</td>
<td>32.61 (17-48)</td>
</tr>
</tbody>
</table>

The most common mode of injury was twist while walking (59%) in both groups followed by sports related injuries (31%) and road traffic related injuries (10%).

Table: Mode of Injury

<table>
<thead>
<tr>
<th>Mode of Injury</th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports Related</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Twist while walking</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Road Traffic Related</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

The most common mode of injury was twist while walking (59%) in both groups followed by sports related injuries (31%) and road traffic related injuries (10%).

Table: Fracture Patterns in Zone 1

<table>
<thead>
<tr>
<th>Fracture Pattern</th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-articular</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Intra-articular</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Extra-articular fracture was the most predominant pattern of injury in our study (81.8%). The intra-articular fracture (18.8 %) was involving just the lateral third of the cubometatarsal joint.

Table: Visual Analogue Scale (VAS) Pain Score

<table>
<thead>
<tr>
<th>Visual Analogue Scale (VAS) Pain Score</th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st week</td>
<td>2.57</td>
<td>3.5</td>
<td>0.008</td>
</tr>
<tr>
<td>4th week</td>
<td>1.38</td>
<td>0.98</td>
<td>0.091</td>
</tr>
</tbody>
</table>

The VAS pain score was significantly low at 1st week in cast group as compared to crepe bandage group. It was less at 4 weeks in crepe bandage group but the difference is not statistically significant.

Table: Days of Independent Mobility

<table>
<thead>
<tr>
<th>Independent Mobility</th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Days</td>
<td>22.48</td>
<td>13.5</td>
<td>0.0014</td>
</tr>
</tbody>
</table>

The mean days of independent mobility in cast group was 22.48 days and crepe bandage was 13.5 days. The difference was statistically significant.

There was no significant difference in the mid-foot circumference after removing cast or crepe bandage at 4 weeks.

Table: Modified AOFAS Mid-Foot Score

<table>
<thead>
<tr>
<th>AOFAS Mid-foot Mean Score</th>
<th>Short-leg Cast (n=21)</th>
<th>Crepe Bandage (n=18)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 4 weeks</td>
<td>77.71</td>
<td>79.89</td>
<td>0.25</td>
</tr>
<tr>
<td>At 8 weeks</td>
<td>85.05</td>
<td>89.44</td>
<td>0.049</td>
</tr>
<tr>
<td>At 12 weeks</td>
<td>94.95</td>
<td>97.67</td>
<td>0.015</td>
</tr>
</tbody>
</table>

The mean modified AOFAS mid-foot score at 4 weeks in cast group was (77.71) less than crepe bandage was (79.89) which is not statistically significant. At 8 weeks and 12 weeks it was 85.05 and 94.95 in cast group and 89.44 and 97.67 in crepe bandage group respectively. This difference is statistically significant.

COMPLICATION

Two patients in the plaster group in this study developed complications. One patient had tight cast at 1 week follow up which needed bivalving. After that his swelling subsided and he had similar follow up findings. Another patient developed clinical and radiological signs of chronic regional pain syndrome (CRPS) type I.

DISCUSSION

Because of circulatory differences in the three zones of the proximal fifth metatarsal, the location of a fracture must be considered when selecting treatment. The most proximal portion of the base of the fifth metatarsal has good blood supply. Fractures in this zone usually extend into the fifth metatarsocuboid joint. History and physical examination may provide useful clinical information to derive the diagnosis with the help of X-rays. Although making a diagnosis is straightforward, the treatment offered could be
arbitrary. This randomness is attributable to the lack of understanding of the heterogeneity of the fracture and the behavior of different subtypes towards fracture healing. The term ‘Jones fracture’ has been used indiscriminately to describe different types of proximal fifth metatarsal fracture. Sir Robert Jones reported 5 cases, including his own, and he was credited with the fracture name. However, there has been much controversy and debate regarding the fracture’s diagnosis and pathomechanics; the importance of acuity and prodromal symptoms; the incidence and potential causes of delayed unions and non-unions; and the optimal methods of treatment. Improved patient outcomes are dependent on correct classification of the fracture, appropriate treatment selection, and proper technique. The classification system for proximal fifth metatarsal fracture proposed by Quill has been the most commonly adopted one. Knowledge of anatomy is vital in distinguishing the fracture types. According to this scheme, there are tuberosity avulsion fractures, acute Jones fractures, and proximal diaphyseal stress fractures. Identifying the correct zone is important because the healing characteristics and treatment are different for fractures occurring in each.

Tuberosity avulsion fracture is the most common fracture subtype of the proximal fifth metatarsal. This fracture was once thought to be the result of avulsion by the peroneal brevis when the hind foot was inverted. However, a cadaveric study suggested the lateral cord of the plantar aponeurosis was responsible because it is attached firmly to the tuberosity. Tuberosity avulsion fracture is usually extra-articular and has a favorable outcome. Therefore, most authors have offered conservative treatment and symptomatic care, which includes either a walking castor an elastic bandage and weight-bearing as tolerated. Most patients would achieve radiological union within 8 weeks.

