RELATIONSHIP BETWEEN LUMBAR CHANGES AND MODIFICATIONS IN THE PLANTAR ARCH IN WOMEN WITH LOW BACK PAIN

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ABSTRACT

Objective: Evaluate the probable relationship among plantar arch, lumbar curvature, and low back pain. Methods: Fifteen healthy women were assessed taking in account personal data and anthropometric measurements, photopodoscopic evaluation of the plantar arch, and biophotogrammetric postural analysis of the patient (both using the SAPO software), as well as evaluation of lumbar pain using a Visual Analog Scale (VAS). The average age of the participants was 30.45 (±6.25) years. Results: Of the feet evaluated, there were six individuals with flat feet, five with high arch, and four with normal feet. All reported algic syndrome in the lumbar spine, with the highest VAS values for the volunteers with high arch. Correlation was observed between the plantar arch and the angle of the lumbar spine ($r = -0.71$, $p = 0.004$) Conclusion: High arch was correlated with more intense algic syndrome, while there was moderate positive correlation between flat foot and increased lumbar curvature, and between high arch and lumbar correction. ***Level of Evidence IV. Case Series.***

Keywords: Flatfoot. Foot deformities. Spine.

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INTRODUCTION

Over the course of evolution, posture and its anomalies have been linked to mankind, which pays a high price for its bipedalism, although it has its daily actions dependent on this condition. The disadvantages include overburdening of the spinal column and lower limbs, comparable difficulties in respiration and also in the transport of blood to the brain.[1,2] Physiological spinal curvatures are adaptations that allow standing and walking. These are influenced by hereditary factors, pathological conditions, mental state of the individual and the forces to which the spine is subject on a daily basis.[2]

During daily activities, changes in the joint mechanics modify these loads imposed on the musculoskeletal tissues, increasing the risk of appearance of orthopedic dysfunctions. Thus, considering the interdependence between the joints of the lower extremities (LE) and the spine, alterations present in one of these structures have consequences on the functioning of the other.[3] The literature also suggests that postural changes contribute to low back pain, caused by the overburden applied or sustained for a long period of time, resulting in cumulative tissue stress.[4]

Changes in the lumbar curvature, such as decrease (lumbar rectification) or increase (lumbar hyperlordosis) can trigger painful conditions. As mentioned previously, in view of structural interdependence, a change in this curvature may be correlated with the increase or decrease of the plantar arch. The foot is an important element for the body structure, mainly for the postural system, as it is a means of confluence with the ground, and therefore calls for adaptations to the irregularities arising from the body itself or from the external environment. Changes in the feet can be responsible for causing postural imbalance, as they adjust to the imbalances originating from overlying structures or can at the same time present a causative slope and another adaptive slope.[5]

Approximately 80% of the general population has alterations in the feet, which can often be corrected going from an adequate assessment. For this purpose it is necessary to know whether the feet are undergoing or generating changes.[1] Modifications of the plantar arches and overburdening of specific regions can be analyzed by means of plantigraphy, a podoscope or baropodometry. Podoscopy is performed using an instrument composed of a metal frame with glass and mirrors, called a podoscope. To carry out the examination, the individual stands with both feet on the glass of the metal frame and the plantar areas are reflected in the mirror, whereby it is possible to analyze the plantar areas submitted to the individual's bodyweight, which makes the assessment more effective.[6]

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Note that patients with flat feet can present correlated postural changes, such as: calcaneal valgus, internal rotation of the tibial and femoral axes, genu valgum, anteversion of the iliac bones, thoracic hyperkyphosis, cervical hyperlordosis and increased lumbar lordosis. Pes cavus (high arch), also known as varus deformity, presents an increased medial longitudinal arch, which generates muscle contracture that enters the plantar concavity, making high-arched feet more rigid. Individuals may present postural changes such as varus talus; tibial and femoral external rotation; genu varum; genu recurvatum; anterior pressure on the acetabulum; iliac retroversion; sacral verticalization; decreased lordosis and flat back.[5,7]

To favor the complete restructuring of the muscle chains and their positioning in movement and/or in the static posture it is important to carry out an adequate assessment of the plantar arches as well as the changes caused by these in the lumbar curvature. Attempts to correct or minimize require therapeutic intervention that seeks to correct the causal factor.

Low back pain is a frequent complaint in clinical practice. However, in the literature, there are few studies that analyze the interference of the plantar arch in this symptomatology. And as the feet are important elements for body structure, particularly for the postural system, it is vitally important to analyze this relationship. In the attempt to decrease or to alleviate low back pain it is necessary to seek the cause of the pain and not just to treat the symptomatology. Therefore, it is extremely important, in the evaluation of low back pain, to also analyze the foot and particularly its arches for the performance of an intervention that minimizes the overload imposed on the feet due to an inappropriate posture. Thus, the aim of this study was to evaluate the correlation between the angulation of lumbar lordosis and the foot arch in women with complaints of low back pain.

