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AMERICAN ORTHOPAEDIC FOOT & ANKLE SOCIETY

Foot & Ankle International®
2022, Vol. 43(5) 602–608

DOI: 10.1177/10711007211069123
journals.sagepub.com/home/fai

# Proximal Fifth Metatarsal Fractures: A Retrospective Study of 834 Fractures With a Minimum Follow-up of 5 Years

**Petter Morten Pettersen, MD[1], Nikola Radojicic, MD[1], Wolfram Grün, MD[1], Tor Kristian Molstad Andresen, MD[2], and Marius Molund, MD, PhD[1]**

## Abstract

**Background:** Proximal fifth metatarsal fractures are common fractures. Treatment strategies have been debated. We wanted to investigate whether Lawrence and Botte's classification has prognostic value because of time to fracture union, and evaluate if weightbearing as tolerated (WBAT) and nonweightbearing (NWB) treatment strategy had effect on time to fracture union in nonoperatively treated fractures.

**Methods:** Computerized database search, patients diagnosed between January 1, 2003, and December 31, 2015.

**Results:** We identified 834 fractures; 510 (61.2%) zone 1, 157 (18.8%) zone 2, and 167 (20.0%) zone 3. Most (94.4%) were treated nonoperatively; time to fracture union was 7.5 (SD 7.7), 7.7 (5.6), and 9.2 (8.1) weeks for zone 1, 2, and 3, respectively, which gave a significant longer time to union for zone 3 compared to zone 1 fractures ($P = .04$). There was no difference in time to fracture union when comparing WBAT and NWB for all fracture zones. Failure to union, defined as crossover to surgery and/or delayed union, was found in 13 (2.7%) zone 1, 5 (3.2%) zone 2, and 6 (3.8%) zone 3 fractures. Refracture during follow-up was found in 3 (0.6%) zone 1 and 14 (8.9%) zone 3 fractures.

**Conclusion:** Proximal fifth metatarsal fractures have high union rates with nonoperative treatment. No difference in time to union could be found between WBAT and NWB treatment strategies for all fracture zones. We observed a significantly longer time to fracture union for zone 3 fractures compared to zone 1 fractures. Refracture occurs in a nonnegligible share of nonoperatively treated zone 3 fractures.

**Level of Evidence:** Level III, retrospective cohort study.

**Keywords:** proximal fifth metatarsal fractures, Jones fractures, weightbearing, conservative treatment

## Introduction

Proximal fractures of the fifth metatarsal bone are among the most common fractures in the foot and count for more than 68% of all metatarsal fractures.[23] These fractures have a heterogeneous etiology, depending on their anatomic localization. The optimal treatment strategy for proximal fifth metatarsal fractures has been debated for several decades, indicating that there might be challenges in treating these fractures. Most authors agree that there is variation regarding prognosis and treatment recommendation depending on the fracture's localization.[3,19] The classification system of Lawrence and Botte (Figure 1) divides the proximal fifth metatarsal into 3 fracture zones,[19] and is used for the choice of treatment and rehabilitation.[32] Fractures of the 2 proximal fracture zones (zone 1 and zone 2) are acute fractures that usually occur after a supination/inversion trauma, whereas zone 3 fractures are defined as stress fractures.[3,19]

Nonoperative treatment of nondisplaced zone 1 fractures yields good outcomes with both symptomatic treatment and cast immobilization, whereas displaced zone 1 fractures could benefit from operative treatment.[1,3,4,8,10,18] Zone 2 and zone 3 fractures usually are nondisplaced, and both operative and nonoperative treatment have been advocated. Several studies argue for operative fixation to be the treatment of choice in young and athletic patients because of anticipated higher union rates and a shorter time to union.[3,6,9,11,15,17,20,22,26,27,37] However, other studies have demonstrated good results with nonoperative treatment for

[1]Sykehust Østfold Trust, Grålum, Norway
[2]Akershus University Hospital, Nordbyhagen, Norway

**Corresponding Author:**
Petter Morten Pettersen, MD, Sykehust Østfold Trust, Kalnesveien 300, Grålum, 1714, Norway.
Email: petter.morten.pettersen@so-hf.no

