The added value of routine radiographs in wrist and ankle fractures

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Routine Follow-up Radiographs for Ankle Fractures Seldom add Value to Clinical Decision-making: A Retrospective, Observational Study

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ABSTRACT

Background

Currently, the routine use of radiographs for uncomplicated ankle fractures represents good clinical practice. However, radiographs are associated with waiting time, radiation exposure, and costs. Studies have suggested that radiographs seldom alter the treatment strategy if no clinical indication for the radiograph was present. The objective of the present study was to evaluate the effect of routine radiographs on the treatment strategy during the follow-up period of ankle fractures.

Methods

All patients aged ≥18 years, who had visited 1 of the participating clinics with an eligible ankle fracture in 2012 and with complete follow-up data were included. The data were retrospectively analyzed. The sociodemographic and clinical characteristics and the number of, and indications for, the radiographs taken were collected from the medical records of the participating clinics. We assessed the changes in treatment strategy that were a result of the radiographic findings.

Results

In 528 patients with an ankle fracture, 1174 radiographs were made during the follow-up period. Of these radiographs, 936 (79.7%) were considered routine. Of the routine radiographs taken during the follow-up period, only 11 (1.2%) resulted in changes to the treatment strategy.

Conclusion

Although it is common practice to take radiographs routinely during the follow-up period for ankle fractures, the results from the present study suggest that routine radiographs seldom alter the treatment strategy. This limited clinical relevance should be weighed against the healthcare costs and radiation exposure associated with the use of routine radiographs. For a definitive recommendation, however, the results of our study should be confirmed by a prospective trial, which we are currently conducting.

INTRODUCTION

Routine radiography during outpatient fracture treatment is known to contribute to the increasing costs of healthcare.[1] The cost-effectiveness of diagnostic imaging has become an increasingly important factor in clinical decision-making with healthcare costs increasing globally.[2] Despite this, routine radiographs made during outpatient clinical visits of patients with an ankle fracture are a common worldwide practice.[3, 4] The arguments for routine radiography include monitoring of bone-healing, identification of complications, resident education, reassurance for the physician and patient, and medicolegal motives.[4] Currently, the added value of routine radiographs is under discussion. Several studies examining the value of radiographs immediately after splinting and radiographs taken at the first postoperative outpatient clinic visit have suggested that radiographs without a clear clinical indication (e.g., pain, loss of mobility, or subsequent trauma to the ankle) will not lead to a change in the treatment strategy.[1, 5-10] These radiographs did, however, contribute to additional radiation exposure and unnecessary costs.

In the Netherlands, with a population of 17 million people, the costs of radiographs during the follow-up period for ankle fractures has been ~3 million Euros annually, based on an incidence of 15,000/y and 4 occasions per patient when a radiograph is made, costing €50 each.[11] Considering that the incidence of ankle fractures is expected to increase worldwide in the coming decades because of an aging population,[12] the clinical value of routine radiographs for monitoring fracture healing and delivering good quality care must be established.

We undertook a retrospective cohort study to identify cases in which an outpatient clinic visit during the follow-up of ankle fractures, which included a routine radiograph that led to a change in the treatment strategy. The objective of the present study was to evaluate whether routine radiographs made during the follow-up for patients with an ankle fracture altered the treatment strategy. We hypothesized that routine radiographs during the follow-up of uncomplicated ankle fractures would not alter the treatment strategy.

METHODS

Study Population

We retrospectively analyzed the information from consecutive patients with complete follow-up data available from 4 level 1 trauma centers in the Netherlands, 2 university hospitals and 2 large teaching hospitals. Patients ≥18 years of age with non-Weber[13] type A ankle fractures (unimalleolar, bimalleolar, or trimalleolar fractures with a Lauge-Hansen[14] classification of supination-adduction [SA] 2, supination-external rotation [SE] 2 to 4, pronation-external rotation [PE] 1 to 4, or pronation-abduction [PA] 1 to 3 (14) that had occurred from January 1, 2012 to December 31, 2012 were eligible for inclusion. Distortions and isolated Danis-Weber classification type A fractures (15) were not included. The exclusion criteria were pathologic fractures, open fractures, multiple fractures, and severe injuries (injury severity score ≥16). The follow-up period consisted of the time the patient was receiving treatment at 1 of our affiliated hospitals. No active monitoring was pursued after this period.

