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ORIGINAL ARTICLE

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Isolated gastrocnemius tightness: impact on foot diseases

Encurtamento isolado do gastrocnêmio: impacto nas doenças do pé

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ABSTRACT

Objective: To determine whether being overweight was associated with isolated gastrocnemius tightness (IGT), generating foot pain.
Methods: This prospective cohort study evaluated 50 consecutively enrolled patients with a diagnosis of forefoot pain (e.g., metatarsalgia) or hindfoot pain (e.g., plantar fasciitis, insertional and noninsertional tendinopathy of the calcaneal tendon). Body mass index (BMI) and IGT (via the Silfverskiöld test) were evaluated. Gastrocnemius contracture was identified in cases with an ankle extension limitation of <10 degrees.
Results: The mean age of the study patients was 64 years. The mean BMI was 27.8kg/m^2. The most prevalent location of foot pain was the forefoot (66%), and 64% had IGT. However, IGT was not significantly correlated with BMI.
Conclusion: Overweight patients showed an IGT prevalence of 66%. However, there was no correlation between BMI and the presence of IGT.
***Level of Evidence II; Diagnostic Studies*.**

Keywords: Achilles tendon; Ankle Joint; Mobility limitation; Foot diseases.

RESUMO

Objetivo: Testar a hipótese de que o sobrepeso leva ao encurtamento isolado do gastrocnêmio (IGT), gerando dor no pé.
Métodos: Neste estudo de coorte prospectiva foram avaliados 50 pacientes consecutivamente com diagnóstico de dor no antepé (metatarsalgias) ou dor no retropé (fascite plantar, tendinopatia do tendão calcâneo insercional e não insercional). Foi avaliado o índice de massa corpórea (IMC) e o IGT através do teste de Silfverskiöld. O parâmetro de contratura gastrocnêmica foi considerado nos casos de limitação na extensão do tornozelo <10 graus.
Resultados: A idade média dos pacientes foi de 64 anos e eles apresentavam um IMC médio de 27,8Kg/m^2. A localização mais prevalente do acometimento da dor no pé foi o antepé (66%) e 64% tinham IGT, entretanto esses pacientes com encurtamento não demonstraram diferença estatística quando correlacionados com o IMC.
Conclusão: Os pacientes com sobrepeso apresentaram uma prevalência de 66% de IGT, entretanto não houve correlação entre IMC e IGT.
***Nível de Evidência II; Estudos Diagnósticos*.**

Descritores: Tendão do calcâneo; Articulação do tornozelo; Limitação da mobilidade; Doenças do pé.

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INTRODUCTION

Complaints related to foot and ankle pain are frequent in orthopedic consultations[1]. Problems such as tendinitis, plantar fasciitis and metatarsalgia are usually secondary to overload and increased mechanical stress[2]. High body mass index (BMI)[3] and isolated gastrocnemius tightness (IGT) are factors that can generate this overload and are associated with foot diseases[4-11].

BMI is calculated by dividing patient body weight by the square of their height and is a simplified way of classifying body composition. It can be used to broadly categorize populations for statistical purposes but is not appropriate for medical diagnoses. Body composition can be classified as low weight (<18.5Kg/m^2), normal (from 18.5 to 24.9Kg/m^2), overweight (from 25 to 29.9Kg/m^2) and obese (≥30Kg/m^2)[3].

Patients with BMI scores above 25Kg/m^2 have changes in their center of gravity and therefore may show changes in their gait, such as shortened and widened steps, slower walking speeds and greater abduction of the foot position, in order to improve their stability[2].

The association between BMI and musculoskeletal foot disorders has previously been described in a systematic review that suggested that being overweight or obese is associated with chronic pain, especially in the hindfoot and forefoot[12].

However, recent literature reports suggest that chronic foot pain is closely correlated with IGT. In turn, IGT causes a change in gait biomechanics, generating a dynamic equinus that can overload the foot[10,11,15-17].

