Musculoskeletal-model based prosthetic gait evaluation for orthopaedic applications using low cost motion capture equipment

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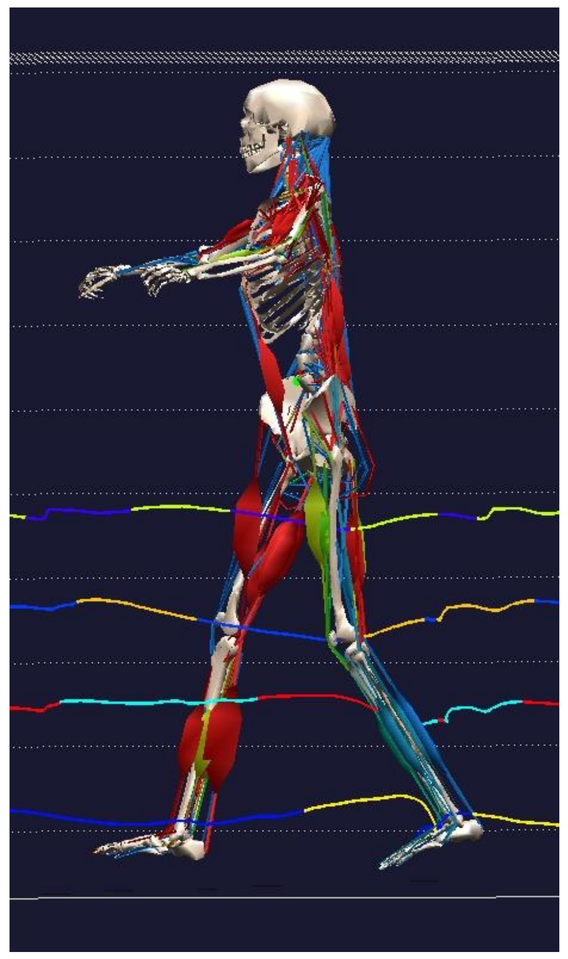
Introduction

Gait deviations caused by amputation of the lower limb create an altered gait pattern and rehabilitation of the gait will need to correct these deviations [1, 2, 3]. While assessing prosthetic gait it is important to know how normal gait in the amputee is affected. To date objective analysis of gait, pre and post to prosthesis fitting has required access to motion capture equipment found only in major hospitals and research institutions. However a new generation of inertial measurement unit based motion capture equipment has significantly reduced cost to those affordable by private prosthestists and orthotists. This paper examines the practicalities of using this equipment to generate results of value to these clinicians.

