Effect of Lateral Wedged Insoles on Medial Knee Compressive Force in Medial Knee Osteoarthritis

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EFFECT OF LATERAL WEDGED INSOLES ON THE MEDIAL KNEE COMPRESSIVE FORCE IN MEDIAL KNEE OSTEOARTHRITIS

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INTRODUCTION

Medial compartment Knee Osteoarthritis (KOA) is commonly treated with Lateral Wedge Insoles (LWI). The aim of LWI is to unload the medial compartment during the gait. However, the effectiveness of LWI is still unclear. Targeting this treatment to patients with biomechanical phenotype characterised by varus malalignment and medial disease may improve treatment efficacy [1]. Moreover, subject-specific musculoskeletal modelling allows the Medial Compressive Force (MCF) to be accurately estimated [2]. The MCF may provide new insights on the mechanism of action of LWI to alter knee joint loads.

Therefore, the purpose of this study was to investigate the mechanical effect of LWI on knee MCF in participants with medial KOA and varus malalignment.

METHODS

Five volunteers with clinical or X-Ray evidence of medial KOA and varus malalignment (age 64.2 ± 6.14 years, BMI 31.8 ± 1.8 $Kg \cdot m^{-2}$) and four healthy subjects (age 56.5 ± 1.5 years, BMI 25.3 ± 2 $Kg \cdot m^{-2}$) were recruited through National Health Service – Greater Glasgow and Clyde.
Three-dimensional kinematic data were collected using a 14 Qualysis Oqus camera system sampling at 120Hz. Ground reaction forces were measured with a Kistler platform.
Participants' feet were 3D surface scanned and custom LWI with 0°, 5° and 10° degrees of lateral wedge were designed in CAD and manufactured using 3D printing.
Each participant performed four gait conditions at preferred speed: a) with standardised sports training shoes only (SO), b) with SO and 3D printed insoles at 0°, 5° and 10° of lateral wedge.
The most symptomatic leg was included in the analysis for KOA patients, the dominant leg (defined as the leg used to kick a football) was selected for the control group.

A subject-specific musculoskeletal model (MS), adapted from Lund et al. [2], was developed in the AnyBody Modeling System (AMS, AnyBody Technology A/S). The model was used to estimate the MCF using an inverse dynamic analysis. The MCF for the four gait tasks was corrected for body weight and presented as %BW (Figure 1). The mechanical effect of the LWI, during the stance phase, was estimated by the relative difference of impulse and peaks values of MCF of the three LWI conditions with respect to the SO condition. Given the sample size and subject-specific nature of the study, formal statistics testing was not employed.

RESULTS AND DISCUSSION

As shown in Figure 1, the KOA group had a higher load during the single support phase in all the conditions compared to the controls. These findings suggest the inability of KOA subjects to unload the medial compartment during the midstance phase.

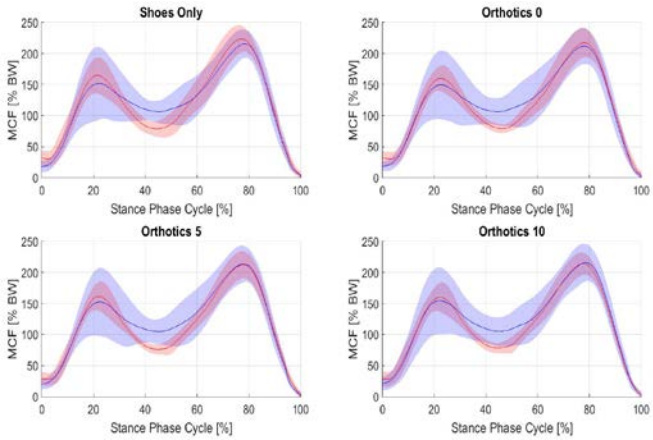

Figure 1: Knee Medial Compressive Force (MCF) for control (red) and medial KOA with varus malalignment (blue). Shaded areas indicates ± 1 standard deviation.

The KOA group showed an average limited reduction of the impulse of the MCF for the three LWI conditions compared to SO. The MCF impulse had a reduction by -2% (range +5%, -12%), -3% (range +4%, -11%) and -0.3% (range +5%, -6%) for the 0°, 5° and 10° conditions, respectively.
The peaks value did not change significantly.
For the control group, in comparison to SO condition, the MCF impulse had a variation by +2% (range +7%, -0.2%), +0.2% (range +5%, -3%) and -1% (range +3%, -1%) for the 0°, 5° and 10° conditions, respectively.

CONCLUSIONS

In this present study employing patient-specific MS model, a highly variable LWI response was demonstrated in patients with biomechanical phenotype, characterized by varus malalignment and medial disease. The MCF was reduced and increased in participants across the range of LWIs investigated and no overall dose-response trend, according to the degree of lateral wedging, was observed. Further analysis based on an extended dataset and more precise participant classification based on MRI confirmation of medial knee compartment disease is warranted.

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