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Advanced tuning of below knee prosthesis using the MOTEK CAREN system

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Background

A transtibial prosthetic alignment is described as a spatial three dimensions with six degrees of freedom of interrelationship between socket and foot. Moreover, dynamic alignment, a crucial step in aligning prosthesis, aims to achieve the most suitable limb position to achieve desire function and comfort. Misalignment may result in walking difficulty, skin abrasion and uneven forces acting on the residual limb within the socket, which could lead to wound, and even more serious skin and joint trauma.

However, the optimal alignment in traditional practice can take one day to several weeks from the starting to finalize in dynamic alignment, depends on prosthetist's skill and experience. The alignment optimization, a very time- consuming process, is accomplished by subjective judgment of the prosthetist based on visual observation of gait and feedback from the patient. Furthermore, a prosthesis aligned in the traditional subjective practice seems to be lacked of any scientific biomechanical systematics.

Aim

The purpose of this study is to develop a new system using CAREN system which can give a real-time tuning feedback and can modify the alignment of a below knee prosthesis while a subject walks on a treadmill so allowing tuning of the prosthesis and then to compare this to conventional tuning methods. In order to do this, three objectives need to be met;

1. To finalize a 3-D gait analysis protocol that could be easiest, accurate, and most repeatable for the assessment of gait performance.
2. To develop a real-time Transtibial prosthesis tuning feedback applications integrated into the D-flow system which produces various parameters useful for real-time aligning protocol based on a below knee fitting standard.
3. To determine which alignment method is associated with better biomechanical outcomes: Traditional Alignment and The CAREN- Assisted Alignment Technique.

Method

First stage: The kinematic gait parameters of ten able bodied subjects were analysed and compared in this study by using the camera Motion Capture System. The marker sets were attached on each subject for a Strathclyde cluster model, the Human Body Model, New Human Body Model and Plug-in-Gait model simultaneously while walking. During the experiment, subjects were asked to walk in self-selected speed. Marker trajectories were captured synchronously and joint angles were calculated using the four marker models.

Second stage: Study design is experimental study design in a two-group randomized clinical trial. The 20 unilateral transtibial amputees will walk at a self-selected comfortable speed for gait analysis. During each test session, biomechanical outcomes will be examined and compared according to aligning method. VICON system will be used to collect the biomechanical outcomes. The statistical will be analysed by using SPSS 16.

Results and Discussions:

Stage one result: All four protocols have shown good inter-trial, intra protocol and inter protocol repeatability. The SC model has demonstrated good correlation, good repeatability, accuracy, and ease to use therefore it will be chosen for further study. The SC model has enabled 3D kinematic description of joints according to standard with clinical acceptance which was used for future study.

Stage two results: The expected result of this study is the CAREN Assisted Alignment Technique using an assisted dynamic aligning system effects better biomedical gait characteristics compared to the traditional alignment technique. The new system will be allows quickly and qualitatively align the device based on a patient's biomedical point of view and enable the prosthetist to align prosthesis objectively.