Geographical Differences in the Forefoot Morphology – A Comparative Radiological Study of Feet in Malawi and UK

A. Tindall[1], L. Chokotho[2], C. James[3], CBD Lavy[4]

[1]Orthopaedic SpR, SE Thames Rotation, [2]Orthopaedic Clinical Officer, Queen Elizabeth Hospital, Blantyre, [3]Orthopaedic Clinical Fellow, Guys Hospital, London, [4]Orthopaedic Consultant, BTCI Hospital, Blantyre, BTCI Hospital, PO Box 31236, Blantyre 3, Malawi,

Correspondence to: Mr A Tindall, 12, Farington House, 22, Gloucester Street, Pimlico, LondonSW1V 2DN. Fax: (+44) 207 976 603. Email: alistair_tindall@hotmail.com.

Background: Many skeletal morphological differences between populations have been reported with possible but unproven clinical importance. This study was aimed at identifying the normal radiographic findings and measurements seen in patients from Southern Africa and compares them to a European population's values.

Methods: AP foot radiographs of 40 adults from Blantyre, Malawi were compared with those of 40 adults from London, UK. For each patient, measurements were taken of: 1st and 2nd metatarsal lengths, the 1st/2nd intermetatarsal angle, the 1st metatarso- phalangeal angle (the 'bunion' angle), and the 2nd metatarsal mortice joint medial and lateral depths.

Results : Our results show an increased 1st/2nd metatarsal angle in Malawian feet, but a reduced 'bunion' angle. We also found the second metatarsal length to be longer relative to the first in the Malawian foot, and the 2nd metatarsal base to be significantly more covered by its mortice than in UK feet.

Conclusion: This racial anatomical variation may convey more stability and less risk of a Lisfranc dislocation. It is also important to be aware of the normal range of these values when considering the need for forefoot arthroplasty procedures.

Introduction

Many skeletal morphological differences between populations have been reportedwith possible but unproven clinical importance[1,2,3]. In 1931 Wells, in South Africa described the Bantu foot as having less stability than the European foot because of a shallower mortice at the base of the second metatarsal (Figure 1). We were unable to find any other geographical comparative studies of this joint. In 2002, Peicha discussed the anatomy of the second metatarsal and showed that the mortice surrounding the base was shallower in a group of 33 patients who had suffered Lisfranc (tarso-metatarsal) dislocations than it was in a group of 88 cadaveric 'normal' feet[4]. We decided to investigate Wells' findings by comparing foot radiographs in Malawian and UK populations.

Materials and Methods

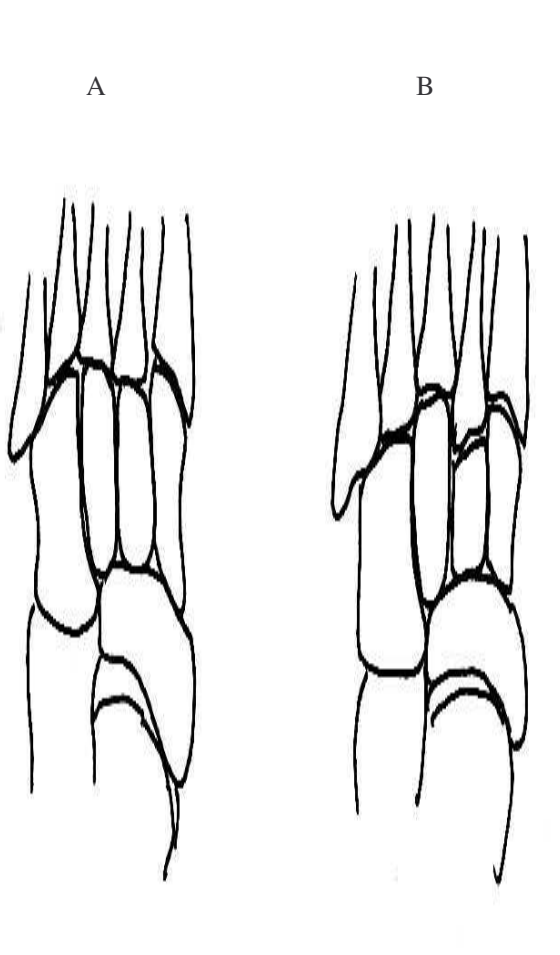
We retrospectively examined plain antero-posterior radiographs of weight bearing uninjured feet from 40 adults taken at random from hospital radiology department files from the preceding 12 months in London UK and Blantyre Malawi.

The characteristics of the patients are shown in Table 1.

Each radiograph was placed on a light box and the following measurements carefully performed (Figure 2):

1. Length of 1st metatarsal
2. Length of 2nd metatarsal
3. Angle between 1st and 2nd metatarsals
4. The 'bunion' angle between the first metatarsal and proximal phalanx
5. The depth of the medial wall of the 2nd metatarsal base mortice
6. The depth of the lateral wall of the 2nd metatarsal base mortice

These results were then analysed using Microsoft Excel spreadsheet software. P values of less than 0.05 were considered to be statistically significant. The mean differences between the two groups were tested using Student's two sample t-test assuming that there is equal or unequal variance depending upon Levenes test for equality of variance after inspection of the data for symmetry of distribution.



