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► **To cite this version:**

Thomas Robert, Simone Ranaldi, Alexandre Naaïm, Cristiano De Marchis, Raphael Dumas, et al.. Margins of stability of individuals with bone-anchored or socket-suspended transfemoral prostheses. 29th Congress of the European Society of Biomechanics, Jun 2024, Edinburgh, Scotland, United Kingdom. hal-04631383

HAL Id: hal-04631383

<https://hal.science/hal-04631383>

Submitted on 2 Jul 2024

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MARGINS OF STABILITY OF INDIVIDUALS WITH BONE-ANCHORED OR SOCKET-SUSPENDED TRANSFEMORAL PROSTHESES

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Introduction

The mechanism with which the prosthesis is fixed to a residual limb plays a key role in the gait control for transfemoral amputees (TFA). Socket-suspended prostheses (SSP) are the most classically used, although they are not fully satisfying in terms of comfort (e.g. skin damages) or efficiency (e.g. lack of perception of the walking surface). Bone-anchored prostheses (BAP) attached to osseointegrated implants have been proposed to overcome some of these limitations, but they are also associated with risks of infection. The potential clinical benefits of BAP over SSP still need to be further investigated, notably by characterizing its impact on gait characteristics. Some methods are provided in the literature for parameters such as joint kinematics or gait spatiotemporal parameters [1]. Yet, information from a more global level is lacking. The margin of stability (MoS), which describes the instantaneous mechanical stability of the person, has been successfully used as a overall descriptor of gait mechanics [2]. This study aims at describing the MoS during TFA gait with BAP compared to SSP.

Methods

The data used in this multicentric study includes 18 TFAs (9 SSPs and 9 BAPs). Participants were asked to perform several level walking gait trials at their self-selected speed. Ground reaction forces were recorded using two force platforms and kinematics of segments was obtained from skin-marker trajectories recorded using an optoelectronic system sampling at 200 Hz. Both protocols and demographic characteristics were detailed in recent publication [1].

The center of pressure (CoP) and final contacts of the contralateral foot (FCc) were obtained from the ground-reaction forces. The whole-body center of mass (CoM) was estimated using a 9-segment body model [3]. The extrapolated center of mass (XCoM) was computed from position, velocity and sound leg length of participants [2].

The MoS was computed at contralateral FC as the distance between CoP and CoM in both anteroposterior (AP) and mediolateral (ML) directions. A negative MoS means that the CoM is more lateral or frontal than the CoP.

Kruskal-Wallis tests were used to analyze potential differences between types of prosthesis and side.

Results

MoS results for sound and prosthetic sides (SS and PS) are summarized in Figure 1.

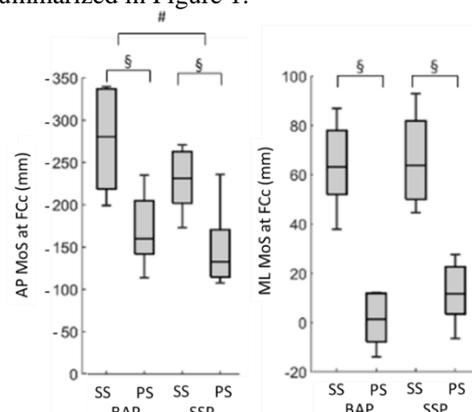


Figure 1: Boxplots of MoS. § and #: significant differences between sides and types of prosthesis.

Discussion

Both types of prosthesis induced asymmetry between SS and PS, with an XCoM closer to the COP on the PS. This was already observed for SSP (in ML for TFA [3] in AP for transtibial amputees [4]) but not for BAP. MoS at FCc were similar between BAP and SSP in ML, while they were overall larger in absolute values for BAP than SSP in AP. This could be linked to a higher acceptance of anterior instability for BAP TFA or to their slightly faster gait velocity, yet not significant [1], as MoS in AP and gait velocity are positively correlated [5]. This study provides the first results on gait MoS for BAP TFA. It tends to show that ML stability is comparable between BAP and SSP while BAP would provide a more efficient gait in the AP direction (more “unstable” in the direction of progression).

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Acknowledgments

This work was partially funded by 2019 US DoD RESTORE Award W81XWH2110215-DM190659 and 2024 NHMRC Idea grant 202963. S.R. was funded by Rome Technopole (PNRR ECS_00000024).

