

Department of Orthopaedic Surgery, Gävle, Sweden.

SKELETAL PARAMETERS IN THE HALLUX VALGUS FOOT

BO J. LUNDBERG & TOMAS SULJA

Accepted 8.viii.72

Among predisposing anatomical causes, a wide intermetatarsal angle, "Spreizfuss", including metatarsus primus varus, is significantly correlated with the hallux valgus deformity (Harris & Beath 1947, Hardy & Clapham 1951). There are also indications of a more prominent "relative protrusion" of the first metatarsal in the hallux valgus foot. The presence of a comparatively long great toe or first metatarsal in hallux valgus has been suggested since the reports of Mayo (1920) and Morton (1935), but seems weakly substantiated.

The present study was decided primarily in order to determine the relationship that may occur between the degree of hallux valgus and the following skeletal parameters: the absolute lengths of the first two metatarsals and the protrusion of the head of the first metatarsal in relation to the second. The analyses of correlation were also made after the addition of the proximal phalanx.

MATERIAL AND METHODS

In the present 25 cases of uncorrected hallux valgus the valgus deformity ranged from 10 to 50°, measured on a standard plantari-dorsal radiograph as the angle between the axis of the first metatarsal and that of the proximal phalanx. The ages of the patients ranged between 19 and 69 years, sex ratio 8 women to 2 men. No cases of neurological or rheumatic disorder were represented; all were "genuine" deformities.

The actual skeletal parameters were recorded on the radiographs according to Figure 1: The absolute lengths of the first and second metatarsal were measured on the axis, their quotient used in the correlation analysis. A true measure cannot be obtained because of the irregularity of the proximal joint surface of these bones. However, the point of intersection of the axis and the distal projected border of this surface was regarded as the best available.

The relative metatarsal protrusion (d) was defined as the difference between the distal articular joint surfaces of the first and second metatarsals after correction

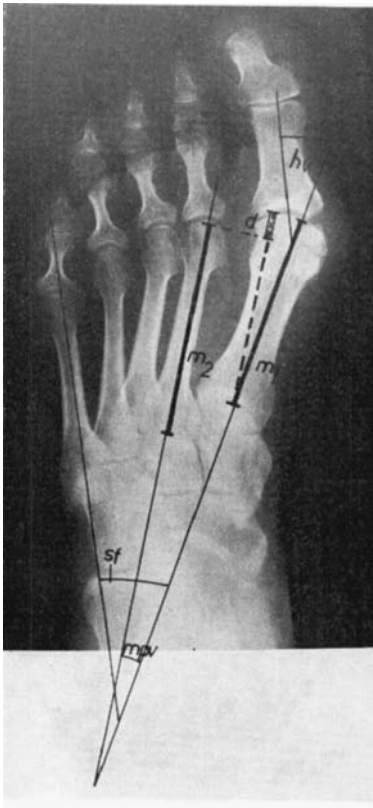


Figure 1. Standard radiograph with actual parameters:

hv – hallux valgus

sf – intermetatarsal angle

mpv – metatarsus primus varus

d – relative metatarsal protrusion

m'1 – 1st metatarsal bone

m'2 – 2nd metatarsal bone

for the metatarsus primus varus angle. Thus the first metatarsal was designed parallel with the second by placing one point of a pair of dividers in the intersection of axis with the base of the first metatarsal, as defined above, drawing an arc with the radius of the first metatarsal with the other. The same principles were applied when the lengths of the proximal phalanx were added. The metatarsus primus varus (*mpv*) and intermetatarsal (*sf*) angles were determined according to the figure. Correlation was calculated as the linear correlation coefficient and has been referred to as “significant” when the level of probability was less than 0.05.

RESULTS

The interdependence of hallux valgus and a wide intermetatarsal angle was established by a significant, high correlation coefficient, 0.6 (Figure 2). Even higher probability existed for an association with a wide metatarsus primus varus angle by a coefficient of 0.8 (Figure 3).

Again the observations on the relative metatarsal protrusion

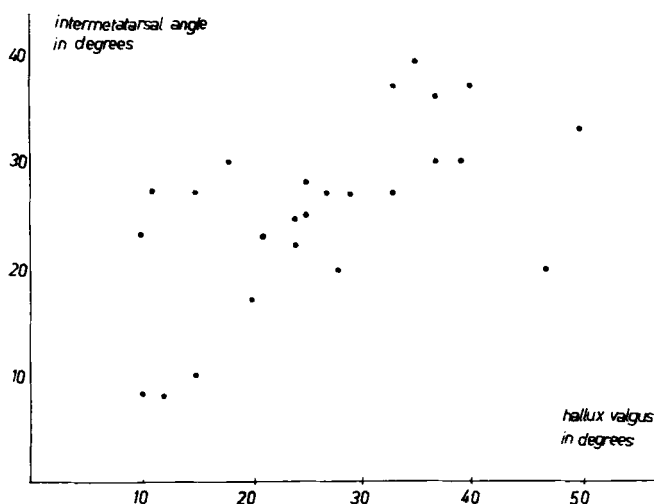


Figure 2. Relationship between hallux valgus and intermetatarsal angles.

