

# Diabetic foot ulcers and isolated gastrocnemius tightness

## Úlceras no pé diabético e a contratura isolada do músculo gastrocnêmio

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### ABSTRACT

**Objective:** To determine the prevalence of isolated gastrocnemius tightness (IGT) in diabetic patients with plantar ulcers in the forefoot using the Silfverskiöld test.

**Methods:** This prospective cohort study consecutively evaluated 50 diabetic patients with Wagner grade I or II ulcers in the forefoot treated conservatively on an outpatient basis and assessed them for IGT using the Silfverskiöld test.

**Results:** The prevalence of IGT was 66.7%. There was no significant correlation between IGT and the ulcer's area or depth (Wagner's classification) or the patient's insulin use.

**Conclusion:** The prevalence of IGT in diabetic patients with plantar ulcers is high, suggesting that this complication may contribute to the development of plantar ulcers.

**Level of Evidence II; Prospective Cohort Study.**

**Keywords:** Diabetes mellitus; Achilles tendon; Ulcer; Muscle, skeletal.

### RESUMO

**Objetivo:** Avaliar a prevalência da contratura isolada do músculo gastrocnêmio (isolated gastrocnemius tightness – IGT) em pacientes diabéticos com úlcera plantar no antepé, através do teste de Silfverskiöld.

**Métodos:** Neste estudo de coorte prospectiva, foram avaliados 50 pacientes diabéticos consecutivamente com úlceras grau I e II de Wagner no antepé, atendidos ambulatoriamente com tratamento conservador e análise do IGT através do teste de Silfverskiöld.

**Resultados:** Foi encontrada uma prevalência de 66,7% de IGT nos pacientes analisados. Não foi encontrada associação estatística entre IGT e área da úlcera, profundidade (classificação de Wagner) e uso de insulina.

**Conclusão:** Os pacientes diabéticos com úlcera plantar apresentam uma elevada prevalência de encurtamento do tríceps sural, sugerindo que essa contratura pode ser uma das causas da formação da úlcera.

**Nível de Evidência II; Estudos Prognósticos; Estudo Prospectivo.**

**Descritores:** Diabetes mellitus; Tendão calcâneo; Úlcera, Músculo gastrocnêmio.

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## INTRODUCTION

The contracture of the triceps surae muscles (gastrocnemius-soleus complex) or isolated gastrocnemius tightness (IGT) limits ankle extension. This limitation causes changes in gait biomechanics, which leads to dynamic equinus and the transfer of a load to the forefoot that is larger than its physiological load<sup>(1)</sup>.

Although several hypotheses have been proposed, the aetiology of IGT is not fully understood<sup>(2-4)</sup>. However, studies have demonstrated a mechanical and functional connection between the plantar fascia and the Achilles tendon via calcaneal tuberosity. Considering that IGT has a significant impact on gait biomechanics, the evaluation of this complication by routine physical examination of the feet is suggested<sup>(5,6)</sup>.

In patients with normal foot sensitivity, IGT leads to forefoot pain; however, in diabetic patients, this overload is a predisposing factor for ulcers when associated with peripheral neuropathy<sup>(7)</sup>.

As one of the secondary effects of diabetes, symmetric and distal peripheral neuropathy of the lower limbs strongly affects quality of life by causing a loss of sensitivity in the feet. The progressive loss of sensitivity predisposes patients to the development of ulcers that may or may not be associated with Charcot neuroarthropathy. Therefore, a patient may present with severe deformities and infections of the soft parts and bone, which may affect the lower limbs and impair the gait. In addition to clinical impairments caused by foot ulcers, economic impacts should also be considered<sup>(8-10)</sup>.

Economic impacts can be minimised by focusing on the prevention of the development of ulcers during orthopaedic outpatient care. A simple and effective approach to prevention is including an IGT assessment in routine physical examinations<sup>(11)</sup>.

One method of differentiating IGT from combined contractures (gastrocnemius and soleus) is the Silfverskiöld test<sup>(12)</sup>. This assessment is performed by measuring the extension of the ankle with the knee flexed and extended. IGT occurs when the ankle extension is less than 10 degrees with the knee extended (passive extension) because, during the terminal phase of flexion, this 10-degree extension is necessary for the advancement of the tibia<sup>(13)</sup>.

The objective of this study is to evaluate the prevalence of IGT in diabetic patients with plantar ulcers<sup>(14)</sup> using the Silfverskiöld test and to assess a possible correlation between IGT and plantar ulcers.

## METHODS

This work was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 79445217.0.0000.5463.

Patients seen by the foot and ankle surgical team from June 2017 to December 2017 were recruited consecutively after signing the informed consent form.

