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Original Research Article

COMPARATIVE ANALYSIS OF RADIOGRAPHIC MEASUREMENTS IN NORMAL HALLUX VALGUS, AND HALLUX LIMITUS FEET AT A TERTIARY CARE CENTRE

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Abstract

Background: Hallux valgus (HV), also known as a bunion, is one of the most common forefoot deformities. Hallux limitus has been described in the literature for more than a century, but it has not attracted as much attention among clinicians as similar dysfunctions, such as hallux abducto valgus. Hence, the present study was conducted for evaluating and comparing radiographic measurements in normal hallux valgus, and hallux limitus feet. **Materials and Methods:** A total of 10 subjects with hallux valgus, 10 subjects with hallux limitus and 10 healthy controls were enrolled. Complete demographic and clinical details of all the subjects were obtained. A performa was made and detailed radiographic findings were recorded. Every patient underwent a standardized x-ray in their comfortable standing position. Subjects with hallux valgus and hallux limitus all experienced first metatarsophalangeal joint deformity symptoms and signs severe enough to require corrective surgery. On three different occasions, radiographs of six dorsoplantar and six lateral weightbearing feet were used to measure various angles and linear lengths. The radiographs were cleared of any pencil markings and randomly remeasured following each measuring session. All the results were recorded and analyzed using SPSS software. **Results:** The results of the ANOVA test showed that the hallux valgus group had substantially larger hallux abductus and metatarsus primus adductus angles than the control and hallux limitus groups. The hallux limitus group had notably greater values of the hallux interphalangeal angle in comparison to the hallux valgus group. The hallux valgus group exhibited a statistically significant increase in first metatarsal protrusion distance and metatarsal breadth as compared to the control and hallux limitus groups. Measurements using lateral radiography revealed no appreciable variations across the groups. **Conclusion:** An increased hallux interphalangeal angle may be predictive of the development of hallux limitus, while a relatively long first metatarsal is linked to the development of hallux valgus.

INTRODUCTION

Hallux valgus (HV), also known as a bunion, is one of the most common forefoot deformities. HV manifests with the proximal phalanx deviating laterally and the first metatarsal head deviating medially and due to the adduction of the first metatarsus, called metatarsus primus varus. However, the precise etiology is not fully understood. HV tends to occur more commonly in women than in men, with a ratio as high as 15:1 in one study, and occurs more in those who wear tight shoes or heels.[1,2] The precise etiology is not fully understood but are many proposed theories. HV deformity is most likely a result of multiple contributing factors, including genetics, short first metatarsal, dorsiflexed first metatarsal, flexible or rigid forefoot varus, rigid or flexible pes planovalgus, gastrocnemius equinus,

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abnormal foot mechanics, and joint hypermobility.[3,4] Hallux limitus has been described in the literature for more than a century, but it has not attracted as much attention among clinicians as similar dysfunctions, such as hallux abducto valgus. Only with the rather recent description of its dysfunctional characteristics by Dananberg, and the popularization of the term functional hallux limitus, has hallux limitus reentered the clinical arena. Since then it has been recognized as an important functional disorder with a mainly biomechanical character. Root and coworkers were the first to present a biomechanical explanation for the development of hallux limitus, but they focused mainly on structural hallux limitus, in which limited dorsal mobility of the first metatarsophalangeal joint is caused by anatomical restrictions and can be demonstrated with a simple static non-weightbearing measurement.[5-7] Hence; the present study was conducted for evaluating and comparing radiographic measurements in normal hallux valgus, and hallux limitus feet.

MATERIALS AND METHODS

The present study was conducted for comparing radiographic measurements in normal hallux valgus, and hallux limitus feet. A total of 10 subjects with hallux valgus, 10 subjects with hallux limitus and 10 healthy controls were enrolled. Complete demographic and clinical details of all the subjects were obtained. A Performa was made and detailed radiographic findings were recorded. Every patient underwent a standardized x-ray in their comfortable standing position. Subjects with hallux valgus and hallux limitus all experienced first metatarsophalangeal joint deformity symptoms and signs severe enough to require corrective surgery. On three different occasions, radiographs of six dorsoplantar and six lateral weightbearing feet were used to measure various angles and linear lengths. The radiographs were cleared of any pencil markings and randomly remeasured following each measuring session. All the results were recorded and analyzed using SPSS software.

RESULTS

The results of the ANOVA test showed that the hallux valgus group had substantially larger hallux abductus and metatarsus primus adductus angles than the control and hallux limitus groups. The hallux limitus group had notably greater values of the hallux interphalangeal angle in comparison to the hallux valgus group. The hallux valgus group exhibited a statistically significant increase in first metatarsal protrusion distance and metatarsal breadth as compared to the control and hallux limitus groups. Measurements using lateral radiography revealed no appreciable variations across the groups.