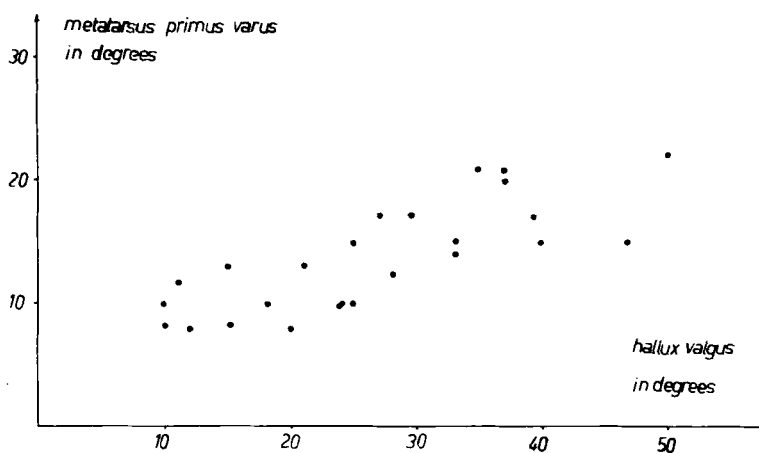


Figure 3. Relationship between hallux valgus and metatarsus primus varus angles.

showed significant positive coefficient of correlation, (0.4 Figure 4) indicating a more prominent first metatarsal to be of importance for the development of hallux valgus. The protrusion of the end of the first proximal phalanx was, however, not significantly correlated.

The quotient of the lengths of the first and second metatarsals showed no significant correlation to the degree of hallux valgus. The incorporation of the proximal phalanxes did not change the outcome.

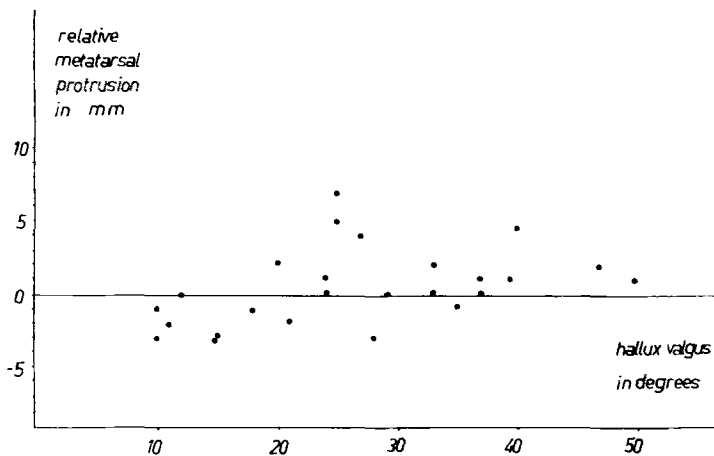


Figure 4. Relationship between hallux valgus and relative metatarsal protrusion.

DISCUSSION

As in the present material, a valgus deformity of the great toe amounting to 10° or more is indicative for diagnosis (Kelikian 1965, Hierton 1969, Dei Poli et al. 1970).

By eliminating obvious secondary cases, such as rheumatoid arthritis, neurological disorders and congenital deformity, the material should be representative for the "genuine" type of hallux valgus. The distribution by age and sex is also in accordance with other studies (Hardy & Clapham 1951, MacIennan 1966), as is the very striking correlation between the hallux valgus and the size of the intermetatarsal and metatarsus primus varus angle. Increasing varus of the first metatarsal should aggravate the valgus of the great toe. In fact the present coefficient of correlation is almost identical with that in Hardy & Clapham's extensive study of 1951. This finding thus emphasizes the conclusion of a causal relationship, but should not be interpreted as aetiologically indicative, especially as the deformity of hallux valgus precedes widening of the metatarsus primus varus angle, which has been demonstrated in younger individuals (Hardy & Clapham 1952, Piggott 1960). The advanced position of the great toe and its metatarsal has been regarded as another intrinsic factor causing hallux valgus. The principle is fairly obvious, as a protruded hallux should be more prone to give way towards valgus. Different methods have been applied in the evaluation of the relative metatarsal protrusion. Morton (1935)