CASUISTRY AND METHOD

This was a retrospective case series study that involved 18 women with complaints of low back pain, aged between 20 and 40 years. All the volunteers who agreed to take part in the survey signed an informed consent form. The project was approved by the Institutional Review Board of Universidade Federal do Triângulo Mineiro (UFTM), protocol 1549. They were selected for convenience, by the investigator in charge, among the employees of the Rehabilitation Center of UFTM, on a previously scheduled date.

The volunteers were submitted to an evaluation that consisted of personal information, anthropometric measurements, evaluation of the plantar arch by means of photopodoscopy (biophotogrammetry), and biophotogrammetric evaluation of the patient's posture, both using the SAPO program, and evaluation of low back pain using the visual analogue scale (VAS).

Evaluation of posture by means of biophotogrammetry

A DSC-W35 SONY® - CYBER-SHOT digital camera of 7.2 mega pixels positioned at a height of 90 cm from the ground, at a distance of 300 cm, was used to acquire the data. The photos, which provided lateral, frontal and posterior views, were taken with the volunteers in swimsuits, in an upright position, barefoot, with their feet together and their arms in front of the body in the right lateral plane, allowing the visualization of the curvatures of the spine in the sagittal plane. Specific anatomical points were marked with expanded polystyrene balls in a diameter of 1cm and fixed with double sided adhesive tape. These anatomical points were: glabella, tragus, acromion, C7 spinous process, seventh thoracic vertebra (T7), first lumbar vertebra (L1), anterior superior iliac spine (ASIS), greater trochanter. The volunteers were instructed to keep their eyes open in the direction of the horizon, and there was no interference for postural correction. A plumb line was positioned to serve as a reference. SAPO postural analysis software was used to analyze the photographs.[8,9]

To measure the lumbar lordosis, in the lateral view, an angle was formed from three anatomical points: L1, anterior superior iliac spine (ASIS) and greater trochanter, with ASIS forming the vertex of the angle. It was characterized that the smaller the angular measurement, the greater the lumbar lordosis.[10]

Evaluation of the plantar arch by means of photopodoscopy

To perform the photopodoscopy, the volunteers were positioned standing upright and barefooted on both feet on a Kroman® podoscope with arms alongside the body. The footprint image reflected in the podoscope mirror was captured using the same digital camera and the images were analyzed in the SAPO software. This process was carried out prior to image calibration, then the foot measurements were taken as follows: 3 lines were drawn, two transversal and one vertical: the vertical line represents the longitudinal measurement of the foot, a straight line that reached from the most posterior point of the calcaneus (B) to the toe of greatest length (A); then half the length of straight line A-B was calculated to locate the point of reference for the measurement of the isthmus (midfoot); the width of the forefoot was also measured from the most lateral point to the most medial point, for subsequent classification of the plantar arch, representation.[11]

Soon after this procedure the values obtained in the line drawn in the forefoot were divided by the line drawn in the midfoot, in centimeters, to arrive at the value corresponding to that of the arch. The following parameters are used to classify:

High arch: when the width of the individual's midfoot footprint is less than 1/3 of the forefoot measurement.

Normal foot: when the width of the individual's midfoot footprint corresponds to 1/3 of the width of the forefoot footprint.

Flat foot: when the individual's plantar width is above 1/3, presenting bulging of the medial border, with the appearance of the lateral semilunar image. The feet were classified as cavus, flat and normal.[12]

Evaluation of pain using the visual analogue scale (VAS)

Pain was evaluated using VAS, which consists of a 10cm straight line of horizontal orientation without numbers, in which there is just an indication at the extreme left of "absence of pain" and, at the extreme right, "unbearable pain". The volunteers were asked to mark a stroke on the ruler at the point that characterized their pain on that day, then the scores between 0 and 10 corresponding to the stroke marked on the ruler were checked and the higher the score, the greater the pain intensity.[13,14]

Statistical Analysis

GraphPad Insat software was used to carry out the statistical analysis, while Pearson's correlation was used to check the correlation between the groups as the distribution was normal.

RESULTS

The sample was made up of 18 individuals, all female and with age averaging 30.45 (±6.25) years, with average height of 1.62 (±0.08) m, mean body mass of 66.50 (±6.52) kg, and average foot size of 35.41 (±2.37) cm.

Of the feet evaluated, eight individuals were observed with flat feet, six with high arch and four with normal feet.[12]

All the survey volunteers reported pain in the lumbar spine, with higher VAS values observed in the volunteers with high arches and lumbar rectification (minimum of 5 and maximum of 9), followed by the volunteers with flat feet and hyperlordosis with VAS (minimum of 4 and maximum of 6). The volunteers with normal feet had the lowest VAS scores, between 2 and 3. In the correlation analysis between the plantar arch and the angulation of the lumbar spine, a high correlation was observed [-(r)=0.71] (Figure 1) and this correlation was significant (p=0.0048). The largest lumbar angles (lumbar rectification) were correlated with smaller midfoot footprints (flat feet). Smaller angulations were also observed in the lumbar spine (lumbar hyperlordosis) with larger footprints of the midfoot (flat feet). Moreover, intermediate angulations were observed with equally intermediate footprints.

