The influence of the type of running shoes in the lower limb muscular activity

Gonçalo Marta[1], Carlos Quental[1], Francisco Guerra Pinto[2], João Folgado[1]

[1]IDMEC, Instituto Superior Técnico
Universidade de Lisboa
Avenida Rovisco Pais 1, 1049-001 Lisboa, Portugal
[goncalo.marta,carlos.quental, jfolgado]@tecnico.ulisboa.pt

[2]FEBOT, Nova Medical School
Universidade Nova de Lisboa
Campo Mártires da Pátria 130, 1169-056
Lisboa, Portugal
fguerrapinto@gmail.com

EXTENDED ABSTRACT

1 Introduction

The growth of amateur athletics in the last decade is associated with technological progress in the field of athletic footwear [1]. This footwear differs in the type of cushioning and support it provides to each practitioner's stride. The influence these parameters have on muscle activity is still poorly understood. The combined application of surface electromyography (EMG) and computational multibody models allows the description of the effect that different external conditions have on the muscle system. In this way, this study aims to investigate the differences in muscle activation patterns for two types of running shoes: neutral support cushioned shoes; and unsupported and uncushioned competition shoes.

2 Methodology

Kinematic data were collected from one volunteer at the Lisbon Biomechanics Laboratory (LBL) using reflective markers and 14 infrared cameras. The volunteer ran at a self-defined speed on force platforms embedded in LBL, using both types of shoes under study. EMG data were also colllected for 8 muscles (lateral and medial gastrocnemius, rectus femoris, biceps femoris, tibialis anterior, gluteus maximus, soleus, and vastus medialis).

Figure 1: Whole-body Musculoskeletal model used in this work.

The whole-body musculoskeletal model applied (Fig. 1), based on Rajagopal et al. [2], consists of 18 rigid bodies and 80 muscle-tendon units. The collected data were input into an inverse dynamic analysis program to estimate joint reaction forces and muscle activations. The muscle redundancy problem was solved using a static optimization approach. The minimized objective function was muscle energy consumption [3], subjected to the compliance of the motion equations and the appropriate limitation of muscle activations. The estimated muscle activations were validated by the muscle activity collected at the LBL.

3 Results and Discussion

The preliminary results for the angles and reaction forces at the ankle, knee, and hip joints, and muscular forces were analyzed. For the cushioned shoes, the results suggest increased plantar flexion at toe-off when compared with the non-cushioned shoes. The peak reaction forces at the hip, knee, and ankle joints were larger for the uncushioned shoes compared to the cushioned shoes, as illustrated in Figure 2(a) for the ankle joint. This result falls in line with what was found by Nigg et al., suggesting that

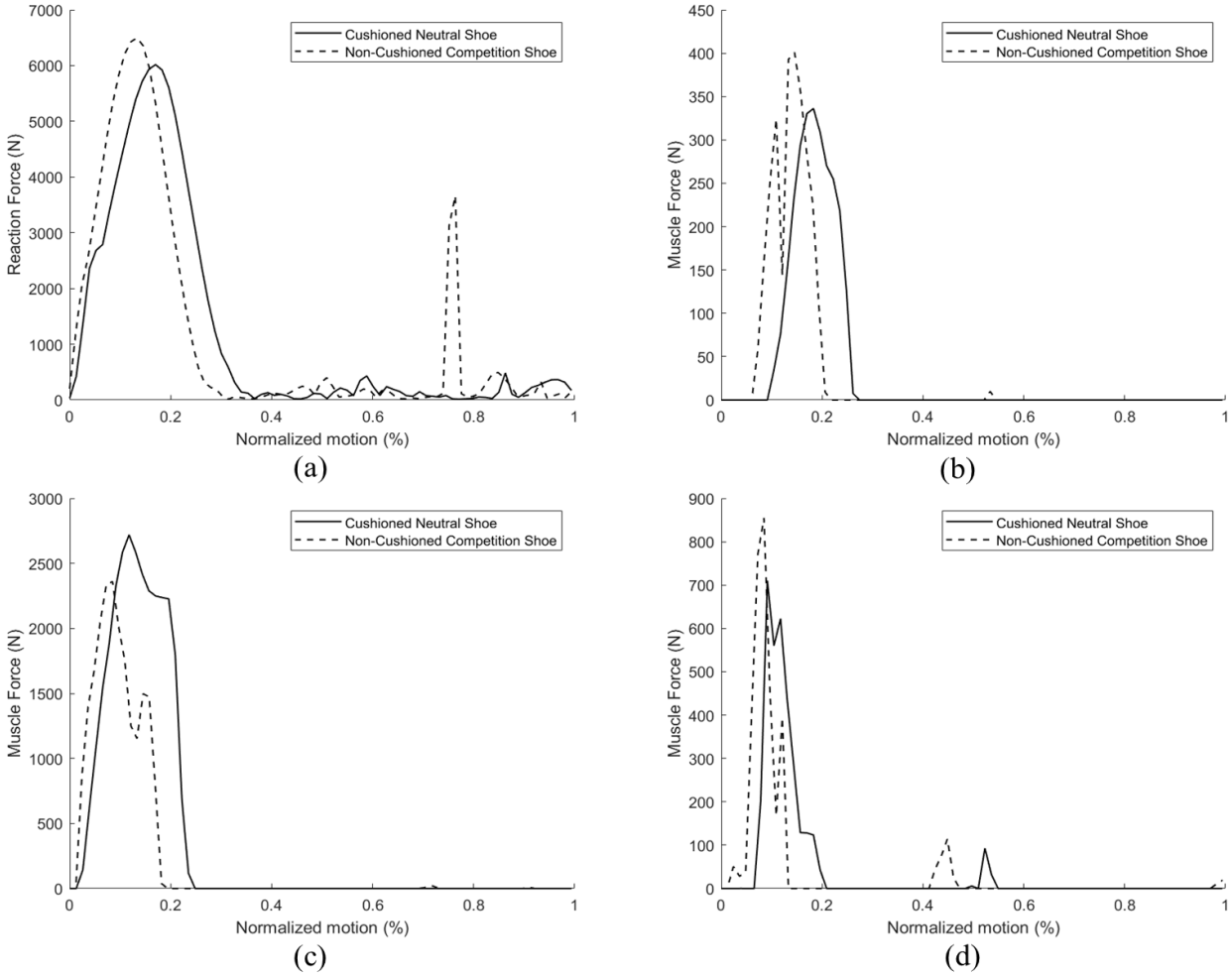

Fig. 2. Ankle joint reaction forces (a) and muscular forces in the gastrocnemius lateralis (b), soleus (d), and vastus medialis (d) muscles for the cushioned (continuous line) and non-cushioned (dashed line) shoes.

cushioning reduces the reaction forces in the foot while rising the stance time [4]. Similarly, the estimated muscle activations had overall higher maximum values for the uncushioned competition shoes, as depicted in Figure 2(b-d) for the gastrocnemius lateral, soleus and vastus medialis, respectively.

4 Conclusion

A more comprehensive understanding of the impact that different types of running shoes have on the mechanisms of muscle or joint injury is necessary. The availability of such studies enables runners to have biomechanical knowledge to choose shoes that are suitable for their physical characteristics and goals.

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