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Measurements of 1st cuneometatarsal angle influencing the 1st Metatarsal Phalangeal Angle

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ABSTRACT

Description of deformities of toes brought forth words like "varus" and "valgus".valgus was originally derived from Latin and meant "bow legged". The terminology changed and it is now defined by Dorland as "bent outwards" where the reference point is midline of body. Varus means bent inwards from the same reference point. The terms hallux valgus was first coined by Carl Hueter in. Gould's medical dictionary defines it as the displacement of the great toe towards the other toes.1Pieque in 1902 was the first clinician to note the oblique setting of the 1st cuneometatarsal joint in a case of hallux valgus2, Truslow3, noted the above fact and metatarsal primus varus for the medially deviated 1st metatarsal.Lapidus4 later considered that the varus of the 1st metatarsal is the primary cause of hallux valgus and coined "metatarsus versus primus here "primus" denotes the primary defect being the varus of the metatarsus. Sir Robert Jones in 1924 mentioned shoes as a cause of hallux valgus after noting its higher incidence in shoe wearing community5. This fact was also noted by Barnicot6 and Hardy7, and Sim Fook and Hodgson8, but F.C.Durbin9, said that hallux valgus is seen even in barefoot races. The 1st cuneometatarsal angle is formed between the long axis of the 1st metatarsal and the line representing the plane of the distal facet on medial cuneiform. The distal facet maintaining its normal slant, this angle will be influenced by the shape of the base of the 1st metatarsal. If its lateral end projects proximally, the 1stmetatarsal tilts towards the midline of the body and this angle reduces. When the first cuneiform from a normal foot is dissected out and laid flat on the table little of the joint surface can be seen but in bones from subjects with hallux valgus, the surfaces usually look medially as well as distally. Similarly the metatarsal base is often set obliquely, but by no means invariably so.Thus both cuneiform and metatarsal usually take part in the alteration of alignment,10 the base of the metatarsal can adapt itself to changed conditions of pressure without gross pathological change, and though the cuneiform has no epiphysis it also is growing in adolescence, and can alter its shape. There is no convincing evidence of any primary lesion of the joint that could be regarded as a cause and not as a result of hallux valgus.11

KEYWORDS 1stMetatarsal Phalangeal Angle,cuneometatarsaljoint,1stcuneometatarsal angle, sesamoids,

INTRODUCTION

In spite of the deviation of the first metatarsal in hallux valgus the cartilages of the cuneometatarsal joint appear normal, and the ligaments are strong and allow only a normally restricted range of movement a study of radiographs, found the varus deviation usually associated with an obliquity of the auricular surface of the cuneiform, more rarely with an oblique setting of the base of the metatarsal similar to that found in the head of the tibia in genu valgum, whereas in normal individuals the joint was usually set transversely and was only occasionally oblique.[12] A joint between the bases of the first and second metatarsals, though often described as a normal variation, was in fact an acquired deformity due to hallux valgus. The point is difficult to decide without access to peoples who wear no shoes and have no trace of valgus, but would imply some lateral displacement of the base of the first metatarsal, forcing it against the second. There is no evidence of any medial deviation of the first cuneiform, or of any opening up of the first intercuneiform joint.This study is carried out and confirm the factors influencing the angle of hallux valgus. Measurements of 1st cuneometatarsal angle with statistical correlations are recorded to achieve this objective. Hallux valgus is a common and disabling disorder of the 1st ray, where there is lateral deviation of the big toe with consequent effect on dynamic weight bearing. Mitchell suggested that in such cases, the medially deviated 1st metatarsal fails to assume its proper role in weight bearing, The patients seek medical advice for pain and cosmetic reasons.The angle of hallux valgus is the usual metatarsal phalangeal angle denoting lateral deviation of the proximal phalanx. This term is ambiguous and misleading. Clinically, hallux valgus develops after this angle has crossed a critical degree. All the tendons surrounding the 1st ray are not attached to the 1st metatarsal head but are attached to the phalanges[14] as the majority of muscles acting o the big toe do so from the fibular side and if there is muscular imbalance, will pull the hallux laterally and increase the angle of hallux valgus. Extensor hallucis longus plays a primary role as there is no extensor expansion on the dorsum of the big toe. Therefore, this muscle loses its soft tissue connection from the dorsum of the 1st phalanx and becomes the chief muscle to have a 'bow-string' action on the big toe and initiate its lateral deviation, which is maintained by other muscles coming from the fibular side. As these muscles are attached to the phalanx and not to the metatarsal head, only the phalanx of the big toe is pulled laterally. This mechanism comes into play when either the 1st metatarsal shifts medially or the proximal phalanx shifts laterally[15].

MATERIALS AND METHODS

The present study was carried out on 58 healthy volunteers (between the ages of 18 and 23 years 43 males and 15 females). None of the volunteers had any foot complaint. There was no history of trauma. Their footwear consisted of chappals or open toed sandles 50% of the waking hours. Occasionally some wore closed toed shoes.