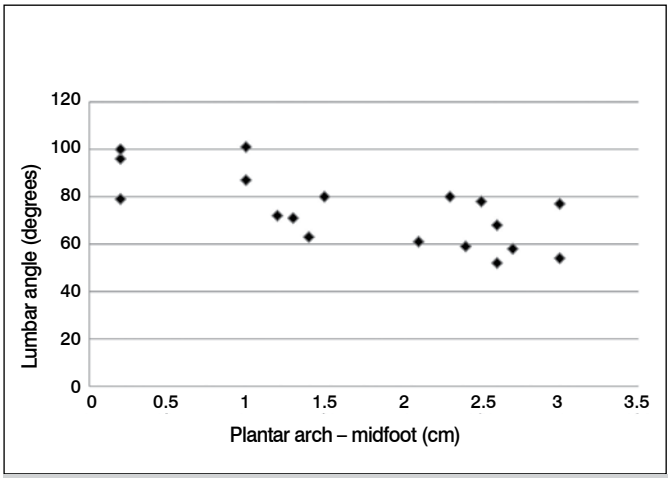

Figure 1. Correlations between plantar arch and lumbar angle.

DISCUSSION

The foot is a structure whose functions are plantar pressure distribution, support, balance, impulse, impact absorption, weight bearing and adjustment of posture in the upright position. As it performs an essential role in posture, it can be responsible for causing postural imbalances, and also adjust to the imbalances originating from structures overlying the feet.[5] Thus complaints of pain in the lumbar spine can arise from changes in the plantar arch, either its decrease or increase.

The feet can be classified according to the changes in their arches since when they start to form in early childhood.[15] The flat foot is characterized by the partial or total collapse of the medial longitudinal arch. The debility of its means of support may be related to musculoligamentous insufficiency, especially of the tibialis anterior and posterior and fibularis longus muscles, resulting in flexible or hypermobile feet. An adduced and pronated hindfoot and an abducted and supinated forefoot are generally found in flat feet. The flat foot is characterized by calcaneus valgus, internal rotation of the malleolar pincer, collapsed longitudinal arch and abducted forefoot.[6]

In this study, it was clearly evidenced that the alteration of the medial longitudinal arch leads to changes in the lumbar curvature. The decrease in this arch was the most common finding in the population studied and was correlated with the increase in lumbar curvature, followed by the increase of the arch, which was correlated with lumbar rectification. The pain appeared more intense in the individuals with high arches and lumbar rectification than in the others.

The treatment of changes in the lower extremities initially involved podological interventions designed exclusively for mechanical correction without any concern for the overlying repercussions of these corrections or for the origin of the pathology. Nowadays it is considered that the problem, as a whole, from the feet to the head, is linked to postural adaptations throughout the body, which determines or is determined by poor posture or some algic manifestation resulting from a specific condition.[16]

Flat feet may have their congenital origin arising from some trauma, muscle weakness, ligament laxity, "fall" of the talar head, paralysis or a foot with pronation deviation.[17] In a study with schoolchildren, it was observed, in the posture evaluation, that all the students with flat feet did not present postural alteration, although they did present an unpredictable gait rhythm, altered rhythmicity of balance in the upper and lower limbs, constant and long-lasting hesitation before moving their weight from one supporting foot to the other and the foot was placed horizontally directly on the ground, characterizing a state of pathological gait, as it presented neither harmony nor synchronism in movements during the gait cycle.[18]

Flat-footed individuals are known to exhibit excess pronation, as the subtalar joint is unable to reach the neutral position before heel elevation, making the support base unstable for propulsion and implying inefficient body balance. The different findings in comparison to our study may be related to the fact that the survey in question was conducted with children while ours involved adults, which indicates the need for an earlier evaluation, since when orthopedic problems are not corrected in early childhood, they can lead to limitations in adult life, due either to changes in posture, balance or gait.

The origin of a high arch may lie in congenital problems, neurological problems or be caused by muscle imbalance. In these cases, the longitudinal arches are accentuated, the metatarsal heads are lower in relation to the hindfoot, so that the forefoot "falls" on the hindfoot at the level of the tarsometarsal joints. The tissues of the sole of the foot are abnormally short, which makes the foot appear shortened. Claw toes are frequently due to the fall of the forefoot combined with the traction of the extensor tendons. Callosities are commonly observed and after some time give rise to a painful process in the tarsal region.[1]

The planovalgus foot is an alteration that if not corrected produces a functional disorder of the foot, consequently affecting posture and walking.