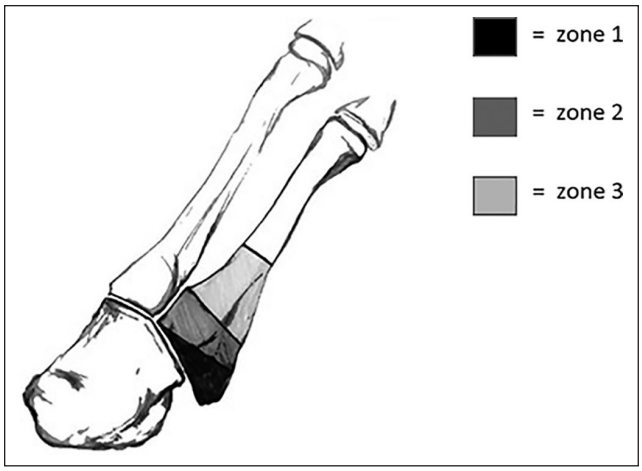


**Figure 1.** Lawrence and Botte's fracture classification. Zone 1 fractures are localized proximal to the intermetatarsal articulation. Zone 2 fractures are localized in the level of the intermetatarsal articulation. Zone 3 fractures are localized distal to the intermetatarsal articulation.

**Figure 2.** Radiologic examples of zone 1, zone 2, and zone 3 fractures. Zone 1 fractures are localized proximal to the intermetatarsal articulation. Zone 2 fractures are localized in the level of the intermetatarsal articulation. Zone 3 fractures are localized distal to the intermetatarsal articulation.

zone 2 and zone 3 fractures.[2,16] It has been argued that the marginal local blood supply might compromise fracture healing in zone 2 and zone 3.[30,31]

The available evidence regarding the treatment of proximal fifth metatarsal fractures is based on mainly retrospective studies with small patient cohorts. Furthermore, the current literature is inconsistent regarding classification of these fractures. This makes both the interpretation and clinical application of recommended treatment approaches challenging.[3,24,32] As an example, the only randomized study between nonoperative and operative treatment seems not to distinguish between zone 2 and zone 3 fractures.[22]

The main aim of the present study was to investigate whether the classification system of Lawrence and Botte has prognostic value regarding time to fracture union. In addition, we wanted to evaluate if weightbearing as tolerated (WBAT) and nonweightbearing (NWB) treatment strategy as well as fracture displacement had effect on time to fracture union in nonoperatively treated fractures. Furthermore, we wanted to register fracture morphology factors, demographics, and rates of refractures. Also, we registered complications in patients who underwent operative treatment.

## Material and Methods

After approval from the Regional Committee for Medical and Health Research Ethics (REC) and the local data protection officer at our hospital was obtained, all patients with metatarsal fractures treated at our hospital between January 1, 2003, and December 31, 2015, were identified by a computerized search in our database. *International Classification of Diseases, Tenth Revision* (*ICD-10*), code S923 was used. All initial plain radiographs were evaluated by the researchers, and fractures localized in the proximal half of the fifth metatarsal were identified and included in the present study. We included patients of all ages, as well as patients with previous proximal fifth metatarsal fractures. High-energy trauma mechanism, additional fractures or other significant major injuries of the ipsilateral foot, patients with registered address outside our hospital's catchment area at initial treatment or follow-up, initial treatment at another hospital, and/or a suspect fracture through a persisting apophysis were excluded.

We classified the fractures according to the classification system described by Lawrence and Botte.[19] Zone 1 incorporates fractures proximal to the intermetatarsal articulation, zone 2 fractures affecting the intermetatarsal articulation, and zone 3 fractures distal to the intermetatarsal articulation (Figure 2).

The amount of fracture displacement was measured using oblique radiographs. Signs of fracture sclerosis were registered according to the classification system described by Torg,[34] defining type I as fractures with a narrow fracture line, with sharp margins, no widening, minimal cortical hypertrophy, and no intramedullary sclerosis; type II as fractures with a wide fracture line with adjacent lucency, involving both cortices, and partial obliteration of the medullary canal by sclerosis at the site of fracture; and type III as fractures with a wide fracture line, periosteal new bone formation, and complete obliteration of the medullary canal by sclerosis at the site of fracture (Figure 3).

