A Novel Method in the Classification of Proximal Fifth Metatarsal Fractures

Kathryn Yeager, MD[1]; Benjamin Packard, MD[1]; Richard A. Miller, MD[1]; Shravan Sridhar, MD[2]; Gary W. Mlady, MD[2], Katherine Gavin, MD[1]

[1]Department of Orthopaedics & Rehabilitation, The University of New Mexico Health Sciences Center, Albuquerque, New Mexico

[2]Department of Radiology, The University of New Mexico Health Sciences Center, Albuquerque, New Mexico

Corresponding Author Kathryn Yeager, MD. Department of Orthopaedics & Rehabilitation, MSC 10 5600, 1 University of New Mexico, Albuquerque, NM 87131 (email: kcyeager@salud.unm.edu).

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ABSTRACT

Background: Proximal fifth metatarsal fractures are common. The authors previously performed a study examining the inter- and intraobserver reliability of the Lawrence and Botte Classification, which showed poor interobserver reliability of 16.67%. A novel approach was proposed for the classification of fifth metatarsal fractures using a mortise ankle radiographic view.

Methods: The observers from the authors' prior study reviewed non-weight bearing mortise views of 20 patients with isolated fifth metatarsal base fractures. These radiographs were identified from the 60 radiographs from the authors' prior study. Five physicians evaluated the radiographs and classified the fractures as type 1, 2, or 3. Results were then analyzed for interobserver reliability.

Results: Five observers reviewed 20 radiographs. Total interobserver reliability was 55.0% (11/20) with a Fleiss' kappa of 0.565 (moderate agreement). The ankle mortise radiograph agreed with previous anteroposterior, oblique, and lateral radiographs at 56.0%, 57.0%, and 57.0%, respectively.

Conclusion: There is poor inter- and intraobserver reliability in the current proximal fifth metatarsal classification system. The use of a mortise radiographic view for classification provides equivocal results in the reliability of classifying proximal fifth metatarsal fractures when compared to the typical 3- view of the foot. A future study should be aimed at a classification system with higher reliability.

Keywords: Metatarsal, Bone, Classification

INTRODUCTION

Sir Robert Jones first described proximal fifth metatarsal fractures in 1902. His initial report described a fracture in the metadiaphyseal region of the proximal fifth metatarsal.[1] Today, the term "Jones fractures" is used inconsistently to describe fifth metatarsal fractures from the metaphysis to the proximal diaphyseal region. Because of this inconsistency, standard classifications should be used rather than the term "Jones fracture."[2] Metatarsal fractures are a common injury. In a study examining 411 metatarsal fractures, Petrisor et al[3] found proximal fifth metatarsal fractures were the most common fracture type.

Accurate classification of these fractures is imperative to choosing the correct treatment. Certain fractures have higher incidences of nonunion and require strict non-weight bearing or surgical intervention, while other fractures may be made weight bearing as tolerated. The Lawrence and Botte Classification is the most widely used classification system for proximal fifth metatarsal fractures.[4] Fractures are classified as type 1, 2, or 3 based on their location. Avulsions of the tuberosity that may or may not extend into the tarsometatarsal articulation are classified as type 1. Type 2 fractures involve the metaphysis-diaphysis junction, including the fourth-fifth intermetatarsal facet. Proximal diaphyseal fractures that are distal to the fourth-fifth intermetatarsal articulation are classified as type 3 (Figure 1).[4]

It is imperative to determine the location of the fracture to guide appropriate treatment. Zone 1 injuries typically heal with good functional outcomes. Standard

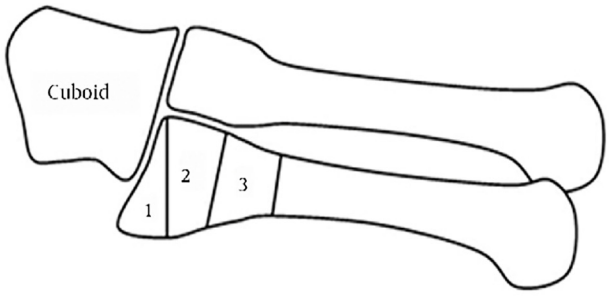

Figure 1. *Figure representing the Lawrence and Botte Classification as a way to classify proximal fifth metatarsal fractures.*[4]