Study Procedure

The present investigation was performed in compliance with the current laws and ethical standards in the Netherlands. All data were stored in accordance with Dutch privacy legislation. All participating centers used a follow-up protocol that recommends radiographs at follow-up consultations 1, 2, 6, and 12 weeks after trauma or surgical fixation. The following data were extracted from the medical records: baseline patient characteristics, including age, sex, and American Society of Anesthesiologists score, fracture type according to Lauge-Hansen[14] and Danis-Weber[13] classification schemes, the treatment strategy, the date of trauma and date of discharge from monitoring, the dates, number of, and indications for the radiographic assessments, and whether the initial treatment strategy was changed by the information gathered from the radiographs.

In the present study, the standard set of anteroposterior, lateral, and mortise views was counted as 1 radiographic assessment. The fracture type was classified according to the radiographs taken at the emergency department or, when the patient had first been treated at a different emergency department, during the first consultation visit. A radiograph was considered routine if the physician had not documented the clinical indication for performing the radiograph in the medical record.

A distinction was made between radiographs taken during the first 3 weeks after trauma (defined as the treatment period, during which a treatment strategy was drafted and surgical fixation might be performed) and radiographs taken after the first 3 weeks (defined as the follow-up period, in which the main reasons for taking radiographs were to monitor bone-healing and assess for complications). In the present study, we focused solely on radiographs taken during the follow-up period. The patients were stratified into 2 groups according to the treatment strategy (i.e., operative or nonoperative management).

Statistical Analysis

Descriptive statistics are reported for the baseline characteristics, fracture type, and radiographic characteristics. The outcome values are reported separately for nonoperatively and operatively managed patients. Categorical data were compared with use of a χ^2 test. Continuous data were compared with use of an unpaired *t* test. For all statistical tests, significance was assumed at $p < 0.05$. All analyses were performed with use of SPSS statistics for Windows (version 23; IBM Corp., Armonk, NY).

RESULTS

In the cohort of 601 consecutive patients with an ankle fracture, 73 were excluded by the exclusion criteria. The study group included 528 patients, 238 (45%) males and 290 females (55%). The mean age of all patients was 49.9 ± 19.5 (standard deviation) years. Of the 528 patients, 261 (49%) were managed nonoperatively and 267 (51%) were treated operatively. The baseline characteristics are listed in Table I. The median

Table I. Baseline Characteristics of participants

		Total cohort (n=528)		Nonoperative treatment (n=261)		Operative treatment (n=267)		*p*-value
Male Sex	*n (%)*	238	(45%)	121	(46%)	117	(44%)	0.56
Age	*mean (SD)*	49.9	(19.5)	53.5	(20.5)	46.5	(18.0)	**<0.05**
ASA score	*n (%)*							
	1	281	(53%)	135	(52%)	146	(55%)	0.50
	2	166	(32%)	72	(28%)	94	(35%)	0.06
	3	71	(13%)	48	(18%)	23	(9%)	<0.05
	unknown	10	(2%)	6	(2%)	4	(1%)	0.50
Fracture type	*n (%)*							
	Lauge Hansen SA	7	(1%)	7	(3%)	0	(0%)	<0.05
	Lauge Hansen SE	360	(68%)	198	(76%)	162	(61%)	<0.05
	Lauge Hansen PE	135	(26%)	40	(15%)	95	(36%)	<0.05
	Lauge Hansen PA	15	(3%)	7	(3%)	8	(3%)	0.87
	Posterior malleolar only	10	(2%)	8	(3%)	2	(0.7%)	0.51
	Weber C stress fracture only	1	(0.1%)	1	(0.3%)	0	(0%)	0.31