The longitudinal arch is maintained by the tibialis anterior, tibialis posterior, flexor digitorum longus, flexor hallucis longus, abductor hallucis and flexor digitorum brevis, by the plantar fascia and by the plantar calcaneonavicular ligament.[1,12,19] The strengthening of this musculature, together with ortheses (bandages and insoles) can solve or minimize both the causal factor and the painful

conditions arising from it. Accordingly, it is proposed that this intervention be performed at a later stage. The importance of this study is consistent with the needs to refine and verify the relations between different body segments and the consequences of this, i.e., physical evaluations become more focused and can be more efficient when changes are found in any part of the body. A study with a larger population, with analysis of both sexes, in age brackets without major variations, would be of considerable relevance to corroborate the findings of this study.

CONCLUSION

There was significant correlation between increase in the lumbar curvature and flat foot and between lumbar rectification and high arches in women with complaints of low back pain.

REFERENCES

1. Magee DJ. Coluna Lombar.In: Avaliação musculoesquelética. São Paulo: Manole; 2005.
2. Santos HH, Másculo FS, Carvalho LC, Rebelo FS. Análise qualitativa da postura estática por meio do método da observação de pontos anatômicos. Fisioter Bras. 2006;7(6):404-9.
3. Souza TR, Pinto RZA, Fonseca ST. Eficácia do uso de palmilhas biomecânicas para a correção cinemática do padrão de pronação excessiva da articulação subtalar, Fisioter Bras. 2008;9(4):275-82.
4. Baraúna MA, Mendes MVB, Barbosa GS, Sanchez HM, Silva RAV, Montes PF, et al. Estudo correlacional entre lombalgia e concavidade lombar em universitários. Fisioter Bras. 2006;7(3):172-6.
5. Bricot B. Posturologia. São Paulo: Ícone; 2001.
6. Oliveira AP, Otowicz I. Análise do apoio dos pés no chão e a sua correlação com as disfunções biomecânicas da articulação ílio-sacra. Ter Man. 2004;2(3):122-7.
7. Carvalho JÁ. Órteses - um recurso terapêutico complementar. São Paulo: Manole; 2006.
8. Iunes DH, Cecílio MBB, Dozza MA, Almeida PR. Análise quantitativa do tratamento da escoliose idiopática com o método klapp por meio da biofotogrametria computadorizada. Rev Bras Fisioter. 2010;14(2):133-40.
9. Souza JÁ, Pasinato F, Basso D, Corrêa ECR, Silva AMT. Biofotogrametria confiabilidade das medidas do protocolo do software para avaliação postural (SAPO). Rev Bras Cineantropom Desempenho Hum. 2011;13(4):299-305.
10. YI LC, Jardim JR, Inoue DP, Pignatari SSN. Relação entre a excursão do músculo diafragma e as curvaturas da coluna vertebral em crianças respiradoras bucais. J Pediatr. 2008;84(2):171-7.
11. Trombini-Souza F, Ribeiro AP, Iunes DH, Monte-Raso VV. Correlações entre as estruturas dos membros inferiores. Fisioter Pesq. 2009;16(3):205-10.
12. Barroco R, Viana S, Salomão O. O pé plano adquirido do adulto por disfunção do tendão tibial posterior. São Paulo: Manole; 2003.
13. Corrêa LL, Platt MW, Carraro L, Moreira RO, Faria Júnior R, Godoy-Matos AF, et al. Avaliação do efeito da sibutramina sobre a saciedade por escala visual analógica em adolescentes obesos. Arq Bras Endocrinol Metab. 2005;49(2):286-90.
14. Alexandre NM, Moraes MAA, Corrêa Filho HR, Jorge SA. Avaliação de programa para reduzir dores nas costas em trabalhadores de enfermagem. Rev Saúde Pública 2001;35(4):356-61.
15. Pinto JA, Saito E, Lira Neto AO, Rowinski S, Blumetti FC, Dobashi ET. Estudo da impressão plantar obtida durante o teste de Jack em crianças. Acta Ortop Bras. 2011;19(3):125-8.
16. Gagey M, Weber B. Posturologie: régulation et dérèglements de la station debout. Mônaco: Masson; 2005.
17. Osório RJ, Marquez CE, Avila GME. Pie plano em niños de 5-14 años. Rev Cubana Pediatr. 1992;64(3):173-6.
18. Corrêa AL, Pereira JS. Correlação entre a redução dos arcos plantares e as alterações da marcha, equilíbrio e postura em escolares. Rev Bras Ciencia Mov. 2005;13(4):47-54.
19. Nicolopoulos CS, Scott BW, Giannoudis PV. Biomechanical basis of foot orthotic prescription. Curr Orthop. 2000;14(6):464–9.