COMPARISON OF TIBIAL TORSION MEASUREMENTS USING MOTION CAPTURE, PHYSICAL THERAPY EVALUATION, AND COMPUTED TOMOGRAPHY

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INTRODUCTION

Abnormal tibial torsion is a common problem that may significantly impact muscle lever arms and force production in children with conditions such as cerebral palsy and spina bifida. While there are many existing methods to measure tibial torsion, computed tomography (CT) has become the accepted standard; however, it is costly and requires a CT scan [1]. More practical methods using various clinical techniques have also been used, but accuracy of these clinical measures has been questioned. The purpose of this study was to compare three methods of measuring tibial torsion: an imaging method using CT (gold standard), a clinical method, and a computational method using motion capture technology.

METHODS

10 healthy children (5 males, 5 females, age 11.6 ± 3.3 yrs) underwent three different measures of tibial torsion bilaterally, using CT, physical therapy evaluation (PT), and motion capture. To measure tibial torsion from axial CT images, the angle was measured between a posterior femoral axis at the proximal end of the tibia and a bimalleolar axis at the distal tibia. The posterior femoral axis was drawn tangent to the posterior condyles, just above the knee. The bimalleolar axis was drawn bisecting the medial and lateral malleoli, just above the ankle (Figure 1).

For the motion capture measurements, markers were placed on 4 anatomical landmarks: the medial and lateral knee corresponding to the knee flexion axis, and the medial and lateral malleoli at points corresponding to the transmalleolar axis. Marker positions were recorded during standing using a 3-D motion capture system (Vicon Motion Systems, Oxford, UK), and Vicon Workstation software was used to calculate the angular offset between the two axes defined by the knee and ankle markers.

Measurements were compared using correlation coefficients and Bland-Altman plots of the difference between measurements [2].

RESULTS AND DISCUSSION

The coefficient of variation (CV) was used to evaluate the repeatability of the CT measures. Average CV was 6.4±1.6%. To reduce variability, 2 individuals made 3 measurements each and the results were averaged for the subsequent analyses.

All three measurements were moderately correlated (Table 1). The Vicon measurements had a higher correlation with CT than the PT measurements.

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<th>PT</th>
<th>Vicon</th>
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<tbody>
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<tr>
<td>Vicon</td>
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Table 1. Correlation coefficients comparing the 3 methods of measurement.
To evaluate agreement between measurements, the difference was plotted against the mean. Threshold lines indicate the mean difference and two standard deviations above and below the mean. By plotting the difference against the mean, offsets between measurements become evident. The PT and Vicon measurements had little offset between them (mean difference 2.0°) whereas they both had an offset of approximately 20° with the CT measurements (mean difference 22.4° for PT and 20.4° for Vicon) (Figure 2).

CONCLUSIONS

The three methods of measuring tibial torsion were moderately correlated; however, there was a 20° offset between the clinical and CT measurements. This discrepancy is consistent with past research [3]. Both the PT and Vicon measures used the same landmark identification and were intended to locate the same axes identified on the CT images. However, the 20° offset suggests that clinical evaluation identifies different axes than those defined based on anatomy. When using clinical methods to measure tibial torsion, this 20° offset may need to be considered in the final outcome.

Compared with CT measures, Vicon had a slightly higher correlation and lower offset than PT measures, suggesting that Vicon may be a better method than PT. The Vicon system calculates the angle between the knee and ankle axes, while the PT method requires the extra step of visually assessing this angle. Also, both the CT and Vicon measures were done with the knee extended, while the PT measurement was done with the knee flexed. The differences between PT and Vicon in this study were small, and repeatability of the measures was not investigated. More research is needed to determine if one of the clinical methods should be recommended over the other.

REFERENCES


ACKNOWLEDGEMENTS

Support provided by NIH-NICHD Grant# 5R01HD059826