Table 1: Comparison of radiographic variables

Radiographic variables	Controls	Hallux Valgus	Hallux Limitus	p-value
Metatarsus adductor angle	17.9	19.2	18.8	0.124
Metatarsus Primus adductus angle	9.9	12.9	8.2	0.001*
Hallux Abductus angle	10.1	25.8	11.8	0.003*
Hallux Interphalangeal angle	9.8	4.9	13.8	0.004*
Metatarsal break angle	141.8	143.5	142.5	0.812
Metatarsal width	90.2	94.1	88.3	0.000*

DISCUSSION

No deformity of the forefoot occurs more frequently than hallux valgus. A recent review estimates the global prevalence of hallux valgus at up to 23% in 18- to 65-year-olds and 35% in those over 65, although of course it is difficult to draw a line between normal and pathological positioning of the great toe. The reasons for hallux valgus in an individual case are hard to define: The deformity can often be attributed to ill-fitting shoes, and sometimes there is a familial disposition. Women are much more commonly affected than men, because they frequently wear narrow, high-heeled shoes and often have more flexible soft tissues. Although hallux valgus is particularly frequent from the middle years of life upwards, many patients of both sexes are affected at a young age, usually in one foot but sometimes in both.[8-10]

Hallux limitus (HL) is a limitation of the dorsiflexion movement (DF) of the first metatarsophalangeal joint (IMTFJ). Functional hallux limitus (HL) was determined as the restriction of the IMTFJ motion in weight bearing and a normal IMTFJ motion in non-weight bearing; HL produces limitations in gait patterns because of a restriction of closed-kinetic-chain joint motion causing functional limitations during the final phase of gait due to the blockage of the third rocker. The blockage of the third rocker generates a variation of the axis of the first radius (1R) in the sagittal plane, causing a compensatory mechanism that helps to advance the center of mass along the extrinsic and intrinsic structures of the foot in order to improve the gait and finish it with the propulsion phase. Consequently, in order to improve the joint movement in the last phase of gait, secondary compensations generate a greater or lesser plantar pressure which can be analyzed with a baropodometric platform.[11-13] Hence; the present study was conducted for evaluating and comparing radiographic measurements in normal hallux valgus, and hallux limitus feet.

The results of the ANOVA test showed that the hallux valgus group had substantially larger hallux

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abductus and metatarsus primus adductus angles than the control and hallux limitus groups. The hallux limitus group had notably greater values of the hallux interphalangeal angle in comparison to the hallux valgus group. The hallux valgus group exhibited a statistically significant increase in first metatarsal protrusion distance and metatarsal breadth as compared to the control and hallux limitus groups. Measurements using lateral radiography revealed no appreciable variations across the groups. Bryant A et al investigated the differences in weightbearing, foot radiographs among normal subjects, those with hallux valgus, and those with hallux limitus. An intrarater reliability study of various x-ray measurements was conducted, utilizing seven dorsoplantar and six lateral measurements. The results showed that metatarsus primus adductus, increased metatarsal width, and a positive first metatarsal protrusion distance were associated with hallux valgus, whereas increased hallux interphalangeal angle was associated with hallux limitus.[14] Lee et al investigated the reliability of eight radiographic measurements used to evaluate hallux valgus, and determined which were correlated and which predicted the hallux valgus angle. They determined eight radiographic indices for 732 patients with hallux valgus: hallux valgus angle, intermetatarsal angle, hallux interphalangeal angle, distal metatarsal articular angle, proximal phalangeal articular angle, simplified metatarsus adductus angle, first metatarsal protrusion distance, and sesamoid rotation angle. Intraobserver and interobserver reliabilities of each radiographic measurement were analyzed on 36 feet from 36 randomly selected patients. Hallux valgus angle had the highest reliability, whereas the distal metatarsal articular angle and simplified metatarsus adductus angle had the lowest. Distal metatarsal articular angle, intermetatarsal angle, and sesamoid rotation angle had the highest correlations with hallux valgus angle. Distal metatarsal articular angle correlated with sesamoid rotation angle. The intermetatarsal angle, interphalangeal angle, distal metatarsal articular angle, first metatarsal protrusion distance, sesamoid rotation angle, and metatarsus adductus angle predicted the hallux valgus angle. They suggested using hallux valgus angle, intermetatarsal angle, interphalangeal angle, sesamoid rotation angle, and first metatarsal protrusion distance considering their reliability and prediction of the deformity.[15]

Janssen DMCC et al determined Hallux valgus angles (HVA) in one hundred and eighty-six participants suffering from diabetes. Radiographic measurements of HVA were performed with standardised static weight bearing dorsoplantar foot radiographs. Comparison of radiographic measurements to clinical goniometry for HVA showed an intraclass correlation coefficient (ICC) of 0.81. Radiographic measurement versus computerised plantar pressure measurement showed an ICC of 0.59. In addition, clinical goniometry versus computerised plantar pressure measurement showed an ICC of 0.77. The systematic difference of the computerised plantar pressure measurement compared with radiographic measurement and clinical goniometry was 7.0 degrees and 5.2 degrees, respectively. The systemic difference of radiographic measurements compared with clinical goniometry was 1.8 degrees. The agreement of computerised plantar pressure measurement and clinical goniometry for HVA compared to radiographic measurement of HVA is unsatisfactory.[16]

CONCLUSION

From the above results, the authors concluded that an increased hallux interphalangeal angle may be predictive of the development of hallux limitus, while a relatively long first metatarsal is linked to the development of hallux valgus.

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