We registered whether the patients initially received operative or nonoperative treatment. The nonoperatively

**Figure 3.** Radiologic examples of Torg type I, II, and III fractures. Torg type I includes fractures with a narrow fracture line, with sharp margins, no widening, minimal cortical hypertrophy, and no intramedullary sclerosis. Torg type II includes fractures with a wide fracture line with adjacent lucency, involving both cortices, and partial obliteration of the medullary canal by sclerosis at the site of fracture. Torg type III includes fractures with a wide fracture line, periosteal new bone formation, and complete obliteration of the medullary canal by sclerosis at the site of fracture.

treated fractures were grouped into nonweightbearing (NWB), including those treated with cast immobilization, and weightbearing strategies summarized as weightbearing as tolerated (WBAT). NWB and WBAT were defined as major treatment strategies during the first 6 weeks from first contact.

Time to fracture union was our main outcome and was defined as time between first contact and "clinical fracture union". Clinical fracture union was defined as pain-free ambulation and no pain on palpation. Our experience is that radiologic signs of healing can occur late in these fractures, and the department's practice has been to evaluate the clinical status. In cases of missing specific information about ambulation and/or palpation pain, we supplemented with subsequent radiographic evaluation. We defined delayed union as recorded absence of clinical union within 26 weeks. In patients with missing information of clinical union as well as radiographic lack of union, time to fracture union was registered as *unknown*. Fractures converted from nonoperative to operative treatment later than 4 weeks after the first contact were defined as crossover fractures. Failure to union was defined as a summation of delayed union, nonunion, and/or crossover fractures.

For the fractures treated operatively, we registered time to union, complications related to surgery, and refractures. Primary surgery was defined as operative treatment within the first 4 weeks after the first contact.

The chart records and radiographs of all patients were reviewed until December 31, 2020, ensuring a minimum follow-up time of 5 years for all fractures. If the patient's registered address at follow-up was not in our catchment area, they were excluded. As our hospital is the only public health care facility in the region for the population, we defined no recontact through follow-up as equal to no failure to union and/or refracture.

## Statistics

Normally distributed data were analyzed using independent sample *t* tests. Nonparametric data were analyzed using the Mann-Whitney *U* test. Categorical data were analyzed using $\chi^2$ test. Significance level was set at .05 for all analyses.

## Results

We identified 834 proximal fifth metatarsal fractures. Based on our hospital's catchment area population of approximately 300 000 people, this gives an incidence of 21 per 100 000 person-years. Age ranged from 6 to 96 years, with a median of 38 years. There was a small majority of female patients (52.1%). We found 510 (61.2%) zone 1 fractures, 157 (18.8%) zone 2 fractures, and 167 (20.0%) zone 3 fractures according to Lawrence and Botte's classification. According to Torg's classification, there were 769 (92.2%) type I, 61 (7.3%) type II, and 4 (0.5%) type III fractures. The share of Torg type I, II, and III fractures in the fracture zones 1, 2, and 3 were, respectively, 98.8%, 0.6%%, and 0.6%; 95.5%, 4.5%, and 0.0%; and 68.9%, 30.5%%, and 0.6%. We registered 788 (94.5%) fractures that were primarily treated nonoperatively and 46 (5.5%) operatively. Mean fracture displacement in zone 1 was 1.1 mm (SD 1.5, range 0-11); zone 2, 0.6 mm (SD 0.7, range 0-4); and zone 3, 0.4 mm (SD 0.5, range 0-2). Six hundred (71.9%) fractures were followed to clinical and/or radiographic union as previously defined.

