

Evaluation of Linking Mechanism in Convertible (Linked/Unlinked) Total Elbow Arthroplasty: A biomechanical cadaveric study

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INTRODUCTION: Total elbow arthroplasty (TEA) has a higher failure rate than other joint replacements, commonly due to postoperative aseptic loosening from varus torque stresses. A convertible TEA system can be useful because surgeons can use it in either linked or unlinked configurations intraoperatively. However, almost all of surgeons tend not to repair the collateral ligaments during linked TEA surgeries. Our aim is to investigate the stability contribution of the linking mechanism of linked TEA after repairing collateral ligaments.

METHODS: Five cadaveric elbows underwent convertible TEA system with modified van Gorder approach. Both medial and lateral collateral ligaments were released from the distal part of the elbows and repaired by making bony holes to the ulna with non-absorbable sutures. A superposition protocol measured varus stability across flexion (20°–130°) in linked and unlinked configurations. Each specimen was tested using a 6-degrees of freedom robotic simulator with physiologic muscle loading. Stability contribution of the linking mechanism was quantified by comparing joint varus torque between all phases. Statistical parametric mapping (SPM) was used to identify significant differences across the continuous flexion arcs.

RESULTS: The mean contribution of the linking mechanism to varus stability shifted from 40% at 20° of flexion to 24% at 130° of flexion (Dark blue line in Fig 1), peaking with 46% at 46° (Black solid arrow in Fig 1). The stability contribution of the linking mechanism was statistically significant at $P < 0.05$ from 23° to 105° (between red dotted line in Fig 1). From the above, 24-46% of varus torque loads were absorbed by the linking mechanism depending on the flexion angle of the elbow. In other words, this result showed that 54-76% of the varus torque loading was supported by the soft tissues; collateral ligaments (static stabilizer) and muscles (dynamic stabilizer).

DISCUSSION AND CONCLUSION: Even with ligament repair, the linking mechanism of TEA contributes significantly to varus stability. However, it was found that more than half of the varus loading was absorbed by the soft tissues. These results suggest that the risk of postoperative loosening of TEA may be reduced by reconstructing both collateral ligaments, not only in unlinked TEA but also in linked TEA.

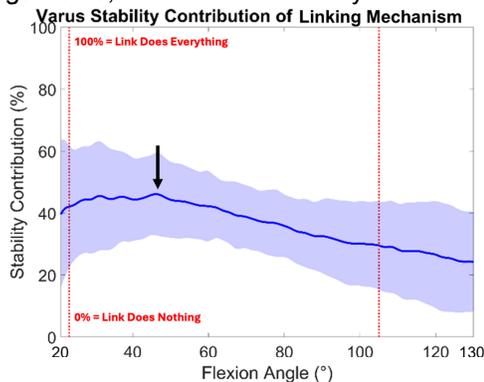


Figure 1. Stability contribution of the linking mechanism calculated by varus torque comparison between linked and unlinked total elbow arthroplasty over flexion range of motion.

In stability contribution, 0% indicated no contribution, *i.e.* linked behavior = unlinked behavior. Dark blue line: mean value, Lighter blue band: standard deviation. Between two red dotted line: The range of significant difference in stability contribution, Black solid arrow: The peak of stability contribution.