A. Southern African foot B.European foot

Figure 1: Taken from Wells 1931

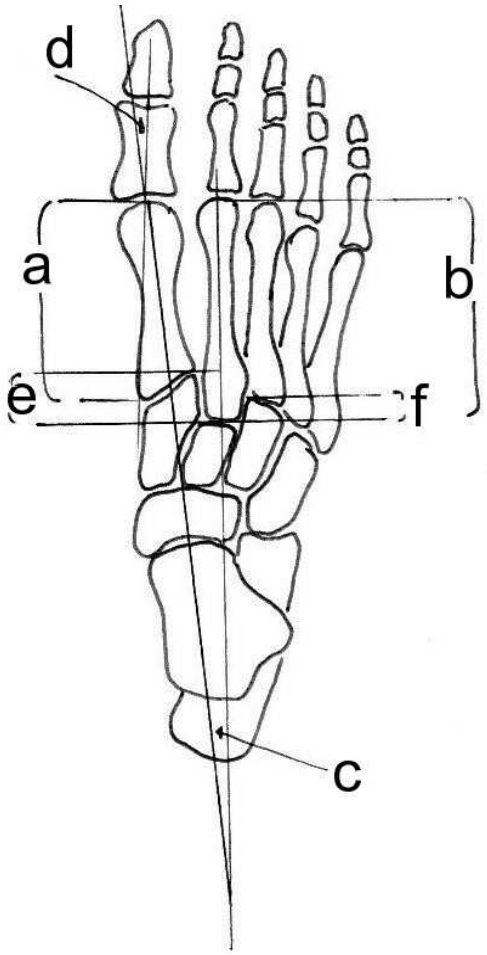


Figure 2

Results

Table 1 summarizes the characteristics of thr two groups. The results of the findings are shown in table 2, which also shows the ratios between the lengths of 1st and 2nd metatarsal bones, both sides of the 2nd metatarsal mortice, and the proportion of the 2nd metatarsal that is bilaterally covered in the mortice.

Table 1. Characteristics of the two groups

	Malawi	UK
Mean age	29.75	33.25
Male to female ratio	1.9:1	1.5:1
Right / left	0.4:1	2.0:1

Table 2. Results for the Malawian and UK populations

Code on fig 2	Parameter	Malawi mean	Malawi sd	UK mean	UK sd	P value (t-test)	Statiscal significance
a	Length of 1st metatarsal/mm	57.8	4.26	62.62	5.28	2.38 e-5	Sig
b	Length of 2nd metatarsal/mm	69.15	4.30	71.8	6.24	0.03	Sig
	Ratio of 2nd to 1st metatarsal lengths (b/a)	1.2	0.07	1.15	0.07	0.002	Sig
c	Angle between 1st and 2nd metatarsals /degrees	10.84	2.48	8.27	2.04	6.79 e-5	Sig
d	'bunion angle' ie angle between 1st metatarsal and proximal phalanx /degrees	12.7	5.03	15.93	5.90	0.01	Sig
e	Medial wall of 2nd metatarsal socket /mm	8.35	1.93	8.52	1.68	0.65	not sig
f	Lateral wall of 2nd metatarsal socket /mm	7.06	2.13	5.36	1.17	9.37 e-5	Sig
	Ratio of f to e, ie f/e	0.85	0.23	0.64	0.12	1.31 e-5	Sig
	Proportion of bilateral cover of second metatarsal by socket, ie b/f	0.10	0.03	0.07	0.01	9.86 e-6	Sig

Discussion

Foot sizes

The overall lengths of 1st and second metatarsals were longer in the UK radiographs. This may be because the population had larger feet, and this is indeed likely as Malawi has regular famines and a high degree of malnutrition. However the lengths of bones on radiographs cannot be accurately be compared between centres as different limb to film distances can distort measurement.

Relative length of 2nd metatarsal

The 2nd metatarsal length relative to that of the 1st metatarsal was significantly longer in the Malawian than in the UK radiographs. This has not been reported before and is unlikely to have any clinical significance.

Angle between 1st and 2nd metatarsals

This is significantly larger in the Malawian radiographs and is probably related to unrestrained splaying of the foot when weight bearing, as many people in Malawi do not wear shoes.

'Bunion' angle

This is significantly larger in the UK population. This is perhaps surprising in view of the bigger 1st/2nd metatarsal angle in the Malawian population; a varus 1st metatarsal is often associated with hallux valgus. It is possible that the lack of shoes allows the metatarsals to splay on weight bearing, and the lack of a varus deforming force on the hallux in the unshod foot reduces the tendency to hallux valgus. Certainly the authors have noticed very few patients in Malawi present clinically with bunions.

Cover of the 2nd metatarsal base

The proportion of the 2nd metatarsal that is enclosed in the mortice both medially and laterally is higher in the Malawian radiographs (10%) compared to those from the UK (7%). This is the exact opposite to the pattern reported

by Wells and on purely anatomical grounds makes the Malawian foot likely to be more stable and less susceptible to a Lisfranc dislocation than a UK foot.[5]

Conclusion

Our study has suggested that the population X-rayed in Malawi have slightly smaller feet than the UK population measured. The Malawi group has a significantly longer second metatarsal relative to the 1st, with significantly more mortice cover at the base of the 2nd metatarsal. Malawian feet also have a significantly bigger 1st / 2nd metatarsal angle and a smaller bunion angle. These differences are probably due to a combination of inherited characteristics and environmental factors such as wearing shoes It is possible that these findings explain the apparent lack of symptomatic hallux valgus. It is also possible that the Malawian foot is inherently more stable to Lisfranc dislocation.

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