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Original Research

Accuracy and Reliability of Postoperative Radiographic Evaluation of First Metatarsal-Phalangeal Joint Arthrodesis

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ABSTRACT

The clinical value of routine postoperative radiographic evaluation after orthopedic procedures has recently been called into question. The objective of the present investigation was to evaluate the ability of foot and ankle surgeons to accurately and reliably assess postoperative radiographs after first metatarsal-phalangeal joint arthrodesis. Thirty sets of digital radiographs from 11 patients who had undergone first metatarsal-phalangeal joint arthrodesis were retrospectively evaluated by 5 podiatric physicians board-certified in foot surgery. The surgeons were asked to answer several questions, including whether the radiograph appeared to be >4 or <4 postoperative weeks; whether the radiograph appeared to be >8 or <8 postoperative weeks; their estimation of the postoperative week; and whether they would allow the patient to begin weightbearing based on the radiographic findings. With respect to whether the radiographs were >4 or <4 postoperative weeks, surgeons made accurate assessments 63.33% of the time (95 of 150; range 56.67% to 73.33%), with a kappa of 0.220. With respect to whether the radiographs were >8 or <8 postoperative weeks, surgeons made accurate assessments 60.0% of the time (90 of 150; range 53.33% to 70.0%), with a kappa of 0.203. With respect to the estimation of the postoperative week of the radiograph, surgeons accurately assessed the radiographs within a 4-week period 34.0% of the time (54 of 150; range 26.67% to 46.67%), with a kappa of 0.425. With respect to allowing the patient to bear weight according to the radiographic findings, the surgeons were in complete agreement 26.67% of the time (8 of 30), with a kappa of 0.251. These results provide evidence against the serial routine use of postoperative radiographs for the first metatarsal-phalangeal joint arthrodesis in the absence of a specific clinical indication.

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Arthrodesis of the first metatarsal-phalangeal joint is a common procedure performed within foot and ankle surgery that is used for indications such as end-stage arthritis, hallux varus, hallux valgus, avascular necrosis, rheumatoid arthritis, and a number of other pathologic entities. Although some form of early postoperative weightbearing of the joint has recently been advocated (1–5), the traditional postoperative course is dictated by non-weightbearing cast immobilization until osseous bridging and consolidation are appreciated on serial postoperative radiographs (6–12). Additionally, postoperative radiographs can be used for assessment of any postoperative complication that might be encountered, including delayed union, nonunion, hardware failure, and infection. Roukis (13) reported a comprehensive systematic review on the first metatarsal-

phalangeal joint arthrodesis procedure and reported an overall nonunion incidence of 5.4%.

However, some investigators have recently questioned the value of “routine” serial postoperative radiographs in the absence of a specific radiologic indication for orthopedic surgery (14–18). McDonald et al (14) studied nearly 900 ankle fractures and found no difference in the complication rates between patients who underwent radiographic studies early (7 to 21 days) versus late (22 to 120 days) in their postoperative course. The investigators concluded that the evidence was insufficient to justify taking routine postoperative radiographs. Grimm et al (18) specifically studied cervical and lumbar spine fusions and found that routine postoperative radiographs rarely changed the postoperative decision making or management of patients when obtained in the absence of clinical symptoms.

Overusage of routine postoperative radiographs might also extend to the first metatarsal-phalangeal joint. Christman’s foot and ankle radiology text describes osseous healing as “progressive radiodense bridging in subsequent views until radiolucency is barely visible” (19). This might be difficult for foot and ankle surgeons to accurately visualize, particularly because fixation constructs have

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advanced from relatively basic wires and screws to anatomic contoured locking plates. These so-called advanced forms of fixation can physically obscure the arthrodesis site on radiographic imaging and could make visualization of healing more difficult. Particularly within the spinal literature, surgeon accuracy and reliability with respect to determining successful arthrodesis from radiographs has been challenged (20–23).

The objective of the present investigation was to evaluate the ability of foot and ankle surgeons to accurately and reliably assess postoperative radiographs after first metatarsal-phalangeal joint arthrodesis.

Materials and Methods

Twenty-seven sets of digital radiographs (Opal-RAD PACS; Viztek, Garner, NC) from 11 patients who had undergone first metatarsal-phalangeal joint arthrodesis were retrospectively evaluated by 5 podiatric physicians board-certified in foot surgery. The radiographs were selected along a spectrum of the postoperative course and ranged from postoperative week 1 to postoperative week 56. Specific radiographs were chosen for inclusion if multiple views of the arthrodesis site were available (at least an anteroposterior, oblique, and lateral radiograph) and adequate reduction and fixation of the joint had been achieved, as judged by 1 of us (A.J.M.). These included radiographic sets of the same patient taken at different points in the postoperative course. Radiographs were excluded if any incidental evidence or visual cues showed that the radiograph had been taken in the immediate postoperative period, including visible casting or splinting material, the presence of percutaneous fixation, or extensive soft tissue edema. Radiographs were also excluded if any evidence of a complication was present, including hardware failure, infection, or nonunion.

Three of these radiographic sets were additionally selected by 1 of us (A.J.M.) for a repeat evaluation for a total of 30 radiographic set evaluations per surgeon. The same 3 radiographic sets were repeated for each evaluator.

