RELATIONSHIP BETWEEN THE KNEE AND HINDFOOT AXES IN PATIENTS WITH SEVERE KNEE OSTEOARTHRITIS

HLKUEQ EntE nO EIXO ANATÔMICO DO JOELHO E O EIXO DO RETROPÉ EM PACIENTES COM GONARTROSE AVANÇADA

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ABSTRACT

Objective: To evaluate the correlation between knee axis and hindfoot axis in patients with advanced gonarthrosis, and the association between ankle function and angular deformities. Methods: 72 patients were enrolled in the study: 66% were women, and mean age was 58.7 years. The anatomical axis of the knee and hindfoot were measured by short knee radiographs and long axial view of the hindfoot. Results: Among the study group, 79.2% presented varus knee (mean 15º ± 7.69º) and 20.8% valgus (mean 15.9º ± 7.7º). 63.9% had hindfoot varus (mean 8.5º ± 6.07º) and 36.1% valgus (mean 3.9º ± 3.92º) (p < 0.05). The mean value for the American Orthopaedic Foot and Ankle Society (AOFAS) score was 74.26 points, and values were significantly higher among patients with hindfoot varus (p < 0.05). We found no correlation between gender or AOFAS score and knee and hindfoot axes, nor between deformities in the knee and hindfoot axes (p > 0.05). The subgroup genu valgum – hindfoot varus presented a moderate correlation (r = 0.564; p < 0.05). Conclusion: We found no association between the anatomical axes of the knee and hindfoot. Patients with gonarthrosis and hindfoot varus presented a better ankle function.

Keywords: Ankle Joint. Arthroplasty. Replacement. Knee. Radiography. Osteoarthritis. Knee.

INTRODUCTION

Approximately 300,000 total knee arthroplasties (TKA) are performed annually in the United States only.1 TKA has proven to be a safe surgery with high success rates, improving patients’ quality of life, and being increasingly indicated.2-4 Some factors may affect TKA success, such as: age below 55 years, male gender, obesity, and presence of comorbidities.1,4-6 The correlation between knee and hindfoot alignment is yet to be fully elucidated.7-10 For Norton et al.,11

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understanding the compensatory mechanisms between these joints would help guiding deformity correction during TKA.

Some authors have reported an association between genu varum and hindfoot valgus, as well as between genu valgum and hindfoot varus, especially among individuals without subtalar joint involvement.\textsuperscript{11-14} Although it is unclear how the hindfoot and ankle joints compensate knee deformity, varus deformity of the knee is believed to promote a deviation of the subtalar in eversion and valgus.\textsuperscript{10,14-16} In this sense, some studies reported an improvement in preoperative hindfoot valgus deformity after femorotibial joint realignment in patients with genu varum submitted to TKA.\textsuperscript{10,12,13,17}

A study also reported that nearly 60% of patients with advanced gonarthritis complained about foot pain before TKA and none of them exhibited radiographic evidence of ankle or subtalar arthritis, what suggests that these pains were caused by deformities in the midfoot and hindfoot. Although the author has related foot and ankle pain in patients in preoperative TKA, he did not evaluate the function of the hindfoot and ankle within the sample.\textsuperscript{18}

Understanding the compensatory association between knee and hindfoot alignment is important, especially among patients with advanced and symptomatic osteoarthritis with indication for TKA.\textsuperscript{10} Associated with the evaluation of ankle function in these patients and its correlation with hindfoot and knee axes, this mechanism will play a key role in managing this deformity and planning its surgery. This study aimed to analyze the correlation between the knee joint and hindfoot axes to evaluate the ankle/hindfoot function in patients with advanced gonarthritis.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the institution, and all participants signed an Informed Consent Form. This is a cross-sectional study conducted in 2015, composed of patients with advanced arthrosis with indication for TKA. Patients who failed in performing the requested imaging tests or disagreed to participate were excluded of this study.