METHOD

1. Roentgenograms of both right and the left feet of a volunteer were taken on the same x-ray plate.
2. Both feet without shoes were kept on the film holder, slightly separated from each other with lateral bordeds of feet parallel to lateral margins of film cassette. Thus, the distance between the film and the object is reduced to a minimum to avoid distortion
3. Volunteers sat on the x-ray table with their knees held together and their feet on the x-ray film holder as shown in the diagram these x-rays are not taken under weight bearing conditions.
4. Central beam was directed at an angle of 150 to the perpendicular from an anteroposterior direction over the point midway between 1st metatarsal heads for bilaterally symmetrical shadows.

Measurment

The following seven parameters were recorded to measure foot.

Measurement of cuneometatarsal angle

The medial angle (x) formed at the intersection of the long axis of the 1st metatarsal and the tangent to the distal facet of the medial cuneiform represents the cuneometatarsal angle.

Measurement of the angle of hallux valgus

The long axis of proximal phalanx of the big toe is drawn by the same method as for the 1st metatarsal. The angle (x) opening out distally, between the long axes of the 1st metatarsal and proximal phalanx, when prolonged to meet, is the angle of hallux valgus

CALCULATIONS

Mean, standard error, Mode and Range are calculated for all the recorded values.

Statistical correlation coefficient 'r' showing interdependence is calculated between- The 1stcuneo-metatarsal angle and angle of hallux valgus.

OBSERVATION

Total no. of volunteers are 58 (15 females, 43 males).
Total no. of feet studied is 116.
The angle of hallux valgus (in degrees):

	Total
Mean	9.93
SE	4.666
Mode	9.56
Range	0-22
Mean+2SE	0.60-19.25
% of feet	93.9%

The 1st cuneometatarsal angle in degrees:

	Total
Mean	99.65
SE	6.04
Mode	99.47
Range	85-120
Mean+2SE	87.58-111.74
% of feet	95.69%

According to above findings an average Indian foot has measerment as detailed.

	Males	Females
1.The angle of hallux valguss	10^0	10^0
2.The 1st cuneometatarsal angle	100^0	100^0

The angle of hallux valgus (in degrees):

	Total
Mean	9.93
SE	4.666
Mode	9.56
Range	0-22
Mean+2SE	0.60-19.25
% of feet	93.9%

DISCUSSION

Metatarsophalangeal joint of the great toe differs from the joints of the other toes in its sesamoid mechanism. The head of the metatarsal carries a large, rounded, cartilage covered prominence, wider than the base of the phalanx with which it articulates. On the plantar surface two grooves are developed for articulation with the two sesamoids bones, and these are separated by a rounded ridge On either side the cartilage overlaps on to the lateral aspect of the bone, to form a smooth surface for the ligaments of the joint. The shaft narrows from the head, but carries a pair of shoulders or epicondyles from which the joint ligaments spring. The basal phalanx has an elliptical concavity for articulation with the metatarsal, and a swollen base which receives the muscular and ligamentous attachments.The sesamoids, are embedded in the plantar pad, a mass of dense fibrous tissue, rectangular in outline. The distal margin of the pad is attached firmly to the base of the phalanx, its lateral margins receive ligamentous and muscular attachments, and its proximal border receives a part of the short flexor and is attached by a few loose fibres to the distal end of the metatarsal. From the dorsal surface of the pad projects the cartilage covers auricular surfaces of the two sesamoids, each concave longitudinally to fit the metatarsal head, but convex from side to side. Between the sesamoids is a groove lined with a little synovial tissue, and into this groove the ridge on the head of the metatarsal fits. The plantar surface of the pad is raised on either side by the two sesamoids so as to form a groove in which the long flexor tendon plays, held in place by its fibrous tunnel. In standing, the sesamoids transmit a part of the pressure from the skin to the head of the metatarsal, relieving the flexor tendon from excessive compression.

In hallux valgus the digit is displaced laterally and is usually pronated on the head of the metatarsal, the plantar pad and sesamoids are displaced with the digit, and the ligaments on the medial side of the joint are stretched, the articular surface for the basal phalanx looks laterally as well as distally, and is separated by a sagittal groove, in which the cartilage is thinned, from a medial eminence over which the stretched ligaments pass. The groove for the lateral sesamoids is normal in appearance

THE LIGAMENTS IN HALLUX VALGUS

In spite of Volkmann's (1856)[5] clear statement to the contrary, it has often been supposed that the deep transverse ligaments were attached directly to the heads of the metatarsal bones, so that when the bones were spread the ligaments were necessarily stretched[4,16] The second and third ligaments passing between the second, third and fourth pads are in their usual positions. The first lies between the normally placed second pad and the displaced first pad with its contained sesamoids bones. The first metatarsal head in moving medially has left the sesamoids behind, tied in their old position by the ligament supplemented by the adductor hallucis pulling through the lateral conjoined tendon. The ligament that has actually given way is not a transverse ligament but the ligament of the medial sesamoid

In dorsal view the first pad appears at first sight to contain three sesamoids, for there are three polished areas. Closer examination shows that the third " facet " is actually a polished area of the ligament of the medial sesamoids developed in relation to the eminence over which it turns it also shows deviation of the fifth metatarsal, a condition mentioned by Hohmann (1925)[17] and by Gottlieb (1930)[18] who gave directions for its surgical correction.

