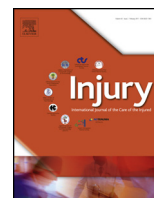




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Mid to distal third tibial shaft fractures caused by gunshots: Characterization and incidence of distal intra-articular extension

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ABSTRACT

Introduction: Spiral tibial shaft fractures are known to have a high rate of distal intra-articular extension; however, the risk of joint involvement caused by gunshots has not been thoroughly evaluated. The purpose of this study was to determine the incidence of intra-articular involvement in tibial shaft fractures caused by gunshots. The secondary purpose of this study was to assess the usefulness of ankle radiographs versus computed tomography (CT) scans in identifying these fractures.

Materials and methods: Ninety consecutive patients were identified as having a tibia fracture caused by gunshot at a Level-1 trauma center. Forty-four of these patients were fractures of the mid to distal third shaft. Twenty-eight patients had ankle CT scans available for review, and 24 patients had dedicated ankle films. Three orthopaedic surgeons and a radiologist read the radiographs and CT scans. Sensitivity and specificity analysis was performed for the ankle radiographs using ankle CT scans as the gold standard. **Results:** Seven of the twenty-eight fractures evaluated with a CT scan proved to have intra-articular involvement (Prevalence: 25%, 95% CI: 11.4%–45.2%). One of the seven intra-articular fractures was not seen on dedicated ankle radiographs (14.3%). The sensitivity of diagnosing an intra-articular extension on ankle radiographs was 0.85, 95%CI: 0.42–0.99. The specificity of diagnosing an intra-articular extension on ankle radiographs was 1.00, 95%CI: 0.81–1.00. Of the seven intra-articular fractures, three required additional treatment to address the intra-articular extension.

Conclusion: The incidence of intra-articular involvement for tibial shaft fractures secondary to gunshot is less than that reported for spiral type fractures (11–45% vs. 25–58%). Although radiographs have a high specificity, the sensitivity is lower than expected, with worse outcomes if a fracture is missed. We recommend that a CT scan should be utilized to determine intra-articular extension in the setting of tibial shaft fractures caused by gunshots.

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Introduction

Spiral tibial shaft fractures have a high association with fractures of the posterior malleolus [1], which affects the surgical planning, operative management, and post-surgical care of a patient. Spiral fractures are secondary to a torsional or rotatory force, which causes distal propagation of the fracture line. Boraiah et al. states 22 out of 24 patients with a spiral fracture of the tibia also had an associated posterior malleolus fracture [1]. The association of intra-articular fractures with tibia fractures can dictate treatment plans or cause displacement of the fracture if not addressed intra-operatively. In addition to altering treatment, poor

functional outcomes can result after posterior malleolar fractures occur [2], which necessitates addressing the fracture and providing anatomic reduction to diminish posttraumatic arthritis [3]. In an effort to detect these injuries, prior studies have suggested preoperative ankle radiographs and CT scans to evaluate for possible intra-articular involvement of such fractures [4,5].

There are 60,000 to 80,000 nonfatal gunshot wounds in the United States per year [6]. The mechanism of injury for gunshots are unique compared to a torsional stress on a long bone. Gunshots, depending on their velocity, have a zone of injury that affects bone and soft tissues. The association of intra-articular fractures in the tibia caused by gunshots is currently unknown. We hypothesize distal tibial shaft as well as the tibial shaft fractures would be less likely to not extend intra-articular to the tibio-talar joint; furthermore, if the fracture was intra-articular, it would be evident on plain radiographs. Secondly we will also determine the

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incidence of associated intra-articular fractures and evaluate the sensitivity and specificity of radiographs in detecting these injuries. This study was performed under an institutional review board approved protocol #13-221.

Materials and methods

No outside funding was used. We retrospectively reviewed all patients who presented to John H. Stroger Hospital of Cook County between January 2011 and September 2014. Inclusion criteria consisted of patients with mid or distal third tibia diaphyseal fractures caused by a gunshot. Patients required tibia-fibula radiographs (anterior-posterior and lateral views) and a computed tomography (CT) scan that included the tibio-talar joint. All CT scans utilized 3-millimeter cuts. Age was not a restriction. Exclusion criteria were a fracture proximal to the mid point of the tibia measured with radiographs, gunshots through the tibio-talar joint, and fractures not caused by a gunshot (Table 1).

