STRESS-STRAIN DISTRIBUTION IN THE MODEL OF RETROCALCANEAL BURSITIS BY USING HEEL-ELEVATION INSOLES

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Abstract

The aim of this study is the analysis of the equivalent stress on the rear foot structures in retrocalcaneal bursitis, when using heel-elevation insoles of different heights (10 mm and 20 mm).

Methods – mathematical calculations of the Achilles force required in the heel-off of the gait stance phase in the conditions of lifting the heel by 10 mm and 20 mm. A 3D-simulation foot model with an enlarged retrocalcaneal bursa was created. The analysis was carried out by the finite element method to calculate and study the stress and strain in the rear foot structures.

Results. When using a 10.0 mm height heel-elevation insole, the calf muscle strength, which must be applied to the heel-off of the gait stance phase, was 19.0 % less than without support and 26.8 % less in 20.0 mm insole. Accordingly, analyzing the simulation results in terms of von-Mises stress, the maximum stress observed on the Achilles tendon decreases by 20.0 % and by 30.0 %. The total deformations maximum in the model when using heel-elevation insoles decreased up to 18.1 % and they were localized not in the tendon, but in the bone structures of subtalar joint.

The maximum values of the total deformation of the model in the case of 10.0 mm and 20.0 mm heel-elevation insoles were 91.67 mm (–20.2 %) and 80.04 mm (–30.3 %), respectively, compared 114.92 mm in the absence of insoles. When using insole with a height of 10.0 mm, the stress in the retrocalcaneal bursa decreased by 20.0 % and was equal to 14.92 MPa compared to 18.66 MPa, and when using a 20.0 mm insoles - by 30.0 %.

Conclusions. It was found that when using 10.0–20.0 mm heel-elevation insoles, the stress distribution in the rear foot structures was significantly reduced by an average of 20.0-30.0 % and correlated with the height of the insoles.

Keywords: Achilles tendon, retrocalcaneal bursitis, tendinopathy, heel elevation insoles.

1. Introduction

Despite the large number of scientific studies, the problem of diagnosis and treatment of diseases of the Achilles tendon (AT) and surrounding structures remains relevant. A special place is occupied by the problem of treatment of AT diseases – tendinopathies and tendinitis. It is believed that the cause of these diseases is a constant overload on the tendon, which leads to inflammatory and subsequently to degenerative changes in tendon tissue. However, there are studies that show a link between the inflammatory process in the retrocalcaneal bursa and concomitant changes in the AT. According to Pavlov H. and others [1] in 9 out of 10 cases of Haglund's syndrome, retrocalcaneal bursitis (RB) and tendinitis were diagnosed. In their study, Karjalainen, P. T., Soila, K. et al., found that in 118 ATs diagnosed by magnetic resonance imaging, 19 % of the cases had enlarged