The characteristics recorded were gender, age at the time of the surgery, and affected foot. The anatomical axis of the knee and hindfoot were measured by radiographs. The function and pain in the hindfoot were quantified using the American Orthopaedic Foot and Ankle Society (AOFAS) scale for ankle and hindfoot, translated to Portuguese.\textsuperscript{19} This scale is composed of nine items summing a maximum score of 100, among which 50 points refer to function, 40 to pain, and 10 to joint alignment.

Patients were separated into subgroups according to the anatomical axis of the knee – genu varum and genu valgum – and hindfoot axis – varus or valgus. Demographic characteristics, AOFAS score, and radiographic parameters were compared among subgroups.

Radiographic Analysis

The anatomical axis of the femorotibial joint was measured by short knee radiographs in anteroposterior (AP) and profile, all with bipodalic support, maximum knee extension, and patellae facing forward. The anatomical axis of the knee was measured using two points in the femur: one in the center of the intercondylar fossa and another 10 cm proximal to the first, at the midpoint between the two outside cortical regions. Regarding the tibia, the points were set in the center of the tibial eminence and 10 cm distal, at the midpoint between the two outside cortical regions. After tracing lines that connected the points in the femur and tibia, their intersection represented the anatomical axis or femorotibial angle (FTA).\textsuperscript{20}

For long axial view of the hindfoot, patients stood over the film in a plain bipodalic support and were imaged in the posteroanterior and craniocaudal direction under a 45º caudal angulation, 100 cm apart from the hindfoot. The film was positioned perpendicular to the central axis of the radiation beam (Figure 1). The hindfoot axis was calculated by the angle between two line: one representing the leg load-bearing axis and another representing the calcaneal axis. The load-bearing axis was represented by the longitudinal tibial axis, by bisecting the tibia into two diaphyseal points 10 and 15 cm proximal to the tibial pilon. The calcaneal axis was identified by bisecting the calcaneus into two points. These values were considered positive when the load-bearing axis was medial to the lowest point in the calcaneus (valgus axis) and negative when lateral (varus axis) (Figure 2).\textsuperscript{21,22} In a normal radiograph of an aligned hindfoot, the calcaneal axis should be parallel to the longitudinal axis of the tibia (0º), although located 5-10 mm lateral to the tibial axis. Angular values of up to 10º for varus or valgus are considered ideal.\textsuperscript{23}