### *Nonoperatively Treated Fractures*

The results for the nonoperatively treated fractures are shown in Table 1. A total of 562 (71.3%) of the nonoperatively treated fractures were followed until clinical fracture union. The mean time to union was 7.9 weeks (SD 7.4). Three hundred (92.0%) of the 326 zone 1 fractures that were followed to union had a fracture displacement of $\leq$2 mm and 26 (8.0%) a displacement of $>$2 mm. Time to union for zone 1 fractures with diastasis $\leq$2 mm and $>$2 mm were 6.9 weeks (SD 6.4) and 8.8 weeks (SD 7.0), respectively ($P = .32$). Failure to union was observed in a total of 24 fractures (3.0% of all nonoperatively treated

**Table 1.** Results for nonoperatively treated fractures.

| Fracture Zone | Zone 1 | Zone 2 | Zone 3 |
|---|---|---|---|
| Fractures, n (%)[a] | 476 (60.4) | 154 (19.5) | 158 (20.1) |
| Followed to union, n (%) | 329 (69.1) | 127 (82.5) | 106 (67.1) |
| Time to union, wk, mean (SD) | 7.5 (7.7) | 7.7 (5.6) | 9.2 (8.1) |
| *P* value, time to union | | Zone 1 vs zone 2 = .76<br>Zone 1 vs zone 3 = .04<br>Zone 2 vs zone 3 = .09 | |
| Time to union, WBAT, wk | Mean 8.2 (SD 9.7) | Mean 7.2 (SD 4.9) | Median 7 (range 4-59) |
| Time to union, NWB, wk | Mean 7.2 (SD 6.7) | Mean 7.9 (SD 5.8) | Median 6.0 (range 2-31) |
| *P* value, time to union, WBAT vs NWB | .30 (*t* test) | .51 (*t* test) | .25 (Mann-Whitney *U* test) |
| Crossover to surgery, n (%)[b] | 6 (1.3) | 4 (2.6) | 6 (3.8) |
| Delayed union, n (%)[b] | 7 (1.5) | 1 (.6) | 6 (3.8) |
| Failure to union-rate WBAT vs NWB | 4/206 vs 9/270 ($P = .84$) | 0/55 vs 5/99 ($P = .31$) | 4/68 vs 2/90 ($P = .23$) |
| Refractures, n (%)[b] | 3 (0.6) | 0 | 14 (8.9) |

Abbreviations: NWB, nonweightbearing; WBAT, weightbearing as tolerated.
[a]Percentage of total nonoperatively treated fractures.
[b]Percentage of total nonoperatively treated zone fractures.

**Table 2.** Results for Torg I and Torg II zone 3 fractures.

| | Torg I | | Torg II |
|---|---|---|---|
| Fractures, n (%) | 113 (71.5[a]) | | 44 (27.8[a]) |
| Followed to union, n (%) | 76 (67.3) | | 29 (65.9) |
| Time to union, wk, median (range) | 6 (2-29) | | 8 (4-59) |
| *P* value: time to union | | .17 | |
| Crossover to surgery, n (%)[a] | 3 (2.7) | | 3 (6.8) |
| Refractures, n (%)[a] | 2 (1.8) | | 12 (27.3) |
| *P* value: refractures | | $<.01$ | |

[a]Percentage of total nonoperative zone 3 fractures.

fractures). There were 14 delayed unions. Sixteen fractures were crossed over to surgery. The zone 3 crossover fractures were due to delayed union, and all crossovers were done before 26 weeks for zone 1 and zone 2 fractures. There were no between-zone differences in rates of failure to union ($P = .46$-$.88$). We registered no nonunions. The results for Torg I and Torg II zone 3 fractures are shown in Table 2. Comparing time to fracture union in Torg I and Torg II zone 3 fractures revealed no difference in time to fracture union with, respectively, median 6 and 8 weeks ($P = .17$). The refracture rate was significantly higher for zone 3 fractures compared with zone 1 and 2 ($P < .01$). Of the zone 3 refractures, 2 occurred in fractures initially graded as Torg type I and 12 in fractures initially graded as Torg type II ($P < .01$). We found no patients with recurrent pain or other persistent discomfort as cause for recontact besides the patients with refractures during follow-up.

