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Influence of thigh cluster configuration on the estimation of hip axial rotation

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Abstract

The non-invasive estimation of hip axial rotation is prone to error. Most of this is likely to originate from soft tissue artefact (STA) at the thigh. The purpose of this study was to evaluate the relative performance of four different thigh cluster configurations. Three were novel configurations whilst one represented the Helen Hayes convention. Twenty able-bodied adults performed two alternative motor tasks involving hip axial rotation: gait and an isolated longitudinal rotation task. Kinematic data were acquired using a three-dimensional motion analysis system (VICON 512, Oxford Metrics, Oxford, England). Indirect criteria were used to evaluate STA. Hip axial rotation kinematic profiles during gait were highly sensitive to thigh cluster configuration. For the longitudinal rotation task, the various thigh clusters were only capable of estimating, at best, up to 60% of the reference amount of movement. The Helen Hayes convention was associated with the greatest degree of STA. Whilst none of the clusters represented an optimal solution, a non-rigid configuration on the distal thigh provided a more favourable alternative. The main limitation associated with this study was the absence of a true gold standard measure of hip axial rotation. Until future work provides further insight, one must remain cautious when using estimates of hip axial rotation for purposes of research or clinical interpretation.

Keywords: Hip; Axial rotation; Soft tissue artefact; Gait analysis

1. Introduction

Hip axial rotation during gait is of clinical significance. For example, children with cerebral palsy typically walk with increased hip internal rotation [1]. Hip axial rotation during gait is therefore a common outcome measure for studies evaluating the effects of surgical interventions in cerebral palsy [2–4]. This necessitates accurate measurement techniques for non-invasively estimating hip axial rotation.

Conceptually, there are two major sources of error associated with the non-invasive estimation of hip axial rotation. The first source concerns the process of defining the relevant anatomical frames (AF). Specifically, the procedure for identifying the femoral AF frontal plane (conventionally defined by the knee joint flexion–extension axis) can be prone to error [5]. As 'neutral' hip axial rotation is reliant upon the orientation of the knee flexion–extension axis, errors in defining this axis manifest as offsets in the hip axial rotation kinematic profile. Optimisation procedures designed to minimise this error have recently been proposed [6–9]. The second source concerns soft tissue artefact (STA). In the context of hip axial rotation, it is STA at the thigh that is most critical. The thigh is surrounded by large amounts of soft tissue and contains few areas of subcutaneous bone. Hence, it is associated with the greatest degree of STA in the lower limb [10–12]. As the amplitude of hip axial rotation during gait is small [13], errors must be minimised. Quantification of thigh STA and its effect on the estimation

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