SCIENTIFIC ARTICLE

A Comparison of Plain Radiographs and Computed Tomography for Determining Canal Diameter of the Distal Phalanx

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Purpose To compare plain radiographs and computed tomography (CT) when determining the narrowest diameter of the medullary canal of the distal phalanx.

Methods A database review identified 48 patients (23 male, 25 female) who underwent a CT scan of the hand and plain radiographs of the same hand. Using digital imaging software, the smallest diameter of the medullary canal was measured for each finger (index, middle, ring, little) on CT and on radiographs.

Results The narrowest diameter of the medullary canal was measured on the axial CT and lateral hand radiograph at the transition between the tuft and the distal phalanx shaft. The mean narrowest diameters on plain radiographs for the index, middle, ring, and little fingers were 1.4 mm, 1.4 mm, 1.4 mm, and 1.1 mm, respectively. The mean diameters on CT were 1.2 mm, 1.3 mm, 1.2 mm, and 1.0 mm, respectively. Men had larger medullary canal dimensions (1.5−1.7 mm) than women (0.8−1.2 mm).

Conclusions The differences in canal diameter measurements between plain radiograph and CT were small and likely clinically insignificant.

Clinical relevance Lateral radiographs can be used for preoperative planning when estimating the size of the distal phalanx intramedullary canal. *(J Hand Surg Am. 2015;40(7):1404−1409. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Canal, CT, distal, medullary, phalanx.

Additional material is available online.

Arthrodesis is a reliable treatment for relieving pain in patients with end-stage arthritis of the distal interphalangeal joint.[1] Rigid fixation of the joint is important for successful fusion. Surgical techniques include Kirschner wires (K-wire),[2] tension band wiring,[3] plate and screw fixation,[4] and interosseous wiring.[2] In recent years, headless compression screws have become a popular option for arthrodesis of the distal interphalangeal joint.[5,6]

Headless compression screws offer some advantages over other arthrodesis techniques. Their theoretical advantages include lack of prominent hardware, compression across the arthrodesis site, and the opportunity for early mobilization. K-wire and interosseous wire techniques result in weak compression across the arthrodesis site.[7] Headless compression screws provide strong compression across the arthrodesis site and lack of the pin track problems associated with K-wire fixation.[8,9]

Reports have indicated that nail bed complications and/or distal phalanx fracture can occur with headless

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compression screws.[9–11] These complications may occur from misplacement of the screw or if the medullary canal of the phalanx is too small for the implant. This is particularly true in the little finger and is likely related to a size mismatch between the screw and the dimensions of the distal phalanx.[9,10]

Previous studies have attempted to measure the size of the distal phalanx. Mintalucci et al[12] described the mean outer cortex diameters of 60 index, middle, ring, and little fingers on plain radiographs. The distal phalanx was narrowest on the lateral radiograph. Song et al[13] measured the narrowest diameter of the distal phalanx outer cortex but also measured the diameter of the medullary canal. Mintalucci et al[12] and Song et al[13] made conclusions with regard to the acceptability of specific implants based on the outer cortex diameter. However, the outer cortex diameter may not be the best measurement to determine the feasibility of implants. The diameter of the medullary canal is intuitively more important for an implant such as a headless compression screw. Implants that are too large for the medullary canal could result in iatrogenic fracture and other complications related to implant prominence.

The dimensions of the distal phalanx medullary canal have not been well described. Previous work in a femur model has demonstrated that plain radiographs may not accurately define the diameter of the intramedullary canal.[14] There is a theoretical advantage of using computed tomography (CT) to measure the dimensions of the distal phalanx because CT is able to measure the size of the canal in multiple planes, allowing determination of the smallest dimension of the canal.

The purpose of this study was to determine the average size and narrowest dimensions of the distal phalanx intramedullary canal in a healthy adult population using both plain radiograph and CT and to assess if there was a significant difference in measurements between these 2 modalities.

METHODS

After institutional review board approval, a billing database query identified 50 patients who underwent a CT scan of the hand and plain radiographs of the same hand between 2007 and 2013. Two patients were excluded owing to poor-quality images or the official radiology report identifying an abnormality in the distal phalanx.

A fellowship-trained musculoskeletal radiologist performed all measurements using a picture archiving and communications system (Stentor, Inc., Phillips, Amsterdam, The Netherlands). The radiologist performed x-ray measurements on anteroposterior (AP) and attempted lateral views and recorded the narrowest diameter of the canal using Phillips iSite (Phillips; Andover, MD) digital imaging software. We used imperfect laterals of each distal phalanx because hand radiographs were obtained rather than specific finger laterals. The radiologist performed CT measurements on the axial and coronal images at the transition point between the tuft and the distal phalanx shaft (Figs. 1, 2) based on findings from 2 previous studies.[12,13] These studies demonstrated that this was the narrowest point of the distal phalanx. Multidetector CT scanners (GE; Milwaukee, WI) with thin-section acquisition (0.63 or 1.25 mm) in bone algorithm acquired the CT images. The data were reconstructed on a separate workstation (Vitrea software; Vital images, Minnetonka, MN) using standard reconstruction algorithms. This image manipulation allowed the radiologist to measure the distal phalanx in true coronal, sagittal, and axial planes regardless of the patient position by allowing reconstruction of these true planes. The best plane to measure medullary canal diameter was the axial plane because the coronal and sagittal planes may not cut through the center of the bone.

We used a 2-tailed student t test ($\alpha = .05$) to compare sex differences for x-ray and CT measurements. Because the x-ray and CT measurements came from the same hand, we used a 2-sided paired t test ($\alpha = 0.05$) to assess the difference in means between plain radiograph and CT. A 2-sided paired t test compared plain radiograph and CT in the AP diameters and mediolateral diameters. We compared the dimensions of each individual digit using analysis of variance and the nonparametric Kruskal-Wallis test.

RESULTS

CT and radiographic measurements were completed for 48 hands (27 right and 21 left) in 48 patients (23 men and 25 women). The average age of the cohort was 44 years, with an SD of 18.

Table 1 summarizes the results for the analysis comparing the measurements of plain radiograph and CT. Plain radiograph measurements were larger than CT measurements for all fingers. The little finger had the smallest average diameter on the lateral radiograph (1.1 mm) compared with the index (1.4 mm), middle (1.4 mm), and ring (1.4 mm) fingers ($P < .001$).

There was a difference in medullary canal dimensions for the index, middle, ring, and little digits between men and women for both x-ray (Table 2) and CT (Table 3). Men had larger medullary canal dimensions than women. This difference averaged about