Although several theories have been postulated, the etiology of IGT is not fully understood. One of the theories is that the posterior leg musculature contracts and shortens during sleep and sitting with the ankle and knee flexed. This is due to the greater volume and strength of the posterior leg musculature compared to the anterior musculature[9, 18].

To better understand the factors that cause foot overload, our study sought to evaluate the hypothesis that being overweight leads to IGT development, generating foot pain.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 79266217.1.0000.5463.

Patients enrolled in this study were seen by the foot and ankle surgery group of our institution between June 2017 and December 2017. All patients were recruited consecutively after signing an informed consent form.

The inclusion criteria were as follows: patients with a diagnosis of forefoot pain (e.g., metatarsalgia) or hindfoot pain (e.g., plantar fasciitis, insertional and noninsertional tendinopathy of the calcaneal tendon) without deformities on physical and radiographic examination.

The exclusion criteria were as follows: bilateral foot pain, central neurological diseases (e.g., stroke, cerebral palsy, demyelinating diseases) or peripheral neuropathy (e.g., diabetes, leprosy, alcoholism) causing gastrocnemius tightness; knee, hip and spine diseases generating lower limb nonfunctional dysmetria and patients using walking aids.

The patient data evaluated included gender, age, BMI, laterality and duration of foot disease.

On foot and ankle physical examination, the following findings were evaluated: ankle flexion and extension, ankle passive range of motion with the patient in the supine position, with moderate pressure exerted on the plantar surface of the forefoot, while keeping the hindfoot in neutral position with the knee extended (Figure 1) and with the knee flexed (Figure 2) (Silfverskiöld test)[19,20]. The measurements were made with a goniometer using the long axis of the fibula and the plantar aspect of the foot as parameters[19]. Gastrocnemius contracture was identified in cases of ankle extension limitation of <10 degrees[14].

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA) version 23.0 software. The mean, standard deviation, maximum and minimum values were determined for the nume-

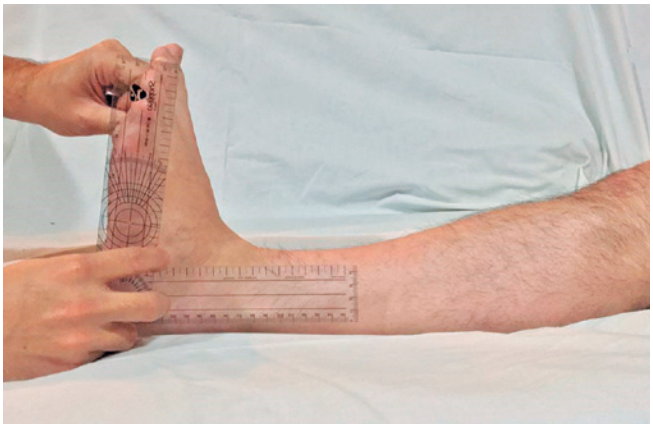

Figure 1. Evaluation of dorsiflexion with the knee extended.
Source: Author's personal archive.

Figure 2. Evaluation of dorsiflexion with the knee flexed.
Source: Author's personal archive.

rical variables. For categorical variables, we used descriptive statistics. The Mann-Whitney U test[21] was used to compare the distributions of the BMI and IGT numerical scores.

RESULTS

Fifty patients participated in the study, including 39 women (78%) and 11 men (22%). The mean age was 64 years (ranging from 43 to 83, with a standard deviation of 9.11 years). The mean BMI was 27.8Kg/m^2 (ranging from 19 to 38Kg/m^2). Regarding laterality, we observed 27 cases of the right foot (54%) and 23 cases of the left foot (46%).

The mean duration of foot pain was 22.6 months. The foot pain location was the forefoot (e.g., metatarsalgia) in 66% of patients and the hindfoot (e.g., plantar fasciitis, insertional and noninsertional tendinopathy of the calcaneal tendon) in 34% of patients.

On foot physical examination, 64% (32 patients) had IGT, and 36% (18 patients) did not have IGT.

