Conference or Workshop Item:
Abouhossein, A, Awad, MI, Crisp, C et al. (2016) Effect of Different Prosthetic Knees/feet on the Roll-Over Shape. In: 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 17-20 Aug 2016, Orlando, Florida, USA.

This is an author produced version of a poster published in Proceedings of the 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society.

Effect of different prosthetic knees/feet on the roll-over shape*

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***Abstract*— Roll-over shape (ROS) of knee-ankle-foot (KAF) is a scientific method which has been used to compare performance and design of the different prosthetic foot. In the current study, however, we aimed to understand the influence of the prosthetic components (i.e. knee and foot) on the knee-ankle-foot roll-over shape in a unilateral transfemoral amputee. We performed a case study based on series of experiments with repeated measures on single amputee wearing two different commercially available microprocessor prosthetic knees, during two weeks adaptation period to understand the influence of the prosthetic knee/foot using KAF ROS as an objective measure during level ground walking. The kinematics of the center of pressure (COP), lateral knee and ankle markers were collected and processed to obtain ROS and the results were used to fit a circular shape arc to obtain radius of curvature (ROC). The results indicated that the prosthetic knees have influenced ROC outcomes. The analysis of variance (ANOVA) and post hoc test of the normalized radius of curvature showed the mean of ROC were significantly different between Rheo3 knee, Orion2 and Orion2 with Echelon foot. The amputee reflected his comfort with Rheo3 plus College park foot and Orion with Echelon foot. A conclusion is drawn that multiple comfort zones may exists based on amputee's ROS metrics. This finding suggests that the design of prosthetic knee should not be considered as a single component but rather as part of a whole system with different comfort zones.**

I. INTRODUCTION

Roll-over shape (ROS) is known to be the representation of the foot center of pressure (COP) in the ankle-knee coordinate system to establish a rocker geometry shape during stance phase of the human gait [1].

II. METHODOLOGY

A. Experimental protocol and procedure

This is a case study with a single amputee with repeated measures with two different prosthetic knees/feet. The study encompassed level ground walking trails with self-selected pace. The prosthetic ankle-foot was kept unchanged during the experimentation period for two prosthetic knees. One of the prosthetic knees is used with recommended foot and ankle as are shown in the table 1. There are many studies looking into the different shoes or prosthetic foot/ankle and effect of them on roll-over shape. However, there is no study in literature evaluating the effect of prosthetic Knee on the roll-over shape. Therefore, the objective was to draw conclusion on weather prosthetic knee has any influence on the outcome of foot rocker. In addition, whether it is possible to identify a comfort zone for the amputees based on ROC metric.

TABLE I. TYPE OF PROSTHETIC KNEE AND ANKLE-FOOT USED IN EACH EXPERIMENTS.

Item	Type of prosthetic knee	Type of prosthetic foot and ankle	Component weight (Kg) Knee/foot
1	Orion2 endolite	Venture College park	1.35/0.585
2	Rheo3 Össur®	Venture College park	1.36/0.585
3	Orion2 endolite	Echelon	1.35/0.900

III. RESULTS AND DISCUSSION

Figure 1 illustrates that the two groups (Orion2 and Orion2 + Echelon foot) have means significantly different from Rheo3. The data is normalized to the height of the amputee for comparison. This study supported our hypothesis that the prosthetic knee also influences the ROS and therefore a foot alone cannot only be considered adequate for proper ROS based design. The amputee stated his comfort with Rheo3 plus Venture College Park foot/ankle and Orion with Echelon foot. The conclusion which can be drawn from this case study is that multiple comfort zones for amputees based on ROS and ROC may exist.

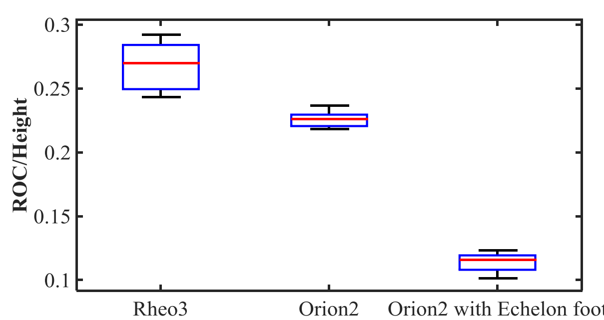

Figure 1 the box plot supports the significant differences between the Rheo3, Orion2 knee with Orion2 knee+Echelon foot. (*P< 0.05)*

REFERENCES

[1] R. J. Williams, A. H. Hansen, and S. A. Gard, "Prosthetic Ankle-Foot Mechanism Capable of Automatic Adaptation to the Walking Surface," Journal of Biomechanical Engineering, vol. 131, 2009.

* Research supported by Engineering and Physical Sciences Research Council, UK (EP/K020463/1).

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