Legend for table I
SD: Standard deviation;
ASA: American society of Anesthesiologists;
SA: Supination adduction;
SE: Supination exorotation;
PE: Pronation exorotation;
PA: Pronation abduction.
Bold = a significant difference between groups ($p < 0.05$)

follow-up period was 14.1 (range 1.1-133) weeks for all patients. The details regarding the use of radiographs and the influence of the radiographic findings on the treatment strategy are listed in Table II. In the nonoperatively managed patients, 257 radiographs were made during the treatment period (median per patient of 1; range 0 to 3), and 415 radiographs were made during the follow-up period (median 2, range 0 to 6).Of the 415 radiographs taken during the follow-up period, 337 (90%) were scored as routine radiographs. In the operatively managed patients, 364 radiographs (median 1; range 0 to 4) were made during the treatment period, and 759 radiographs (median 3; range 0 to 11) were made during the follow-up period.

Of the 759 radiographs taken during the follow-up period, 563 (74%) were scored as routine radiographs. In the nonoperatively and operatively managed patients, 6 of 337 and 5 of 563 routinely scored radiographs, respectively, resulted in a change in the treatment strategy (Table III).

Table II. Usage of (routine) radiography in the follow-up of ankle fractures.

	Patients (n=528)	**Nonoperative management** (n=261)	**Operative management** (n=267)
Treatment-period:			
No. of radiographs (median, range)	621 (1, 0-4)	257 (1, 0-3)	364 (1, 0-4)
Follow-up-period:			
No. of radiographs (median, range)	1174 (2,0-11)	415 (2, 0-6)	759 (3, 0-11)
No. of routine radiographs	936 (80%)	373 (90%)	563 (74.2%)
No. of radiographs on clinical indication	238 (20%)	42 (10%)	196 (25.8%)
Radiographs leading to a change in treatment strategy	23 (2.0%[a])	8 (1.9%[a])	15 (2.0%[a])
Routine radiographs leading to a change in treatment strategy	11 (1.2%[b])	6 (1.6%[b])	5 (0.9%[b])

Legend for Table II

[a] Radiographs leading to a change in treatment strategy / No. of radiographs in follow-up period.

[b] Routine radiographs leading to a change in treatment strategy / No. of routine radiographs.

Table III. Routine radiographs leading to a change in treatment strategy

Change in treatment strategy:	**Routine radiographs** (n=936)
Total number of changes N(%)	11 (1.2%)
Prolonged cast immobilization (two weeks)	6 (0.6%)
Changed to surgical treatment 3 weeks after trauma	2 (0.2%)
Changed to surgical treatment 6 weeks after trauma	1 (0.1%)
Changed to surgical treatment 5 months after trauma	1 (0.1%)
Cancellation of scheduled implant removal	1 (0.1%)

Cast immobilization was prolonged by 2 weeks for 6 patients, nonoperative management was changed to operative management for 4 patients, and a planned implant removal was canceled for 1 patient because no radiologic consolidation was visible. Of the 4 patients who were scheduled for surgery because of findings from routine radiographs, 2 were assigned to operative management during their second outpatient clinic visit, which was 21 days after the initial trauma. The third patient complained of pain during the first 3 months after the trauma and was referred for physiotherapy. During the next outpatient clinic visit 5 months after the trauma, no complaints were documented; however, the patient was assigned to operative management because no signs of consolidation were seen on the radiographs. The fracture of the fourth patient scheduled for surgery was 2 weeks old before presentation at the emergency department and was initially deemed suitable for nonoperative management. The patient was assigned to surgery during the first outpatient visit 4 weeks later owing to secondary loss of reduction.

In the present cohort, 1174 (65.4%) of the total of 1795 radiographs were taken during the follow-up period. Of these 1174 radiographs, 936 (79.7%) were considered routine. For the general Dutch population, this could mean that 65.4% (€1,962,000) of the total annual radiographic costs of €3 million is spent within the follow-up period. Of these costs, 79.7% (€1,563,714) can be attributed to routine radiography. This indicates that with use of the data found in the present cohort, 52% of all the costs involved in radiography of ankle fractures could potentially be saved by omitting routine radiographs during the follow-up period.

