DYNAMIC KNEE AXIS ALIGNMENT: A CLINICAL COMPARISON

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Introduction

Clinical motion analysis is used with a variety of patient populations for making treatment decisions and to evaluate different treatment outcomes. Accordingly, it is imperative that such techniques provide both clinically meaningful and reliable data. Over the past decade, clinicians have voiced concerns regarding the accuracy and repeatability of manually defined knee axes for clinical gait analysis. Inaccurate knee axis definition has the effect of altering both hip and knee kinematics and kinetics. In response to such concerns, algorithms have been developed that utilize lower extremity motion to identify functional joint axes[1-5]. Although multiple algorithms have been proposed, they have not been compared with clinical data to determine which provides the best solution for the knee. Consequently, clinicians are left to arbitrarily select one of the many algorithms for use in their own labs. The purpose of this study was to compare the clinical performance of five different functional axis algorithms[1-5] to determine which provides the most consistent results over two different conditions of knee joint motion.

Statement of Clinical Significance

By providing clinicians with an objective comparison of different functional axis algorithms and by illustrating the constraints associated with each, practitioners will be able to make informed decisions about which method to employ and when it is appropriate to use them. Ultimately, these decisions may lead to improved treatment planning and better evaluation of treatment outcomes.

Methods

Clinical gait analyses were performed on 15 healthy adult subjects using an eight camera high-resolution motion analysis system (Motion Analysis Corporation, Santa Rosa, CA). Each subject performed five unweighted knee flexion trials (≈ 90° knee F/E range) and five gait trials at self-selected walking velocity (≈ 60° knee F/E range). Also, individual measures of tibial torsion were determined using Ultrasound for comparison with knee rotation averages. Specifically, tibial torsion was used as an anatomical reference to enable pooling the data from different subjects. Each of the five functional axis algorithms[1-5] was used for each trial in both of the movement conditions. In addition to comparing the knee axis positions, we compared the resultant knee ab/adduction range values from each movement condition.

Results

Figure 1 displays the transverse plane orientation of the functionally defined knee axes relative to each subject's measure of tibial torsion. Figures 1a and 2a demonstrate that nearly all of the functional axis algorithms perform comparably in the 'ideal' condition of unweighted knee flexion through a range of 90°. The data presented in Figures 1b and 2b illustrate each algorithm's performance with clinical gait data.

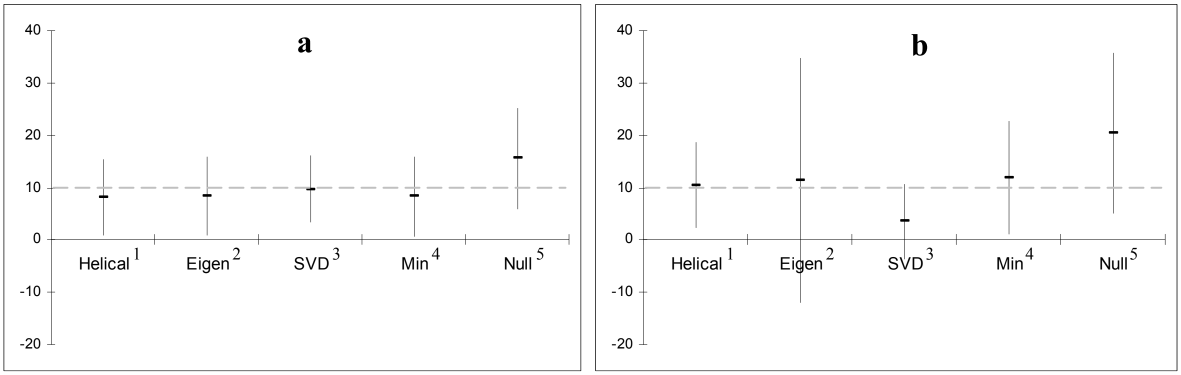

Figure 1. AVG ± SD of functional knee axis orientation (degrees) relative to tibial torsion: a) unweighted and b) gait trials (the dashed line represents the average of the knee axis positions from each algorithm in 1a).

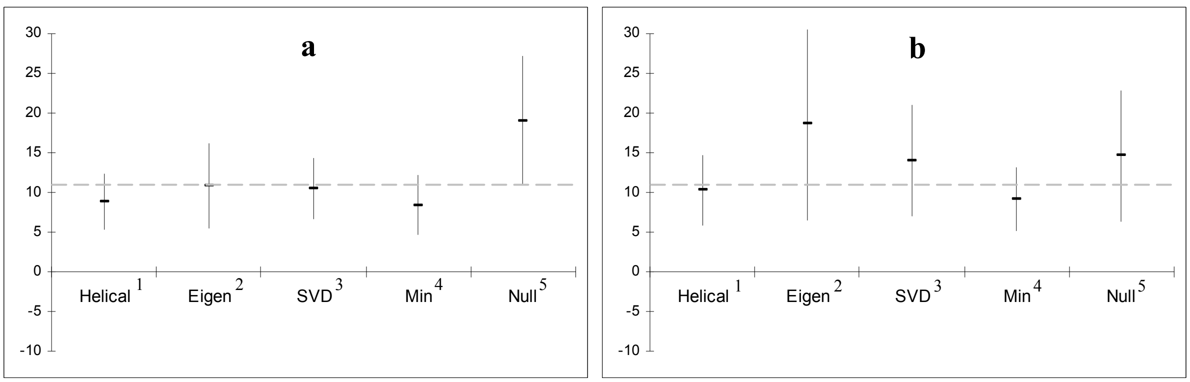

Figure 2. AVG ± SD of knee ab/adduction range (degrees): a) unweighted and b) gait trials (the dashed line represents the average of the knee ab/adduction ranges from each algorithm in 2a).

Discussion

The results of this study demonstrate that the five functional axis algorithms performed comparably in the unweighted condition, even though each algorithm utilizes a different mathematical approach to solve the problem. If a clinician were committed to having patients perform unweighted trials prior to each data collection, there would be little advantage to selecting one algorithm over another. If we accept the assumption that the algorithms provide appropriate estimates of the true knee axis position in the unweighted trials, we would expect a more robust algorithm to provide similar results during a condition that provides less knee flexion/extension (i.e. 60° vs. 90°). Likewise, the algorithm would be expected to provide similar knee ab/adduction range values. Our results suggest that the helical axis and ab/adduction minimization algorithms are two methods that provide both comparable knee axis positions and knee ab/adduction ranges between each of the two movement conditions.

References

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