COMPARISON OF ARTHROMETER (PASSIVE) AND FUNCTIONAL ACTIVITY (ACTIVE) ANTERIOR TIBIAL DISPLACEMENTS

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INTRODUCTION

KT-1000 and KT-2000 arthrometers commonly are used as diagnostic aids by clinicians to passively detect excessive amounts of anterior tibial displacement (ATD) associated with disruption of the anterior cruciate ligament (ACL) as well as during reconstructive surgery and subsequent rehabilitation as a means to determine levels of restored and maintained ACL integrity [1]. However, these devices assess only passive ATD during non-weight-bearing. Because many daily functional activities involve active movement on weight-bearing limbs, it is important to know whether the passive ATD measures imply anything about ACL integrity during actively performed non-weight-bearing (NWB) as well as weight-bearing (WB) functional activities. The purposes of this presentation are to examine whether: 1) there is concurrent validity of passive KT-1000 and active movement, functional activity ATD measurements; 2) joint surface kinematics of ATD, % rolling, and % gliding differ between a NWB and WB activity; and 3) tibiofemoral % rolling and % gliding reflect ATD during the active movement functional activities.

METHODS

Data were collected on 12 subjects (3 males and 9 females, mean age 24.8±2.1 yrs, mean weight 138.4±22.6 lbs.) and a history of no injury to the test knee within the last 5 years.

Passive anterior tibial displacement was measured at maximum manual force using a KT-1000 arthrometer. The measurements were obtained between 25°-30° knee flexion based on patient size and comfort, and according to manufacturer guidelines. Active movement ATD, % rolling, and % gliding measurements were obtained by inputting 3-D videographic motion analysis kinematic data into a computational geometric knee model [2] for a sitting knee extension (NWB) and a sit-to-stand (WB) activity. Based on the model, a slip ratio [3] was computed from which percent rolling and gliding were calculated. Using femoral arc length and tibial contact point displacement components of the slip ratio, active movement ATD measures were obtained. All knee arthrometer and active movement knee model data were averaged over three trials at respective subject-specific, knee arthrometer test angles.

Analysis: A Pearson correlation between knee arthrometer passive and knee model active movement ATD of the NWB and WB activities was used to establish concurrent validity. ANOVA was performed to determine whether meaningful differences occurred between the NWB and WB activities for ATD, % rolling, and % gliding. A multiple regression was used to identify whether tibiofemoral % rolling and/or % gliding reflect active movement ATD during NWB and WB activities.

RESULTS AND DISCUSSION

The mean passive ATD was 6 times greater than the active movement ATD of the NWB and WB activities whereas ATD for the NWB and WB activities were similar (Table 1). Pearson r-values ($r = 0.572$; $r = 0.488$) strongly support no concurrent validity between the passive and active measures of ATD suggesting they measure different aspects of ATD. High correlation values ($r = 0.978$ to 0.993) between active ATD and % rolling and % gliding demonstrate a strong association of ATD to rolling and gliding (Table 2). The lower value of active ATD for NWB likely reflects stabilizing effects of muscle activity while the lower ATD for WB likely reflects the role of both muscle activity and joint compression effects that minimize ATD, while enhancing joint stability. Conversely, the greater passive ATD may indicate tibiofemoral stability without constraints of muscle activity and joint surface compression.

Table 1. Mean Passive and Active ATD Values

Passive ATD (mm)	NWB ATD (mm)	WB ATD (mm)
8.94 ± 1.80	1.56 ± 0.05	1.37 ± 0.07

Table 2. Multiple Correlation of Functional Activity (Passive) ATD with Percent Rolling and Gliding

	NWB ATD	WB ATD
% Rolling	-0.993	-0.978
% Gliding	0.993	0.978

CONCLUSIONS

We analyzed both passive NWB and active NWB and WB measures of anterior tibial displacement in healthy knees. A similar analysis is planned for ACL deficient knees. We believe our preliminary results provide a foundation for further investigation. Substantiating a combined use of passive and active ATD measures may help differentiate whether impairments of appropriate muscle activity patterns and/or joint surface alignment contribute to abnormal joint surface kinematics with ACL disruption.

REFERENCES

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