ELBOW JOINT INSTABILITY QUANTIFIED WITH SCREW DISPLACEMENT AXES

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INTRODUCTION:
Screw displacement axes (SDA's) have typically been employed to define the axis or axes of rotation of the elbow for proper positioning and design of endoprostheses [1]. However, the application of SDA's to quantify elbow instability has not apparently been reported. The purpose of this study was to determine the efficacy of SDA's to describe elbow instability during flexion using an in-vitro model. Transection of the medial collateral ligament (MCL) and lateral collateral ligament (LCL) complexes was employed as a model of elbow instability.

METHODS:
Eighteen human cadaveric elbows (75.6±11.9years) were clamped at mid-humerus with the arm in the dependent orientation into a custom testing apparatus. Passive flexion was conducted manually by an investigator, while holding the forearm in pronation or supination. Testing was performed on the intact forearm, followed by sectioning of either the MCL (n=10) or LCL (n=8) complexes. Testing was then repeated during simulated active motion, using a simulator [2,3]. Motion was recorded using an electromagnetic tracking device (Ascension Technology, Burlington, VT). Prior to SDA calculation, data was filtered using a double low-pass Butterworth filter. SDA's were calculated at 5° intervals for 20-120° of flexion. SDA deviation, defined as the standard deviation in orientation of all SDA's determined throughout elbow flexion in the frontal plane, was implemented to describe changes in stability. Statistical comparison was performed using ANOVAs and SNK post-hoc test (significance at 0.05).

RESULTS:
Figure 1 shows SDA's generated throughout elbow flexion for a single specimen, in the intact and MCL deficient states. Division of either the MCL or LCL caused SDA's to diverge from their mean, as indicated by an increase in deviation values compared to the intact state ($p<0.05$). After MCL transection, instability was greater with the forearm maintained in pronation compared to supination ($p=0.03$). After LCL resection, greater instability was observed with the forearm held supinated rather than pronated ($p=0.02$). Active testing produced similar findings, although the SDA variability was reduced.

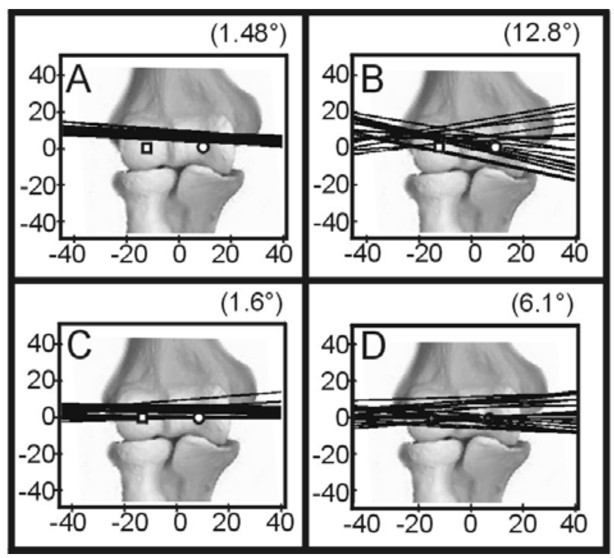

Figure 1: SDA's determined for passive flexion, with the forearm maintained in pronation and supination, are plotted for a single specimen in the intact and MCL deficient states. (A) and (B) represent passive pronated flexion for the intact and MCL deficient elbow, respectively. (C) and (D) represent passive supinated flexion for the intact and MCL deficient elbow, respectively. The square and circle represent the geometric centres of the capitellum and trochlea, respectively. Axes are in mm. Angular SDA deviation values for this specimen are included with each plot (in parentheses).

DISCUSSION AND CONLUSIONS:

Implementation of SDA's to detect changes in elbow stability agree with results from previous studies, which have quantified kinematic changes employing Euler analyses, measured changes in joint space, or determined changes in load-displacement characteristics after ligament sectioning. SDA results also agree with previous studies that have demonstrated an effect of forearm rotation on stability. In summary, implementation of SDA's appears to be a useful method for detecting changes in stability during elbow flexion.

REFERENCES:

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