measured the distance from the head of the first metatarsal to a perpendicular to the axis of the second metatarsal at the point of intersection of the distal articular surface. The disadvantage is, however, that any increase in the metatarsus primus varus angle should lead to an apparent shortening of the first metatarsal. Harris & Beath (1947) estimated the radial distance between arcs of circles centred on the calcaneum. Hardy & Clapham (1951) measured the relative metatarsal protrusion as the radial distance between arcs centred in the intersection between a transverse tarsal line and the axis of the second metatarsal which, in cases of metatarsus primus varus, gives a slight underestimation of the relative protrusion of the first metatarsal. These arcs should ideally be centred in the intersection of the first and second metatarsal axis which, however, in practise could be inconvenient. The method used in the present study reduces the metatarsus primus varus before measurement. In spite of some inaccuracy in the measurement, the finding of no correlation to the quotient of the lengths of the first and second metatarsals does not detract from the results, because a systematic error would tend to produce rather a closer correlation.

In Hardy & Clapham's study (1951) a significant positive correlation occurred between the prominence of the first metatarsal and hallux valgus in cases with high valgus and a low intermetatarsal angle only. A significant difference of relative metatarsal protrusion was also established between a morbid group and controls with means of 4 mm and 2 mm respectively. Theoretically this result could imply a dependency upon the degree of flatfoot, an often mentioned cause of hallux valgus. This should be true, provided the base of the first metatarsal is depressed relatively more than the second, which is probably not the case in the pronated foot. Hardy & Clapham's study did not incorporate measurements on the absolute lengths of the first two metatarsals. Our results, including also this parameter, should allow the statements that in hallux valgus the first metatarsal is not comparatively longer than the second, as no correlation occurred in respect to length, but also that the causal anatomical factor should be sought more proximally in the tarsus in view of the correlation found regarding the relative protrusion of the first metatarsal. A prominent innermost cuneiform bone, not only by shape but even by some indirectly effecting anatomical variation, could be of relevance. This would correspond to the interpretation given by Ewald (1912) and Truslow (1925) on the cause of metatarsus primus varus being due to

the oblique setting of the distal articular facet of this particular bone, which they regarded as a condition inherent in the individual's growth and development and not an acquired deformity.

Neither a relatively long great toe nor a more distal position of the first proximal phalanx seem to be determining factors for hallux valgus. Because of the correlation with the metatarsal protrusion, the latter circumstance was unexpected and is without any rational explanation: the further correlation between hallux valgus and the protrusion of the first proximal phalanx beyond the second would have been anticipated as the more logical.

Thus, concerning this question, only a protruded first metatarsal head is of significance for hallux valgus.

SUMMARY

In a study of radiographs of hallux valgus feet, significant positive correlations were found between the degree of valgus and the degree of metatarsus primus varus, as well as the intermetatarsal angles, which are in correspondence with results in earlier publications. We also found a significant correlation concerning the relative protrusion of the first metatarsal head but not the quotient of the length of the first two metatarsals. We therefore suggest that a causal skeletal factor for hallux valgus should be sought more proximally in the tarsus.

REFERENCES

- Dei Poli, G., Dei Poli, N., Forcheri, V. & Rosso, P. A. (1970) Sull'alluce valgo. *Minerva chir.* **25**, 934.
- Ewald, P. (1912) Die Aetiologie des Hallux valgus. *Dtsch. Z. Chir.* **114**, 90-103.
- Hardy, R. H. & Clapham, J. C. R. (1951) Observations on hallux valgus. *J. Bone Jt Surg.* **33-B**, 376.
- Hardy, R. H. & Clapham, J. C. R. (1952) Hallux valgus. Predisposing anatomical causes. *Lancet* **1**, 1180.
- Harris, R. I. & Beath, T. (1947) *Army Foot Survey*, Ottawa National Research Council of Canada.
- Hicrton, T. (1969) *Nordisk lärobok i ortopedisk kirurgi*. Svenska Bokförlaget.
- Kelikian, H. (1965) *Hallux valgus, allied deformities of the forefoot and metatarsalgia*. W. B. Saunders, Philadelphia & London.
- Mayo, C. H. (1920) The surgical treatment of bunions. *Minn. Med. J.* **3**, 326.
- Morton, D. J. (1935) *The human foot*. Columbia University Press, New York.
- MacLennan, R. (1966) Prevalence of hallux valgus. *Lancet* **1**, 1398.

- Piggott, H. (1960) The natural history of hallux valgus in adolescence and early adult life. *J. Bone Jt Surg.* **42-B**, 749.
- Truslow, W. (1925) Metatarsus primus varus or hallux valgus? *J. Bone Jt Surg.* **7**, 98.

Correspondence to:

Bo J. Lundberg
Department of Orthopaedic Surgery
Gävle, Sweden