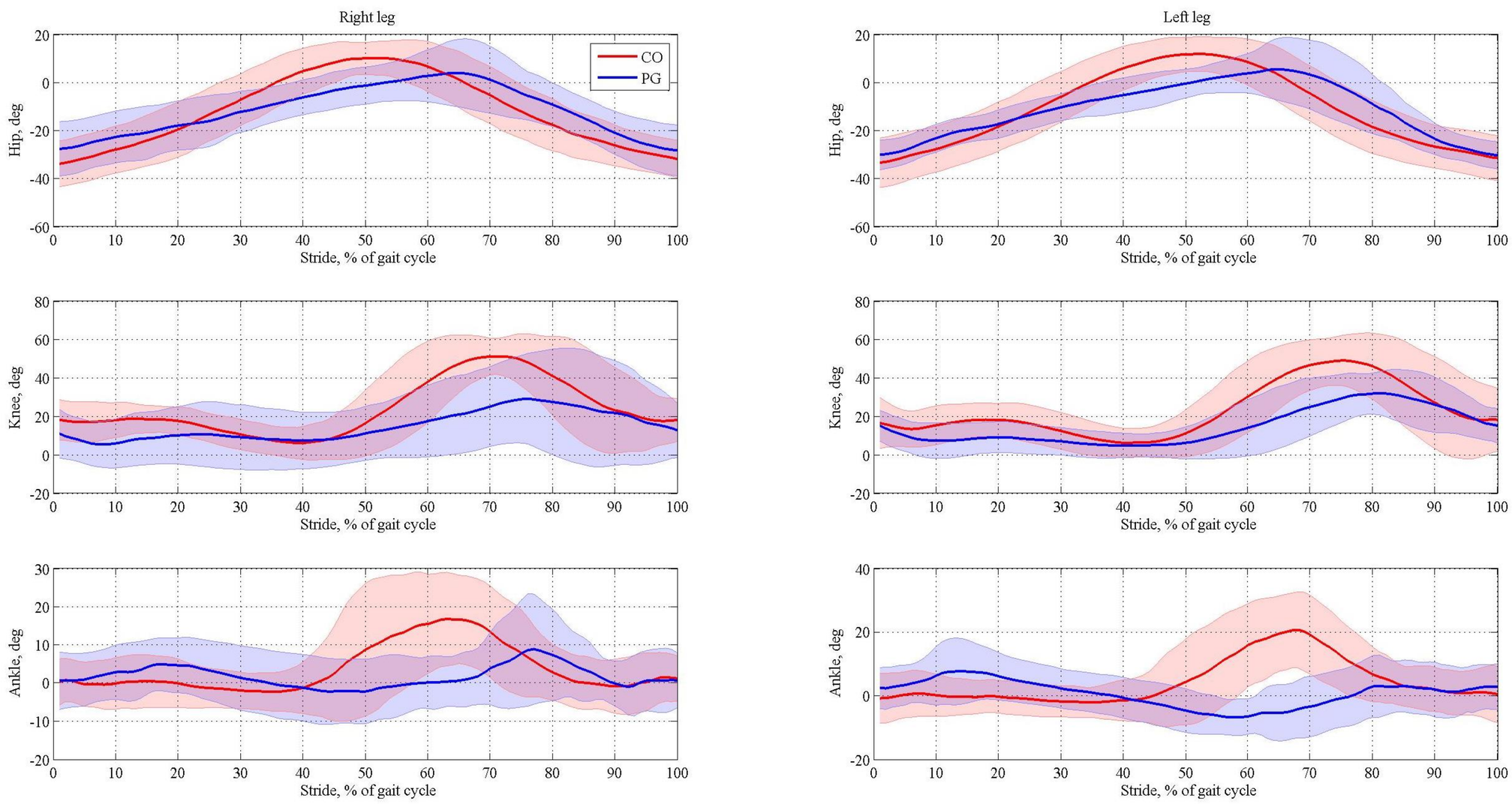
Methods

Total 15 subjects were recruited for the study, ie. 10 healthy volunteers as control group (CO, mean age ± SD 21.8 ± 1.3) and five below-knee amputees with stiff ankle and SACH type foot prosthesis (PG, mean age ± SD, 39.4 ± 23.2). Inclusion criteria were as follows: ability to walk independently, spatial awareness and orientation, at least one year of prosthesis usage. Exclusion criteria: low level of mobility, by past injuries induced gait changes (for CO). The subjects were instructed to walk as fast as possible over a distance of 15 m. Kinematics of gait was measured using full-body magneto-inertial system Perception Neuron (Noitem, China). A full body musculoskeletal model Biomechanics of Bodies (BoB, BoB-Biomechanics Ltd) was used for biomechanical analysis. The hardware and software are commercially available for a price of $1,900.



Results

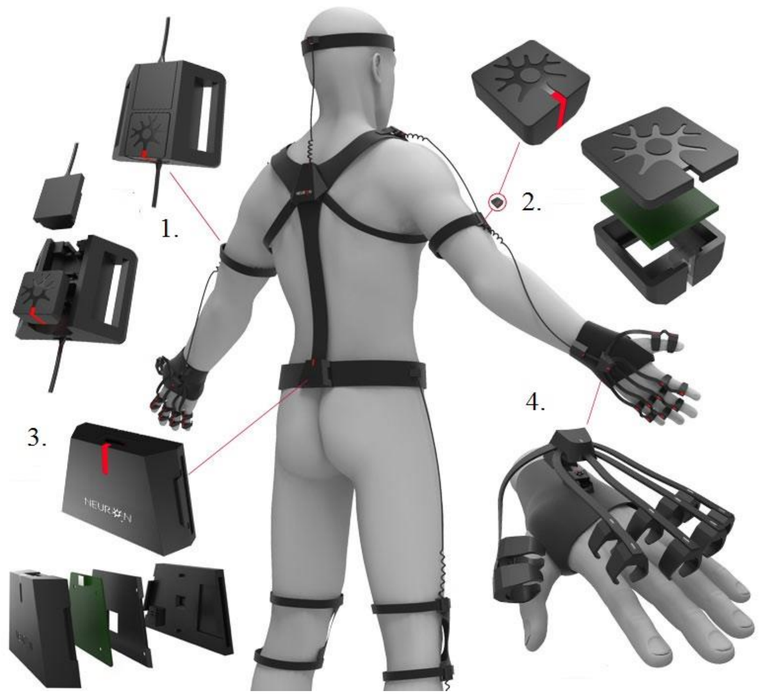
Figure shows the mean and ± 1 SD for the hip, knee and ankle sagittal plane rotation for the CO and PG subjects.



Significant variations in joint articulation can be observed between the CO and PG groups at the knee and ankle joints. This results in a short stride length and a higher support phase for the PG group (65% PG vs 60% CO).

Discussion

Temporal and kinematic parameters can be objective criteria when deciding on the choice of prosthesis. Depending on the kinematic parameters, the mobility of the prosthetic limb can be adjusted to ensure gait stability, body symmetry and comfort. It has been found that a low cost musculoskeletal modelling system consisting of hardware and software components can provide information of value to the prescription and evaluation of prosthetics and orthotics at a price which is suitable for a small manufacturer, single practitioner or a small clinic.



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