A Shimadzu X-ray device, rated at 50 kV and 40 mA, was used. Angulations were determined using the DICOM® digital application. To ensure a greater reliability of angulations, scans were evaluated by two foot and ankle surgeons of the institution.
The axes of the lower limb may be affected by deformities involving the hip, knee, and ankle joints. Deformities that occur in one of these joints are believed to cause compensatory changes in the others. However, such mechanisms are still unclear.7,8,10,11
Our study evaluated: (1) the presence of hindfoot deformity in patients with advanced knee osteoarthritis and the association between the knee and hindfoot axis; and (2) the ankle/hindfoot function in patients with advanced gonarthritis, considering the knee and hindfoot axis. Our results indicate no association between the knee and hindfoot axes, except for a moderate association in the genu valgum – hindfoot varus subgroup. We also found no correlation between the ankle/hindfoot function and the knee and hindfoot axes. However, patients with hindfoot varus presented significantly higher values in the functional scale (p < 0.05). Some studies have already verified the correlation between the hindfoot and ankle alignment but achieved conflicting results. Corroborating our findings, Chandler et al.12 and Mullaji et al.13 found no preoperative correlation between the alignment of the knee and hindfoot axes. In turn, Norton et al.11 observed an association between valgus knee deformity and hindfoot varus, and varus knee and hindfoot valgus. However, such association was not observed in patients with mild deformities (lower than 10º) in the knee axis.11 Another study, conducted with patients with rheumatoid arthritis, found a moderate correlation between femorotibial and tibial-calcaneal angles, especially among patients with little subtalar joint involvement.10
We found no significant correlation between the foot and ankle axes. However, 86.6% of the patients with genu valgum presented hindfoot varus, and 92.3% of the patients with hindfoot valgus presented varus knee. This is a key information to understand the lower limb compensatory mechanisms, particularly the adaptive capacity of the subtalar joint.13 Clinically, for knee specialists, patients with advanced gonarthritis and foot pain may benefit from the use of insoles until surgical correction of the knee axis is performed. As for foot and ankle surgeons, patients with knee deformities, hindfoot deviations, and acutely symptomatic feet that require surgical treatment must have hindfoot axis correction carefully planned to avoid hypercorrection in case an axial realignment is later performed on the knee.
Unlike previous studies, we subdivided patients into four groups – (genu varum – hindfoot varus; genu varum – hindfoot valgus; genu valgum – hindfoot varus; and genu valgum – hindfoot valgus) – to better understand the association between these lower limb axes. The only subgroup to present a significant correlation was genu varum – hindfoot varus (p < 0.05). This might be explained because the subtalar joint is responsible for most of the hindfoot compensatory mechanism, in which the ankle play a small role.11 As the mobility of the talocalcaneal joint ranges from 25-30º in inversion and 5-10º in eversion,24 patients with genu valgum demand a greater subtalar compensation. Such mechanism was equally observed in patients with tibiotarsal arthrosis, in which the subtalar joint plays a key role in compensating the deformity and delaying the degenerative process.25
We found no other articles in the literature addressing ankle/hindfoot function association in patients with advanced knee osteoarthritis. Our study adopted the AOFAS scale to assess ankle/hindfoot function and obtained a final mean value of 74.26 points. We observed a significant difference (p < 0.05) in the scores of patients with hindfoot varus and valgus, with higher values in the first subgroup. However, the ankle function was not associated with the hindfoot or knee axis (p > 0.05). Elbaz et al.26 verified the association between gonarthritis and Achilles tendon involvement by analyzing gait and applying two scores: Western Ontario and McMaster Osteoarthritis Index (WOMAC) and 36-item Short-Form (SF-36) Health Survey. Both scores, although validated, are not specific for assessing ankle/hindfoot function, and can be applied for any joint with osteoarthritis. A different study,
Conducted with patients submitted to TKA, analyzed the presence of foot pain in the preoperative and one-year postoperative. Among the 64 participants with advanced gonarthrosis, 59.4% reported preoperative pain and none exhibited radiographic evidence of ankle or subtalar arthritis. Radiographic improvement of the midfoot pronation was related to the reduced foot pain one year after the surgery, suggesting that deformities in the midfoot and hindfoot cause pain in patients with gonarthrosis. In the same study, nearly 70% of patients still reported foot pain after one-year postoperative. This group presented no improvement in radiographic parameters or in various foot plantar pressure measures.

Our study poses some limitations, such as using the short knee bipedalic radiography to measure knee axis. However, this radiographic method is supported by several studies in the literature. Kraus et al.27 evaluated 114 knee radiographs and compared the angles of anatomical axis measured by goniometer and X-ray in posteroanterior (PA) with flexed knee to the panoramic X-ray of the lower limb and found corresponding values without needing to use the higher cost examination. Another author28 analyzed the alignment and joint wear of 608 knees with arthrosis using antero-posterior (AP) orthostatic X-ray and concluded that such incidence enables the evaluation of the axis and degree of joint involvement.

**CONCLUSION**

Our results show a correlation between knee and hindfoot axes in patients with advanced gonarthrosis, particularly in the genu valgum – hindfoot varus subgroup. We also observed an association between the AOFAS scale values and the hindfoot axis, in which patients with gonarthrosis and hindfoot varus presented a better ankle function.

**AUTHORS’ CONTRIBUTIONS:** Each author contributed individually and significantly to the development of this article. HM: wrote the article, participated in the review process, and approved the final version; FAR: conceived and planned activities that led to the study, wrote the article, and approved the final version; PGTSF: planned the activities that led to the study and wrote the article; IMCJ: participated in the review process and approved the final version.

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