

COLLECTION OF COMPARATIVE DATA FOR AMPUTEE ENERGY COST AND SUBJECTIVE INPUT ON FUNCTIONAL PARAMETERS FOR VALIDATION OF THE LEGS M1 KNEE DESIGN

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INTRODUCTION

LEGS (LeTourneau Empowering Global Solutions) has developed the LEGS M1 low-cost 4-bar polycentric knee that can be manufactured in developing countries with local materials. The Physiological Cost Index (PCI), Timed Walk Test (TWT), and Prosthetics Evaluation Questionnaire (PEQ) have been utilized in a preliminary study to compare the function of the M1 knee to two other knee configurations; a locked configuration to simulate the single-axis Jaipur limb, and a mechanically comparable first world OrthoEurope 4-bar knee (OE4bar)[1]. TWT and PCI have both been extensively used in clinical settings as a simple, functional, and noninvasive way to look at energy cost of ambulation[2,3, 4]. TWT measures the distance walked in six minutes and is based on the fact that the velocity of individuals walking at a self selected pace will slow down as energy cost increases[4]. Developed by MacGregor in 1979 and used widely since then, PCI takes heart rate into account [2,3]. The PEQ, a validated self-reporting tool, collects subjective amputee input on various functional parameters of a lower limb prostheses[5,6,7]. We expect that the PEQ, TWT and PCI will provide a useful way to compare energy cost and subjective amputee input on functional parameters of different knee comparisons in a field setting.

MATERIALS AND METHODS

We selected 17 questions of the PEQ which allow for a short term evaluation of knee configurations, and administered them to 24 amputees in Kenya, Bangladesh and the United States. The PCI and TWT were simultaneously administered as each of the 24 patients walked at a self selected pace for six minutes on level ground with each knee configuration. Heart rates were recorded with a Polar RS400® heart rate monitor. Distances were measured with a surveyor's wheel.

RESULTS

The TWT and PCI indicated that the LEGS M1 knee is more costly to walk with than the OE4Bar conformation. In the comparison with the locked configuration, TWT and PCI indicated wide individual variation in energy cost with some walking consistently more cheaply with the locked configuration while others walked more cheaply with the LEGS M1 knee. The PEQ indicated amputee preference for the LEGS M1 knee over the locked conformation in all but two functional parameters, both pertaining to knee stability.

DISCUSSION

Preliminary results seem to indicate that these outcomes measures are collecting usable and pertinent data. Amputee preference for an articulating knee that allows for a cosmetically more normal gait was as expected. The OE4bar knee is lighter and has a less stable configuration than the M1 knee so a lower energy cost for that knee was not unexpected. Literature comparing the energy cost of walking with a locked and then an articulating knee is scant and contradictory; one article does indicate that a locked knee configuration may be less expensive [8, 9]. We found wide individual variation, possibly due to habituation issues. Follow up data with the same subjects and a larger sample size is planned. Improvements to our protocol are ongoing, but overall we feel that these tests are robust and reliable for our purposes.

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