Figure 2. *An example of a non-weight bearing mortise view used in a novel classification. Note the proximal fifth metatarsal fracture.*

treatment is nonoperative with a walking boot, and patients generally are allowed to weight bear.[2,5] Owing to these fractures being located in a vascular watershed area, healing is more variable for zone 2 and 3 injuries. These fractures have a higher propensity for nonunion and are typically managed with strict non-weight bearing in a cast or operative fixation.[5-8]

The authors previously found that the Lawrence and Botte Classification has poor inter- and intraobserver reliability when classifying proximal fifth metatarsal fractures.[9] Therefore, we sought to use an alternative radiographic view to classify fifth metatarsal base fractures to find better inter- and intraobserver reliability. We hypothesized that a non-weight bearing mortise view would improve interobserver reliability of the Lawrence and Botte Classification when compared to standard anteroposterior (AP), lateral, and oblique foot radiographic views.

METHODS

Institutional Review Board approval (HSC #19-506) was obtained. From the cohort of our previous study of 60 patients with fifth metatarsal base fractures, we identified 20 of these patients who also had non-weight bearing mortise radiographs of the ankle at the time of their injury (Figure 2). These 20 mortise view radiographs were distributed to five observers, each of whom classified the fracture as a type 1, 2, or 3, according to the Lawrence and Botte Classification (Figure 1).[3] The five observers included one radiology resident, two orthopaedic surgery residents, one fellowship-trained musculoskeletal radiologist, and one fellowship-trained foot and ankle orthopaedic surgeon. The same five observers who participated in the previous study were used.

Table 1. *Landis and Koch's Interpretation of Kappa Values*[1a]

Kappa	Interpretation
<0	Poor agreement
0.01 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

[a]There is some disagreement about the validity of this scale.[2] The K value will be higher when there are fewer categories.[3]

1. Jones R. I. Fracture of the Base of the Fifth Metatarsal Bone by Indirect Violence. Ann Surg.1902;35(6):697-700.2.
2. Cheung CN, Lui TH. Proximal Fifth Metatarsal Fractures: Anatomy, Classification, Treatment and Complications. Arch Trauma Res. 2016;5(4).
3. Petrisor BA, Ekrol I, Court-Brown C. The epidemiology of metatarsal fractures. Foot Ankle Int. 2006;27(3):172-174.

The classifications were performed in a blinded manner. The observers did not know how the other observers classified the fractures or how they classified the foot radiographs previously. The results of the mortise view classifications were compared between observers and with the results from the AP, lateral, and oblique foot radiographs of the same patients from our previous study.[9]

Results were then analyzed to determine the agreement between observers. Interobserver reliability was the primary outcome measure. In this study, interobserver reliability represents the rate at which the five observers identified the same fracture type for a given radiograph or patient. Fleiss' kappa was calculated for interobserver reliability to find the statistical measure of reliability. Fleiss' kappa values can be interpreted using the description in Table 1.[10-12]

RESULTS

There were 20 patients in total. Each patient had one non-weight bearing radiographic view of the ankle mortise. The radiographs were reviewed by the five observers, producing a total of 100 observations. All five observers chose the same fracture type in 11 out of the 20 radiographs, which was an interobserver reliability of 55.0% (11/20). Fleiss' kappa was calculated to be 0.565, indicating moderate agreement (Table 2).

