AN ANALYTIC APPROACH TO ASSESSING TRANSFEMORAL SOCKET FLEXIBILITY
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INTRODUCTION
Flexible prosthetic socket systems are generally thought to contribute positively to residual limb health and comfort of persons with amputations. Such systems allow greater accommodation of the socket walls to muscular contraction, improving circulation, as well as improving suction suspension due to the clinging nature of the socket walls (Pritham, 1985). Early examples of flexible systems include the use of double wall sockets, with a flexible inner socket joined to an outer rigid socket (McCollough, 1968) and a decade later, fenestrated sockets, with supporting struts formed by windows cut into the rigid socket at medial, posterior and anterior locations (Volkert, 1982). However, despite continued development of such flexible socket systems, there remains a need for formalization of the criteria defining socket flexibility. Existing working definitions, such as that articulated by Ossur Kristinsson as “the ability to deform [the socket] by hand and the resistance to stretching under the loads it will be subject to,” although accurate, are not sufficiently nuanced to allow comparison of dissimilar flexible socket designs. The goal of this work was to use an analytic process to provide guidelines for characterization of transfemoral socket flexibility, incorporating the following elements:
(1) Identification of regions of the socket that have distinct functions of clinical significance;
(2) An analytic evaluation of the deformation and internal socket stresses at these functional regions using a computational model.

METHOD
Apparatus: 3-D Creafom Megacapturor digitizer, Abaqus (Dessault Systemes), AMTI forceplates.

**Figure 2:** Selected functional regions on the structural frame component of a sub-ischial transfemoral socket.

Procedure: (A) Distinct regions of a transfemoral prosthetic socket with different loading and support functions were identified through discussion with an experienced Certified Prosthetist (Fig 1). (B) The selected regions were evaluated in a previously described finite element model of a sub-ischial prosthetic socket (Komolafe et al. 2012). Evaluation included a global deformation and stress assessment of the selected “functional regions” (from A above).

Data Analysis: The equivalent (von Mises) stress was calculated as an average of all elements in the selected region.

RESULTS

**Figure 1:** Results from computational model of sub-ischial socket subjected to experimentally measured stance loads.

DISCUSSION/CONCLUSION
Our analysis (Fig 2) confirmed the region of maximum socket flexibility (indicated by minimum stress values) for the duration of the stance phase in this sub-ischial socket design was along the proximal brim. During loading response and early stance, calculations indicated low deformation (and high stresses) along the anterior and medial regions, however, during later stance; low values of deformation were calculated along the posterior and lateral regions of the socket.

CLINICAL APPLICATIONS
Characterization of regional socket flexibility for different loading conditions may benefit the design of activity specific socket systems.

REFERENCES
Komolafe et al. 38th AAOP Meeting, Atlanta GA, 2012.

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