## *Operatively Treated Fractures*

Forty-eight (5.8%) fractures were treated with primary surgery, including 35 displaced zone 1 fractures (7.6% of all zone 1 fractures), 4 zone 2 fractures (2.6%), and 9 zone 3 fractures (5.7%). Thirty-eight (79.2%) were followed to union. According to records, indication for surgery in zone 1 fractures were based on fracture displacement, with mean displacement 4.6 mm (SD 2.0). Time to union for all fractures treated with primary surgery was 8.7 weeks (SD 3.8). Complications related to surgery, including both patients receiving primary surgery and the crossover patients, were registered in 27 cases (58.7%). Nineteen (28.8%) patients underwent secondary surgery with metal implant removal owing to local symptoms. Six patients (9.1%) developed superficial surgical site infections, which were successfully managed with oral antibiotics. Deep vein thrombosis was observed in 1 patient (1.5%). One patient (1.5%) had failing of osteosynthesis resulting in redisplacement of the fracture, without loosening or breakage of the metal implant. However, the patient was without symptoms 19 weeks postoperatively and not followed up after this point. Apart from this case, we found no delayed unions, nonunions, or refractures among all operatively treated patients, including the crossover patients.

## Discussion

In this retrospective study, we present our results from a large cohort of patients with proximal fifth metatarsal fractures with a long follow-up time. The main treatment approach for these fractures has traditionally been nonoperative at our hospital. Therefore, our main outcome is time to union after nonoperative treatment. We found that time to union was significantly longer for zone 3 fractures compared to zone 1 fractures. There were no significant differences between time to fracture union for zone 2 fractures compared with the other fracture groups, and there were no significant differences in time to fracture union between NWB and WBAT for any fracture zone. Our results demonstrate that time to union for both zone 1 and zone 2 fractures are as expected for universal fracture healing and with a low risk of failure to union, whereas zone 3 fractures showed longer time to fracture union as well as higher refracture rate during follow-up.

We classified the fractures according to the Lawrence and Botte classification, dividing the proximal fifth metatarsal into 3 fracture zones. It has been argued that proximal fifth metatarsal should be divided into 2 fracture zones, in order to guide the therapeutic approach.[24] To our understanding, this corresponds to the inclusion criteria of the only previous randomized controlled trial on these fractures.[22] In our clinical practice, we have found the Lawrence and Botte classification useful in treating proximal fifth metatarsal fractures. Based on our results, we consider the Lawrence and Botte classification to be of both prognostic and clinical relevance. Therefore, we recommend the use of this classification system in clinical practice, as well as in future research as this is crucial for the academic collaboration in understanding the proximal fifth metatarsal fractures.

Fifth metatarsal fractures are the most common of all metatarsal fractures, counting 68% of the fractures, and their incidence is previously documented as 46 per 100 000 person-years.[23] We found an incidence of proximal fifth metatarsal fractures of 21 per 100 000 person-years. Fracture zone distribution was previously stated as a 93%, 4%, and 3% distribution between zone 1, 2, and 3, respectively.[33] In our material, we observed a 60%, 20%, and 20% distribution between zone 1, 2, and 3 fractures, respectively. We consider the current study as valuable in regard to evaluating the epidemiology of these fractures, given our large patient material and low risk of selection bias as our hospital is the only treatment center for acute fractures in our catchment area.

### *Zone 1 Fractures*

With 93.2% of these fractures treated nonoperatively and 70% of the patients followed until union, we consider that our results provide useful knowledge regarding the time to union with nonoperative treatment for this fracture group. Time to fracture union of 7.5 weeks after nonoperative treatment is in accordance with other authors' findings.[10,13,14,22,35,36] In accordance with other authors' findings, our results support a nonoperative treatment approach for nondisplaced zone 1 fractures.[1,3,5,8,10,18] Previous studies have indicated better results for WBAT strategy regarding pain, function, and time to fracture union compared with NWB.[7,14,29,36] Our findings show no differences between these strategies, supporting WBAT to be the treatment of choice for these fractures. Some authors argue that operative treatment in fractures with displacement >2 mm might be justified.[12,21,25,28,38] In the current study, we found relatively few nonoperatively treated fractures with more than 2-mm dislocation. Our results suggest that nonoperatively treated fractures with more than 2-mm displacement might have a tendency toward longer time to union. However, our findings were not statistically significant. Therefore, our results suggest that the threshold for operative treatment due to fracture displacement could be more than 2 mm.