When compared with the prior study, the ankle mortise radiograph classifications agreed with the AP, lateral, and oblique radiograph classifications at a rate of 56.0%, 57.0%, and 57.0%, respectively (Table 3). In this study, all five observers chose the same classification for 11 out of the 20 patients using the ankle

Table 2. Inter-rater agreement, comparing the 5 observers' scores for 20 participants for non-weight bearing mortise view of the ankle

	Mortise View Inter-Rater Agreement
% Agreement	55
Fleiss' kappa	0.565 (Moderate agreement)
Z-score	9.64
P-value	0

Table 3. Inter-rater agreement, comparing the 5 raters[a]

	AP View Inter-Rater Agreement	OBL View Inter-Rater Agreement	LAT View Inter-Rater Agreement
% Agreement	57	45	35
Fleiss' kappa	0.643 (Substantial agreement)	0.508 (Moderate agreement)	0.441 (Moderate agreement)
Z-score	21.4	16.4	14
P-value	0	0	0

AP, anteroposterior; OBL, oblique; LAT, lateral
[a]60 subjects for each of the three views

Table 4. Rate at which all 5 observers classified fracture the same

Radiographic View	Rate of Agreement
Ankle Mortise	11/20
Foot Anteroposterior	11/20
Foot Oblique	10/20
Foot Lateral	5/20

radiograph compared to 11/20 using the AP view, 10/20 for the oblique view, and 5/20 of the lateral view of the foot (Table 4).

DISCUSSION

Our proposed method for classifying proximal fifth metatarsal fractures using an ankle mortise view radiograph shows moderate interobserver reliability. This trend was seen across various medical providers, including orthopaedic surgery residents, radiology residents, attending radiologist with musculoskeletal fellowship training, and an orthopaedic attending with fellowship training in foot and ankle surgery. The rate of agreement among observers was not significantly different when compared to that observed using the classic radiographic views for classification (AP, lateral, and oblique foot series).[9]

Proper classification of proximal fifth metatarsal fractures is essential to guide the appropriate treatment of these fractures. Fracture location correlates with differences in outcome secondary to the distinct blood supply of the proximal fifth metatarsal. The metaphyseal-diaphyseal junction is a watershed area creating an increased risk for delayed union and nonunion.[13] The proximal metaphysis has a more robust system of arterioles that allows for more predictable healing.[13] There is also variability in the stability of the region. The metaphyseal region is more stable than the metadiaphyseal region, which promotes reliable healing. The meta-diaphyseal region is more mobile, creating a less favorable environment for healing.[6,14]

This study shows similar interobserver reliability in the classification of proximal fifth metatarsal fractures using the ankle mortise view compared to the prior study, which used AP, lateral, and oblique radiographs for classification. The previous study showed interobserver reliability of 56.7% for AP view with Fleiss' kappa of 0.643, 35.0% for lateral view with Fleiss' kappa of 0.441, and 45.0% for oblique view with Fleiss' kappa of 0.508. In comparison, the present study showed interobserver reliability of 55.0% with a Fleiss' kappa of 0.565.[9] Thus, the ankle mortise view provided a similar interobserver reliability for classification when compared with the AP view when both are used in isolation.

This study is not without limitations. First, having residents participate as observers may have skewed the data owing to their limited training and experience. Furthermore, the study design does not consider other information that would likely be available to the physician, such as a full set of foot and ankle radiographs instead of an isolated radiographic view. Additionally, clinical history and mechanism of injury can provide further information about the character of the fracture. Further study might examine the inter- and intraobserver reliability of the Lawrence and Botte Classification when using a combination of all radiographic views.

In conclusion, the authors' previous study showed poor inter- and intraobserver reliability in the Lawrence and Botte Classification as a way to classify proximal fifth metatarsal fractures.[9] The current study's aim to identify a more reliable radiographic view for classification showed similar results with moderate reliability. Between the two studies, the AP and ankle mortise views showed the highest interobserver reliabilities. Further study is needed to evaluate the optimal radiographic study for reliable classification of fifth metatarsal fractures. However, the present information from these two studies indicates that AP and mortise views should be used for the classification and treatment planning for these injuries.

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