DISCUSSION

We assessed the effect of conducting routine radiographs during the follow-up period on clinical decision-making in a large cohort of patients with ankle fractures. Our results suggest that only a small percentage (1.2%) of routine radiographs made during the follow-up period will lead to changes in patient management, with effort and cost involved in generating these radiographs. Just 2 of 936 radiographs taken during the follow-up period (0.2%) led to surgical fixation based on radiologic findings (i.e., secondary dislocation in 1 patient, and nonunion 1 patient scheduled for surgery). These findings should be considered in light of the increasing healthcare costs and unnecessary exposure to radiation. Although the quantified radiation dose of a single ankle radiograph is low,[15] it is difficult to defend administering even small amounts of ionizing radiation, if the indication to do so is lacking. In addition, each radiograph requires an investment in time from the patient, their companion, and the healthcare professionals involved.

We divided the therapy of our patients into a treatment period and a follow-up period and focused solely on the latter. We did this to diminish any bias that might arise because of differences in fracture-specific, surgeon-specific, or hospital-specific preferences in the early phases of ankle fracture treatment. Previous studies have also focused on routine radiographs taken in later stages of treatment, when protocols are more standardized or have a greater level of adherence[1, 7]. The present results are consistent with previous studies.[1, 4-7] For example, Ghattas et al., Miniaci-Coxhead et al., Ovaska et al., and Harish et al. demonstrated that radiographs taken at the first postoperative clinic visit of patients with various fracture types did not provide any additional clinically relevant information.[1, 6, 8, 9] Eastly et al. studied the effect of radiographs late in the follow-up of distal radius fractures.[7] To the best of our knowledge, to date, no studies have evaluated the use of routine radiographs in the follow-up period of patients with ankle fractures. The present study explored the use of routine radiographs in a large cohort of patients with a non-Weber type A ankle fracture. We choose not to include isolated Danis Weber type A fractures (Lauge-Hansen SA1), because these mainly represent ligamentous injuries, and no radiologic follow-up is recommended for this type of trauma (3). All types of ankle fractures requiring radiologic follow-up (Lauge-Hansen SA 2, SE 2 to 4, PE 1 to 4, and PA 1 to 3) and all treatment strategies (operative and nonoperative management) were included in the present evaluation.

However, the present study had some important limitations. Given its retrospective character, clinically relevant information that might affect fracture healing (e.g., smoking habits[16]) could not be retrieved from the medical records for many patients. Subsequently, the observed number of changes in the treatment strategy might be an underestimation of the assumed effects of these radiographs, because the radiographs can also confirm a correct treatment strategy and acknowledge its continuation. This effect could not be measured in the present study, because this is often not noted in the medical records.

Perhaps even more important is that the clinical indications to generate a radiograph might not always have been properly documented. If no clinical indication was noted in the medical records, a radiograph was considered "routine," potentially leading to an underestimation of the number of radiographs made for a clinical indication. We undertook a crude estimation of the costs of routine radiographs during the follow-up period of ankle fractures. Given the potential underestimation of the number of radiographs made for a clinical indication, these results should be interpreted with care. Second, our analysis does not represent either a cost-effectiveness analysis or a cost-benefit analysis, because the data on the cost associated with a possible gain of health in terms of quality-adjusted life-years or incremental cost differences could not be retrieved from the medical records in the retrospective study design. Similarly, documentation on the continuation of the preset treatment strategy based on the radiographic findings was probably also lacking in many cases. We only considered the documented reasons for a change in the treatment strategy, which created a bias such that the total influence of radiographs on the continuation of the treatment strategy would have been underestimated. Nevertheless, even if we included a certain range of cases in which continuation of the treatment strategy was influenced by routine radiographs, the overall added value of these radiographs would seem overestimated.

In conclusion, although it is common practice to routinely take radiographs during the follow-up period for ankle fractures, the current results suggest that these radiographs seldom influence clinical decision-making and can possibly be omitted. Because of the study limitations, the results of these analyses and the clinical consequences of a reduced imaging protocol should be confirmed in a prospective trial. Our research group is currently conducting a randomized controlled trial in which a group receiving routine radiographs is compared with a group in which radiographs in the follow-up period are made only when deemed necessary. These results could help in weighing the clinical importance of routine radiographs and help establish guidelines for their use in the management of patients with uncomplicated ankle fractures.

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