The inclusion criteria were diabetic patients with Wagner grade I or II ulcers in the forefoot with only one foot receiving conservative treatment. The exclusion criteria were Wagner grade III ulcers, IGT resulting in shortening of the triceps surae muscles due to central neurological diseases (stroke, cerebral palsy, and demyelinating diseases); diseases of the knee, hip, and spine that caused non-functional dysmetria of the lower limbs; patients using walking aids; and Charcot neuroarthropathy.

The patient data that were evaluated were gender, age, weight, height, time since onset of diabetes, use of insulin, time since onset of ulcers, and laterality of the affected foot.

In the physical examination of the foot and ankle, the area of the foot ulcer was determined by measuring the largest and smallest diameter with a tape measure. The ulcer's depth was measured using a probe, and the Wagner classification was obtained using the Silfverskiöld test. This test was conducted using a goniometer centred on the lateral malleolus to measure the ankle's extension with the knee flexed and extended. IGT was considered present when the extension was less than 10 degrees with the knee extended.

The statistical analysis was conducted using Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL, USA) software, version 23.0. Means, standard deviations, and maximum and minimum values were used for numerical variables, and descriptive statistics were used for categorical variables.

## RESULTS

Fifty diabetic patients with Wagner grade I or II ulcers in the forefoot were evaluated. With respect to the epidemiological profile of the patients, 76.5% were men and 23.5% were women. The mean age was  $63.56 \pm 7.95$  years, the mean BMI was  $28.29 \pm 3.41$  kg/m<sup>2</sup>, the time since onset of diabetes was  $16.49 \pm 6.32$  years, and the mean duration of the use of insulin was 10 years.

With regard to the profile of the foot ulcers, 54.9% of cases involved the right foot and 45.1% involved the left foot, the mean time of disease evolution was 9 months, and the

mean ulcer area was 2.96 cm<sup>2</sup>. Furthermore, 80.4% of the cases were classified as Wagner grade I ulcers and 17.6% were classified as Wagner grade II ulcers.

In the Silfverskiöld test, IGT was identified when the extension was less than 10 degrees with the knee extended. Using that criterion, the prevalence of IGT was 66.7%, and the average extension was 4.46 degrees.

There was no significant correlation between IGT and the ulcer's area or depth (Wagner's classification) or the patient's insulin use.

## DISCUSSION

Diabetes mellitus is a serious public health problem, and its prevalence has increased worldwide, reaching epidemic proportions<sup>(15)</sup>.

Holstein et al. reported that, in diabetic patients, the incidence of plantar ulcers was 2% to 6%, the prevalence was 3% to 8%, and the recurrence rate was 70% after 5 years<sup>(16)</sup>.

Salsich et al. evaluated the effect of elongation of the Achilles tendon using total contact plasters for treating plantar ulcers in diabetic patients and found a temporary decrease in the force applied to the plantar flexors and an increase in ankle dorsiflexion in the group subjected to stretching<sup>(17)</sup>.

Several studies evaluating the incidence of ulcers and their complications suggested a relationship between IGT and the development of ulcers. In these cases, Achilles tendon elongation is effective for healing neuropathic ulcers<sup>(16)</sup>.

Therefore, the routine evaluation of IGT using the Silfverskiöld test is a simple, reproducible, and useful tool. However, other signs may help make the diagnosis when IGT is not clinically evident, including knee recurvatum, hip flexion, lumbar hyperlordosis, and foot overload<sup>(18)</sup>.

Several theories have been proposed to explain idiopathic contracture of the triceps surae muscles; however, the aetiology of this condition is not fully understood. One possible cause is that laying in a sitting position during sleep, with the ankle and knees flexed, allows for the contracture and shortening of the posterior muscles of the leg; this is due to the higher volume and strength of the posterior leg muscles relative to the anterior leg muscles<sup>(19)</sup>.

The prevalence of contracture of the triceps surae muscles reported in the literature is variable. DiGiovanni et al. reported that, in a group of patients with symptoms in their feet, 75% had contracture of the gastrocnemius muscle alone whereas 33% presented with contracture of the gastrocnemius-soleus complex. In the group without symptoms in their feet, 25% presented with gastrocnemius contracture and 16% had combined contractures<sup>(13)</sup>. Hill reported that out of 209 patients complaining of foot pain, 96.5% had ankle dorsiflexion limitations that required compensation during walking<sup>(20)</sup>. Kibler reported that the prevalence of reduced ankle dorsiflexion in patients with forefoot symptoms was 86%<sup>(21)</sup>.

In our study, the prevalence of IGT in patients with forefoot overload predisposing them to ulcers was 66.7%. In addition, there was no significant correlation between IGT and the ulcer's area or depth (Wagner's classification) or the patient's insulin use.

## CONCLUSION

In this study, the prevalence of IGT in diabetic patients with plantar ulcers was 66.7%, suggesting that this complication may predispose them to the development of ulcers. Therefore, the routine evaluation of IGT can effectively prevent ulcers in patients with diabetes.

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