THE MUSCLES IN HALLUX VALGUS

The tendons of the muscles that move the great toe are arranged round the metatarso phalangeal joint in four groups. The long and short extensors pass dorsally, the long flexor on the plantar surface. The two conjoined tendons pass medially and laterally, but much nearer the plantar than the dorsal surface, so that the dorsomedial and dorsolateral aspects of the joint are covered only by the hood ligaments that bind the long extensor tendon in place. Even in the normal foot the long flexor and the two extensors are somewhat obliquely placed so as to adduct the great toe towards the second in addition to their main actions, particularly when the toe is already adducted, and when the ligaments are stretched this adduction component becomes very strong. The long flexor tendon has moved laterally with the sesamoids and now acts as a bowstring across the angle of the joint so that tension on the tendon again increases the valgus (Fig. 53), as suggested by Volkmann[5] and many others, and the two heads of the short flexor are also displaced laterally relatively to the metatarsal head. Silver's(1923)[19] suggestion that the adductor is shortened, the lateral sesamoids and basal phalanx are displaced relatively to the first metatarsal, they are no nearer the other metatarsals than in the normal foot Thus in the normal foot there is already some tendency for the toe to be pulled into valgus, but while the ligamentous and sesamoids mechanisms are intact this tendency is not realised.None of the muscles mentioned is inserted into the metatarsal itself, so that Girdlestone (1936)[20] has suggested that " the forefoot is held together by the structures inserted in the proximal phalanx of the big toe, and by them alone, and he and Spooner (1937) stated that in hallux valgus " the fore-foot is splayed not through stretching of the adductor structures, but because the first metatarsal head escapes from the control exercised by the base of the proximal phalanx into which the muscles are inserted. The phalanx and the sesamoids remain held by the adductors, while the first metatarsal head drifts away out of control.

FIRST CUNEOMETATARSAL ANGLE FIG.A,B,C,D

This angle is measured to determine the posterior elongation of the lateral end of the base of the 1st metatarsal causing its medial deviation. The mean of this angle is 99.660+_16.580(83.080-116.240) with 95.69% cases falling in this range. So, the above mean is taken as the standard observation. As no work is reported on this angle, no figures are available for comparison. Statistical correlation showed that this angle had a significant negative correlation with the 1st intermetatarsal angle and also with the angle of hallux valgus. If this angle reduces, causing medial deviation of the 1st metatarsal, it will increase the 1st intermetatarsal angle with consequent increase of the angle of hallux valgus. The statistical findings in the present study, thus corroborate the opinion that the shape of the base of the 1st metatarsal influences its medial deviation and also the angle of hallux valgus.A possible mechanism is suggested by which a short 1st metatarsal can cause hallux valgus. Such a metatarsal does not reach the ground to take its share of weight in locomotion. In its effort to do so, the 1st cuneometatarsal joint becomes hypermobile and allows the 'short' 1st metatarsal to go into varus position. The hallux shifts laterally and extensor hallucis longus tendon starts having its "bow string" effect, causing hallux valgus. It appears that in feet with short 1st metatarsal it is mainly the intrinsic factors which precipitate the hallux valgus. It would be proper to state here, that since the study is on normal feet between the ages of 18 and 23 years and as no case of hallux valgus has been studied, it is difficult to decide the critical angle beyond which it can be diagnosed as being pathological.

Fig - A - Cuneiometatarsal angle - diagrammatic representation



Fig - B - Cuneiometatarsal angle - normal angle in x-ray of right foot.



Fig - C - Cuneiometatarsal angle - Normal angle in x-ray of left foot.



Fig - D - Cuneometatarsal angle - diagrammatic representation showing abnormal angle.



SUMMARY AND CONCLUSIONS

A significant negative correlation is found between the angle of hallux valgus, and the 1st cuneometatarsal angle. This angle also influences the angle of hallux valgus. It is observed from the above correlations that a variety of bony factors tend to influence the angle of hallux valgus and predispose the foot to clinical hallux valgus.

The articular surfaces at the cuneometatarsal joint become adapted to the changed positions of the metatarsal without gross pathological change.

The four deep transverse ligaments that bind together the five plantar pads of the metatarsophalangeal joints are not unduly stretched, so that as the metatarsals spread it is the ligaments that bind the pads to the heads of the metatarsals that give way.

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