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ORIGINAL ARTICLE

Comparative Radiographic Analysis of the Width of the Lesser Digit Proximal Phalangeal Heads

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Background: Digital deformities represent a common presenting pathology and target for surgical intervention in podiatric medicine and surgery. The objective of this investigation was to compare the radiographic width of the heads of the lesser digit proximal phalanges.

Methods: One hundred and fifty consecutive feet with a diagnosis of digital deformity and performance of weight-bearing radiographs were analyzed. The maximum width of the heads of the lesser digit proximal phalanges were recorded from the radiographs utilizing computerized digital software.

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Results: The mean±standard deviation (range) of the head of the second digit proximal phalanx was 9.74±0.87 mm (7.94-11.78), of the head of the third digit proximal phalanx was 9.00±0.91 mm (7.27-10.94), of the head of the fourth digit proximal phalanx was 8.49±1.01 mm (5.57-10.73), and of the head of the fifth digit proximal phalanx was 8.67±0.89 mm (6.50-11.75). The width of the head of the proximal phalanx decreased from the second digit to the third digit (p<0.001), decreased from the third digit to the fourth digit (p<0.001), and then increased from the fourth digit to the fifth digit (p=0.032).

Conclusions: The results of this investigation provide evidence in support of an anatomic and structural contribution to digital deformities. The width of the heads of the lesser digit proximal phalanges decreased from the second to the third to the fourth toes, and then subsequently increased with the fifth proximal phalangeal head.

Digital deformities represent a common presenting pathology and target for surgical intervention in podiatric medicine and surgery (1-23). The specific hammertoe, claw toe, and adductovarus deformities are characterized by relative dorsiflexion of the metatarsal-phalangeal joint and plantarflexion of the proximal interphalangeal joint. This results in the head of the proximal phalanx being in a comparatively prominent position, potentially as a source of irritation, pain, and hyperkeratotic tissue formation in shoe gear.

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The etiology of digital deformities is typically ascribed to a biomechanical and dynamic source, namely in the form of flexor stabilization, flexor substitution and extension substitution (7). Each of these might result in relatively prominent heads of the lesser digit proximal phalanges. With that said, this might not occur symmetrically across all of the lesser digits. For example, Meyr et al. performed an epidemiologic review of 1684 forefoot procedures and found that the second and fifth digits were more frequently operated on in comparison to the third and fourth digits (24). This might indicate a structural anatomic contribution, in addition to the dynamic biomechanical component, to these deformities.

Therefore, the objective of this investigation was to compare the radiographic width of the heads of the lesser digit proximal phalanges.

Methods

This investigational protocol was submitted through our Institutional Review Board (Temple University Hospital Protocol #28596) and deemed exempt. A diagnostic code search was first performed from the records of the Temple University Foot and Ankle Institute to include M20.40 (other hammer toe(s) (acquired), unspecified foot), M20.41 (other hammer toe(s) (acquired), right foot), and M20.42 (other hammer toe(s) (acquired), left foot). Returned records were then reviewed for selection criteria. Subjects were included if aged 18-89 years,
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with a diagnosis code of M20.40, M20.41 and/or M20.42, and with performance of at least a weight-bearing dorsal-plantar (DP) radiographic projection. Subjects were excluded with any history of previous foot surgery and/or history of digital trauma. One hundred and fifty consecutive feet meeting selection criteria were included.

The maximum width of the heads of the lesser digit proximal phalanges was recorded from the DP radiographs utilizing computerized digital software (Opal-RAD PACS, Viztek, Garner, NC) measuring to a precision of 0.01 mm (Figure 1). Radiographic measurements were performed by three study authors (KK, AC, RH) and confirmed by a fourth (AJM).

Data was stored in a password protected personal computer for subsequent statistical analysis. All statistical analyses were performed by one study author (AJM) using Statistical Analysis Systems software, version 9.2 (SAS Institute, Cary, NC). Continuous variables were considered in terms of the mean, standard deviation and range and compared by means of the paired student t-test and ANOVA test.

Results

Results are displayed in Figure 2. One hundred and fifty consecutive feet in 104 subjects met inclusion criteria and were included in the analysis. Forty-six (44.2%) subjects were of male gender and 82 (54.7%) feet were of right laterality. The mean±standard deviation (range) of
the head of the second digit proximal phalanx was 9.74±0.87 mm (7.94-11.78), of the head of the third digit proximal phalanx was 9.00±0.91 mm (7.27-10.94), of the head of the fourth digit proximal phalanx was 8.49±1.01 mm (5.57-10.73), and of the head of the fifth digit proximal phalanx was 8.67±0.89 mm (6.50-11.75).

A statistically significant difference was observed between all groups with the analysis of variance (ANOVA) test (p<0.001). The width of the head of the proximal phalanx decreased from the second digit to the third digit (p<0.001), decreased from the third digit to the fourth digit (p<0.001), and then increased from the fourth digit to the fifth digit (p=0.032).

Discussion

As with any scientific investigation, critical readers are encouraged to review the study design and specific results in order to reach their own independent conclusions, while the following represents our conclusions based on the preceding results. We also never consider data to be definitive, but do think that these results might be worthy of attention and future investigation.

We conclude that there is a difference in the width of the heads of the lesser digit proximal phalanges. A somewhat “U”-shaped distribution was observed, progressively decreasing from the second to the third to the fourth proximal phalangeal head, and then subsequently increasing with the fifth proximal phalangeal head. Digital deformities are

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considered both a dynamic and structural pathology (7, 23), and these results provide evidence in support of this structural component. Meyr et al. found that the second and fifth digits were overwhelmingly the most commonly corrected lesser digits with surgical intervention (24).

All scientific investigations have limitations, and this one has several important limitations to consider. First, data was collected from a limited number of subjects and from a single institution, and therefore some sampling bias is likely present. Second, this is a study of radiographic outcomes and not specifically of subjective patient complaints or functional outcome measures. Third, only transverse plane radiographic parameters were assessed whereas the osseous prominence of digital deformities is at least a two-dimensional pathology. Although an area or volume calculation might be more anatomically accurate, we did not feel as though this could be reliably calculated with plain film radiography.

In conclusion, the results of this investigation provide evidence in support of an anatomic and structural component to digital deformities. The width of the heads of the lesser digit proximal phalanges decreased from the second to the third to the fourth toes, and then subsequently increased with the fifth proximal phalangeal head.

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Conflict of Interest: None reported.

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Figure 1: Measurement of the width of the lesser digit proximal phalangeal heads.

The maximum width of the head of the lesser digit proximal phalanges was recorded utilizing digital software measuring to a precision of 0.01 mm.
Figure 2: Width of the lesser digit proximal phalangeal heads.

Proximal Phalanx Head Width (millimeters)

*Statistical significance defined as p<0.05.

A statistically significant difference was observed between the width of the heads of the lesser digit proximal phalanges. The width of the head of the proximal phalanx decreased from the second digit to the third digit (p<0.001), from the third digit to the fourth digit (p<0.001), and then increased from the fourth digit to the fifth digit (p=0.032).