The results in our study are comparable with recent reports in the literature. We advised our patients protected weight bearing with crutches or cane from the beginning and noted the time of independent mobility. Quill also recommended protected weight bearing in a cast or fracture orthosis, to immobilize both foot and ankle for a period of between 3 and 6 weeks. We have advised our patients to wear the cast or bandage for 4 weeks. Though, the selection of the duration an arbitrary but it was comparable to the other studies. In Wiener et al.’s paper, patients wore their casts for a mean of 29 days, and the bandage treatment for 25 days, whilst Zenios et al. did not document the duration each group wore their allocated intervention. Sadry and Martin reported that their groups wore their respective intervention worn for a total of 4 weeks.

An observational retrospective study was done by Peter Vorlat, Wim Achtergael and Patrick Haentjensto identified those factors that influence the outcome after conservative treatment of undisplaced fractures of the fifth metatarsal. The most significant predictor of poor functional outcome was longer non weight bearing (NWB), which was strongly associated with worse global outcome, discomfort, and reported stiffness. Thus, they recommended NWB should be kept to a minimum for acute avulsions of the tuberosity of the fifth metatarsal.

Wiener et al. reported that the time to preinjury level of activity was significantly shorter in those who were treated with a bandage (33 days) compared to a cast (46 days; p < 0.05). Wiener concluded that soft dressings had allowed patients to return to pre-injury levels of activity quicker and without compromise to clinical or radiological union. In contrast, Zenios et al. reported that there was no significant difference between the 2 interventions in respect to the amount of time taken to walk independently off crutches from the time of injury (p = 0.32).

The VAS pain score at 1st week was lower in cast group (2.57) as compared to crepe bandage group (3.5) which is statistically significant. At 4 weeks the score was lower in crepe bandage group (0.98) compared to cast group (1.38) but the difference was not statistically significant. Zenios et al. reported that whilst subjects who received the bandage intervention reported significantly lower pain scores at 1 week, there was no statistically significant difference between the groups at 4 and 12 weeks.

Our study showed no significant difference in swelling of foot in two groups. We measured the diameter of foot at 4 weeks when we had removed the cast or bandage. Similar to our study Zenios et al. also assessed mid-foot swelling, reporting no significant difference between the bandage and cast intervention groups at 1, 4 or 12 weeks post-injury for this outcome.

In our study almost all fractures united clinically by 6 weeks except a patient in cast group which also had
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united (no tenderness on palpation) at 8 weeks. There was no significant difference in clinical fracture union time between two groups. Similarly 81% of the short leg cast group and 83.3% of the crepe bandage group had radiological union at 8 weeks. Almost all fractures showed radiological union by 12 weeks except a patient in cast group who already had the clinical union and the difference was not significant. Wiener et al. reported that there was no significant difference between the cast and bandage immobilization in respect to the time to radiological union, where the cast group achieved fracture union at an average of 43 days, compared to 45 days in those who received the bandage treatment (p > 0.05).

In our study, the patient-rated foot and ankle function scores using modified AOFAS score was 89.44 and 97.67 in crepe bandage group and 85.05 and 94.95 in short leg cast group with p-value 0.049 and 0.015 at 8 and 12 weeks respectively. The difference was statistically significant. But, the mean score was comparable at 4 weeks (p=0.25) between two groups. Wiener et al. assessed patient-rated foot and ankle function scores using a modified foot score devised as was in study. They reported that whilst there was a trend for superior results in the bandage group, where their cast treatment group presented a score of 86, corresponding to 33 excellent, 12 good, and 1 poor functional outcomes, and their bandage group reported a slightly higher score of 92, corresponding to 36 excellent, 7 good and no fair or poor functional results, this difference was not statistically significant (p > 0.05). Zenios et al. also assessed functional outcomes using the AOFAS score. They also reported a trend for better outcomes in the bandage group, but this difference was statistically significant at 12 weeks compared to the cast group (p < 0.001), with a power equaling 0.91. Gray et al. reported significantly better functional outcome in the plaster slipper groups (median 68) compared to the tubular bandage group (median 57) at 2 weeks (p = 0.02). However there was no statistically significant difference between the groups for this measure at 6 and 12 weeks post injury (p = 0.27; p = 0.32).19

Only a single patient in cast group had non-union at 12 weeks. But it was asymptomatic and no intervention was advised. Gray et al. also concluded that whilst 2 patients in each group demonstrated non-union at 12 weeks, only 1 patient, in the tubular bandage group reported pain and poor functional outcome.

CONCLUSION:

Patients generally run a benign course with functional treatment for four (4) weeks and symptomatic non-union are rare. A crepe bandage allows patients to return to independent levels of activity faster than when treated in a short leg cast without compromising clinical or radiographic union.

REFERENCES

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