Three orthopedic surgeons and a radiologist independently reviewed all radiographs for fracture propagation into the tibio-talar joint. CT scans were also reviewed for intra-articular fracture involvement. All imaging was viewed using GE PACS Software (General Electric, Scottsdale, AZ) allowing the physician to adjust contrast, magnification, and brightness. When available, dedicated ankle radiographs (anterior-posterior, lateral, and mortise views) were examined for intra-articular involvement of a fracture.

Utilizing CT scans (axial, coronal, and sagittal views) as the gold standard, the radiographic interpretations were evaluated for the

sensitivity, specificity, positive predictive value and negative predictive value of diagnosing an intra-articular fracture extension.

Results

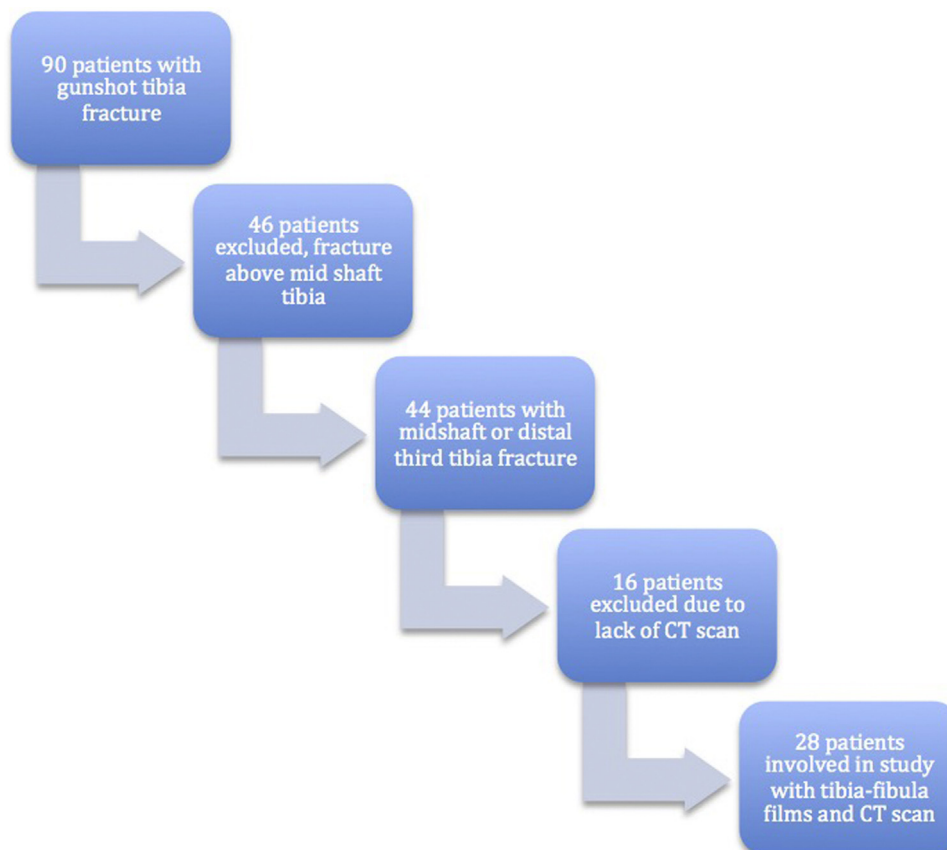
Ninety consecutive patients presented to John H. Stroger Hospital of Cook County with a tibia fracture caused by gunshot between January 2011 and September 2014. Of these, 44 patients had mid or distal third tibial diaphyseal fractures. Of these, 28 patients had both tibia-fibula radiographs and a computed tomography (CT) scan that included the ankle.

The age of the patient ranged from 17 to 54 years. The average age was 27 years. No patients had metabolic bone disease and no patient suffered from osteoporosis. Low velocity firearms caused all of the gunshots. This was ascertained based on clinical examination of the soft tissue envelope as well as entry and exit wounds. Nerve and vessel injury was not recorded, as this would be out of the scope of this paper.

Conventional radiographs detected fracture propagation into the tibio-talar joint in 6 of 28 fractures (21%). CT scans detected 7 of 28 fractures (Prevalance: 25%, 95% CI: 11.4%–45.2%) that involved the tibio-talar joint. There was one intra-articular fracture out of 7 that was not seen on plain radiographs (tibia-fibula and dedicated ankle series) that the CT confirmed intra-articular involvement (14.3%) (Figs. 1–4).

According to the official radiologist report, 2/28 reports contain any information about intra-articular involvement of the tibio-talar joint. These two reports did have intra-articular involvement. However, none report negative involvement of the joint.

Table 1
Inclusion criteria for study.



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