### *Zone 2 Fractures*

Historically, zone 2 fractures have been classified, labeled, and treated inconsistently. This applies also to the only previously conducted randomized controlled trial, comparing operative with nonoperative treatment, which has merged zone 2 and 3 fractures.[22] In our view, combining zone 2 and 3 fractures might have resulted in review articles defending operative treatment of zone 2 fractures.[3,24] We found good results regarding union in zone 2, as time to union was not significantly longer than zone 1 fractures. We found no statistically significant differences in time to fracture union for WBAT vs NWB, supporting previous recommendations that these fractures can be treated with WBAT.[24] We consider the failure to union rate and thereby crossover to surgery of 2.6% and delayed union of 0.6% as remarkably low rates given the common understanding of these fractures to be problematic. The absence of nonunions and refractures in our material seems to confirm that. We found zone 2 fractures to have minimal displacement, which hypothetically outweighs the suspected marginal vascular conditions in this fracture region according to fracture union. Based on our results, we recommend zone 2 fractures to be treated nonoperatively with WBAT.

### *Zone 3 Fractures*

According to Lawrence and Botte, zone 3 fractures are stress fractures.[19] In our material, the majority of zone 3 fractures were treated nonoperatively. Our results show that zone 3 fractures treated nonoperatively most likely will heal with both WBAT and NWB, as there were high union rates and no difference in time to fracture union with or without weightbearing. We consider the question whether zone 3 fractures should be treated operatively or nonoperatively as central. Our finding of close to 10% of patients treated nonoperatively

suffering refracture during follow-up, indicates that surgery is a relevant treatment option. This especially counts for fractures with sclerotic bone formation at first contact, as we observed a 27% refracture rate in Torg II fractures during follow-up. However, we observed only a slight, nonsignificant difference in healing time between zone 3 Torg I and II fractures ($P = .17$). This study may be underpowered to prove difference, and the importance of the Torg classification on clinical decision making is yet to be proven in high-quality studies. To our mind, sclerotic fractures might benefit from primary surgical treatment. Previously, only 1 randomized controlled trial comparing nonoperative treatment with cast immobilization to operative treatment with intramedullary screw fixation has been conducted.[22] This study found that operative treatment leads to shorter time to union and faster return to sports. We consider the findings of that study not directly applicable to the general population, since the included patients were healthy, young men and because both zone 2 and zone 3 fractures seem to have been included. Based on our results, we see a necessity to conduct high-level clinical trials on zone 3 fractures in the general population, to investigate whether surgery of these fractures is justified.

### *Strengths and Weaknesses*

To our knowledge, the current study consists of the largest patient cohort investigating proximal fifth metatarsal fractures up to this date. The long follow-up time is especially important in documenting the refracture rates for proximal fifth metatarsal fractures. Through record search, we have not found any patients who have sought our hospital due to persistent or recurrent pain, other than the patients who visited us with refractures, indicating that the observational bias in relation to fracture healing is small. The retrospective design in this study is an obvious weakness. We were unable to register potentially important variables affecting fracture healing, such as smoking status. Within our material, 71.8% of the included fractures were followed to clinical fracture union, giving a certain level of uncertainty of the results. However, our hospital is the only public health care facility for the local population. This makes it unlikely that a significant number of patients have been followed elsewhere. Stating that clinical union without evidence of radiographic union is certain union can be discussed. An unknown size of painless fibrous nonunions could have influenced our findings. We observed relatively heterogeneous treatment strategies, concerning both operative and nonoperative approaches. The inconsistency we observed in the patients' records appear to be based on the surgeons' own preferences, and less based on routines and guidelines for these fractures. As we have not evaluated clinical outcomes in the current study, we are unable to make conclusions on the patients' clinical longtime outcome.

## Conclusion

Most proximal fifth metatarsal fractures show high "clinical union" rates and expected acceptable time to union with nonoperative treatment for all fracture zones, but we observed a significantly longer time to fracture union for zone 3 fractures compared to zone 1 fractures. For all fracture zones, there were no differences in time to fracture union with WBAT and NWB. Based on this evidence, we think that proximal fifth metatarsal fractures in general should be treated nonoperatively. Primary operative treatment can be considered in zone 3 fractures, especially in fractures with sclerosis at first contact because of high risk of refracture.

### Acknowledgments

A special thank you to Maria Serafin for the illustration in Figure 1.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### ORCID iD

Petter Morten Pettersen, MD, https://orcid.org/0000-0001-9824-3745

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