Each surgeon viewed the 30 radiograph sets independently on a laptop computer and in an order produced by a random number generator. No time restriction was applied to the evaluations, but they were not allowed to return and review previously viewed radiographic sets. The surgeons were kept unaware of all patient- and surgery-specific information. The surgeons were asked to answer several questions with respect to each set of radiographs:

1. Whether the radiograph appeared to be >4 or <4 postoperative weeks
2. Whether the radiograph appeared to be >8 or <8 postoperative weeks
3. Their estimation of the postoperative week
4. Whether they would allow the patient to begin weightbearing according to the radiographic findings

The data were procured from the data collection sheets and stored on a micro-computer for subsequent analysis. All statistical analyses were performed using Statistical Analysis Systems software, version 9.2 (SAS Institute, Cary, NC). Accuracy and repeatability were measured as a percentage count. Reliability was measured using the Fleiss' kappa. This is a measure of agreement between >2 raters when data are categorical. An established value interpretation of the kappa statistic is as follows: a kappa from 0.01 to 0.20 indicates "slight" agreement; 0.21 to 0.40, "fair" agreement; 0.41 to 0.60, "moderate" agreement; 0.61 to 0.80, "substantial" agreement; and 0.81 to 1.00, "almost perfect" agreement (24).

Results

A total of 150 total radiographic evaluations were performed by the 5 surgeons (Table). Of the 30 radiographic sets, 24 presented an arthrodesis that was fixated with a plate and interfragmentary screw

and 6 presented an arthrodesis that was fixated with crossed cannulated screws. The mean \pm standard deviation of the postoperative week was 10.60 ± 12.41 (range 1 to 56) weeks. Of the 30 radiographic sets, 9 presented an arthrodesis that was earlier than postoperative week 4, 7 presented an arthrodesis that was between postoperative weeks 4 and 8, and 14 presented an arthrodesis that was later than postoperative week 8.

4 Versus 4 Versus >4 Versus <4 Postoperative Weeks

Regarding whether the radiographs were >4 or <4 postoperative weeks, the surgeons made an accurate assessment in 95 of the 150 cases (63.33%; range 56.67% to 73.33%), with a corresponding kappa of 0.220. In 15 evaluations, the same radiographic set was repeated to the surgeon at some point during the radiographic series. The surgeons gave the same answer with respect to whether the radiograph was >4 or <4 postoperative weeks in 9 of these cases (60.0%).

Thirty evaluations involved the question of >4 or <4 postoperative weeks with an arthrodesis fixated with 2 cannulated screws. The surgeons made accurate assessments in 18 of these cases (60.0%; kappa = 0.184). A total of 120 evaluations involved the question of >4 or <4 postoperative weeks with an arthrodesis fixated with a plate and an interfragmentary screw. The surgeons made correct assessments in 79 of these cases (65.83%; kappa = 0.179).

8 Versus 8 Versus >8 Versus <8 Postoperative Weeks

Regarding whether the radiographs were >8 or <8 postoperative weeks, the surgeons made an accurate assessment in 90 of the 150 cases (60.0%; range 53.33% to 70.0%), with a corresponding kappa of 0.203. In 15 evaluations, the same radiographic set was repeated to the surgeon at some point during the radiographic series. The surgeons gave the same answer with respect to whether the radiograph was >8 or <8 postoperative weeks in all 15 of these cases (100.0%).

Thirty evaluations involved the question of >8 or <8 postoperative weeks with an arthrodesis fixated with 2 cannulated screws. The surgeons made accurate assessments in 17 of these cases (56.67%; kappa = 0.359). A total of 120 evaluations involved the question of >8 or <8 postoperative weeks with an arthrodesis fixated with a plate and an interfragmentary screw. The surgeons made accurate assessments in 75 of these cases (62.5%; kappa = 0.165).

Estimation of Postoperative Week

Regarding the estimation of the postoperative week of the radiograph, we considered an estimation accurate if it was within 2 weeks on either side of the actual postoperative week (a 4-week window). Surgeons accurately assessed the radiographic sets within this 4-week period in 54 of the 150 cases (34.0%; range 26.67% to 46.67%), with a corresponding kappa of 0.425. In 15 cases, the same radiographic set was repeated to the surgeon at some point during the radiographic series. The surgeons gave an answer with respect to the

Table

Accuracy and reliability outcome measures for evaluation of first metatarsal-joint arthrodesis (n = 150 radiographic evaluations)

Variable	Total (n = 150)	Blind Repeat Analysis (n = 15)	Fixation With 2 Screws (n = 30)	Fixation With Plate and Interfragmentary Screw (n = 120)
>4 versus <4 wk	63.33 (0.220)	60.0	60.0 (0.184)	65.83 (0.179)
>8 versus <8 wk	60.0 (0.203)	100.0	56.67 (0.359)	62.5 (0.165)
Postoperative week estimation	34.0 (0.425)	80.0	33.33 (0.504)	34.17 (0.444)
Weightbearing allowance	26.67* (0.251)	86.67	66.67 (0.451)	20.83† (0.163)

Data presented as accuracy (percentage of the count) and agreement (Fleiss' kappa) or agreement (percentage of the count).

* Complete agreement (n = 30).

† Fixation with plate and interfragmentary screw (n = 120).

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