We determined the presence of IGT in the patients and correlated it with BMI. There was no significant difference in the distributions of BMI values between patients who did and did not have IGT (p=0.769).

DISCUSSION

The gastrocnemius muscle originates in the posterior femoral condyles and crosses the knee, ankle and subtalar joints. The soleus muscle arises from the posterior surface of the tibia, fibula and interosseous membrane, crossing the ankle and subtalar joints. The gastrocnemius-soleus complex has a common insertion in the posterior tuberosity of the calcaneus bone via the calcaneal tendon[11,22,23]. Clinical differentiation between IGT and combined gastrocnemius-soleus contracture is crucial and can be clinically determined via the Silfverskiöld test[13,24].

Assessment of IGT may be performed during the physical orthopedic examination. An ankle extension limitation of <10 degrees is considered a parameter of gastrocnemius contracture. This parameter was defined in a study that identified an 88% incidence of gastrocnemius contracture (by <10° dorsiflexion) in patients with symptomatic foot pain, compared to an incidence of 44% in asymptomatic controls[14].

However, on routine physical examination of the foot and ankle, the presence of IGT is often not evaluated. Consequently, the interpretation of the causes of various foot and ankle diseases can be erroneous, and proper treatment is often not instituted. If conservative treatment does not target the ultimate cause, which is biomechanical gait dysfunction due to IGT, treatment will not achieve satisfactory results, and surgery can be indicated unnecessarily[6,11].

In addition to IGT, there is evidence to suggest that being overweight places adults at greater risk of developing foot disease complications, such as tendinitis and plantar fasciitis. However, no study has rigorously examined the effects of being overweight or obese on the feet of individuals over 60 years of age[25,26]. In our study, when investigating patients with forefoot pain (e.g., metatarsalgia) or hindfoot pain (e.g., plantar fasciitis, insertional and noninsertional tendinopathy of the Achilles tendon) without deformities on physical and radiographic examination, we identified a patient population with a mean patient age of 64 years who were largely overweight (mean BMI of 27.8Kg/m^2). We believe that interventions aimed at weight loss can relieve the load on foot structures and, in turn, improve foot pain and quality of life in older, obese individuals.

The patients evaluated in our study were largely overweight and showed a 64% incidence of IGT, mostly with ankle involvement (66%). There was a higher prevalence of women in our study (78%) and a mean age of 64 years. However, we did not find any significant association between the presence of IGT and patient BMI (p=0.769).

Several studies have previously reported an incidence rate of IGT. Hill et al. examined 209 patients with complaints of foot pain and found that 176 (96.5%) had ankle dorsiflexion limitation that required compensation during gait[8]. Kibler et al. found an 86% prevalence of reduced ankle dorsiflexion in patients with symptoms in the forefoot[27]. However, in our study, we determined a 64% prevalence rate of IGT, a value below that previously reported in the literature.

Because all patients in our study group had pain symptoms in the feet, we did not question whether the Silfverskiöld test[13,24] would be the best option to evaluate IGT. It is known that a discrepancy in strength between the agonist (gastrocnemius) and antagonist (tibialis anterior) muscles may be a cause and one of the aggravating factors of tightness, which is closely related to pain symptoms in the foot.

New studies assessing muscle strength by dynamometry, gait laboratory analysis or electromyography are necessary to further test this hypothesis.

CONCLUSION

Overweight patients showed a 66% prevalence of IGT. However, there was no significant association between BMI and IGT identified in this study.

Authors' contribution: Each author contributed individually and significantly to the development of this article: LVMM *(https://orcid.org/0000-0002-2657-012X) performed data collection and wrote the article; VQB *(https://orcid.org/0000-0001-7889-8090) performed bibliographic review and data collection; GFF *(https://orcid.org/0000-0001-8032-3077) performed statistical analysis and interpreted the study results; KCS *(https://orcid.org/0000-0003-1534-9654) conceived and planned the activities that led to the study, approved the final version. *ORCID (Open Researcher and Contributor ID).

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