A case study with custom : a comparison of normal and altered gait with an ankle brace

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A CASE STUDY WITH CUSTOM: A COMPARISON OF NORMAL AND ALTERED GAIT WITH AN ANKLE BRACE

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Introduction

The need for easy computation of biomechanical quantities is required in motion analysis routine such as joint kinematics, joint net moments and muscles forces. However, musculoskeletal softwares require expert knowledge for clinical routine. Here, we propose a kinematic analysis of a normal gait and altered gait with an ankle brace using CusToM [1] which is a modular toolbox aimed at performing inverse dynamics based musculoskeletal analysis. This study aimed at revealing compensation strategies of one subject following an ankle injury.

Materials and methods

One subject was recorded performing range of motion tasks and four left gait cycles prior to a complete tear of his right lateral ankle ligament. The subject underwent a second time the experiment with a complete ankle brace ensuring the right ankle to be immobilized. Three weeks after his injury and three months after the first session, the subject underwent the same experiment with a complete ankle brace ensuring the right ankle to be immobilized. A lower limb kinematical model was used with 3 rotational DOF at the hip, one at the knee and two at the ankle. These two last DOF were immobilized on the altered gait session. The selected model was adapted by suppressing these two DOF. For both sessions, the subject was equipped with a set of 45 markers (Figure 1). A hundred frames of the range of motion trial were chosen to calibrate the kinematic chain through an optimization-based identification. Then, joint kinematics of lower limbs was computed by multibody kinematic optimization [2]. Mean and standard deviation of the normalized joint kinematics of the right leg were compared over gait cycles between the two sessions. Paired t-test using Statistical Parametric Mapping (SPM) was applied to detect significant differences between the two sessions on each DOF.

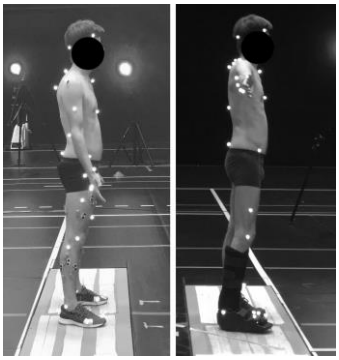

Figure 1: Subjects for the two sessions: normal gait (left) and the altered gait with the ankle brace (right).

Results

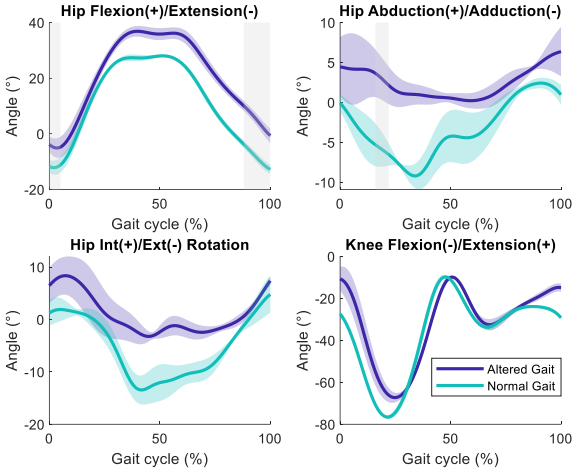

Figure 2: Means and standard deviations of the right limb kinematics. Grey areas indicate significant different between each condition ($p<0.05$).

Means and standard deviations of curves exhibited different trends (Figure 2). Significant differences in hip flexion/extension at early and end stages of the gait were revealed ($p=0.011$ and $p<0.001$). Also hip abduction/adduction was significantly affected between 16% and 22% of the gait cycle ($p<0.001$). Internal/external rotation of the hip and knee flexion were not significantly different.

Discussion

This kinematic analysis highlighted the impact of the ankle brace, particularly on the hip joint. This compensation motion has been previously reported as a residual circumduction of the hip to allow the leg and the foot to move forward during the swing phase of the gait, as it has been reported for transtibial amputees [3]. It may explain the absence of vaulting strategy on the opposite ankle. Besides, we highlighted the ability of CusToM to perform such analysis. Further analysis of this case study at musculoskeletal level may be relevant.

References

1. Muller et al, JOSS, 4(33):1-10, 2019.
2. Begon et al., J Biomech Eng, 140, 1-11, 2018.
3. Schmalz et al., Gait Posture 16(3):255-263, 2002.

Acknowledgements

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