# A Double Cortical Button Technique Yields Similar Biomechanics as the Traditional Docking Technique for Ulnar Collateral Ligament Reconstruction

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## Introduction

Ulnar collateral ligament (UCL) ruptures are debilitating injuries primarily incurred by high-level throwing athletes. The docking technique is widely used for UCL reconstruction due to its high failure torque and reliable clinical outcomes[1] This approach uses an autograft palmaris longus tendon, which is looped through bone tunnels and held in place with sutures on the humerus (Figure 1A). Failure of the docking technique is often attributed to bone tunnel failure. Recently, a double cortical button technique has been described, in which the graft is fixated using cortical buttons (Figure 1B). Advantages of this approach include greater control in graft tensioning and elimination of bone tunnel failure. Currently, it is unclear whether a double button reconstruction provides the same repair strength as the docking procedure. The goal of this study was to compare the biomechanics of docking and double button UCL techniques using cadaveric specimens. We hypothesized that there would be no difference in post-operative joint stiffness and reconstruction strength between the two techniques.

## Methods

This study was performed on eight matched pairs of cadaveric arm specimens (7M, 1F, 74-87 years of age) randomized into docking and double button groups. Palmaris longus tendons were harvested when present; a sectioned portion of flexor carpi radialis was used when palmaris longus was absent. To model a pitching motion in the cocked position, humeri and forearm bones were secured to a test frame with the elbow flexed 90°, the forearm in neutral position, and a valgus torque applied to the humerus (Figure 2). 3D marker clusters were attached to bones to facilitate the measurement of strain between graft insertion points during testing. Similar to previous studies, controlled valgus rotations were applied to the humerus to develop a reaction moment at the elbow joint[2-4]. Specimens underwent a 4-step non-destructive protocol (Intact, Injured, Initial Repair, 1000 cycles) followed by a destructive ramp to failure test. The stiffness in the toe region and elastic region of torque-rotation curves were calculated. Additionally, maximum torque, and insertion point strain were calculated for all tests. Paired t-tests were used to compare longitudinal measures within the same specimen, and two sample t-tests were performed to determine differences ($p < 0.05$) between the docking and double button groups.

## Results

The docking and double button reconstruction techniques provided similar values for torsional stiffnesses in the toe and elastic regions (Fig 3A&B), percent torque recovered (Figure 3C), and graft insertion point strain (Fig 3D) immediately after surgery (10 cycles) and after cyclic loading (1000 cycles). Reconstructed elbows displayed similar restoration of toe and elastic stiffness ($p = 0.483$, $p = 0.754$), regardless of technique used. Both groups had similar decreases in these measures after cyclic loading. Similarly, the docking and double button groups recovered 68.91% and 65.08% of their resistive torque ($p = 0.777$), which also decreased after cyclic loading ($p = 0.918$). Insertion point strain was also similar between groups during the 10-cycle ($p = 0.645$) and 1000-cycle ($p = 0.921$) tests. Ramp to failure testing showed no significant differences in ultimate torque for the docking

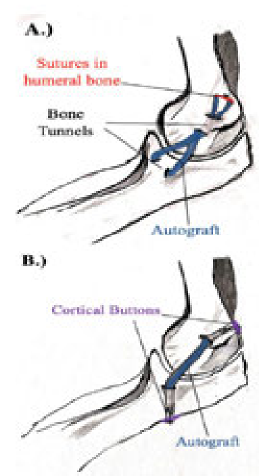


**Figure 1.** Illustrations of the **(A)** docking; **(B)** double button reconstructions used to restore UCL function.

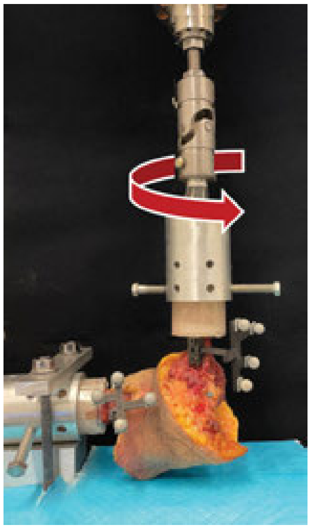

**Figure 2.** Photograph of an elbow during mechanical testing. A valgus humeral torque (red arrow) applies stress to the medial elbow.

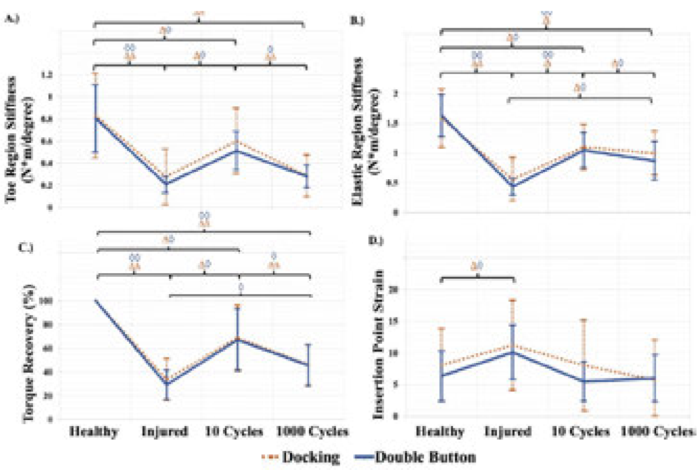


**Figure 3**. Graphs of **(A)** toe region stiffness; **(B)** elastic region stiffness; **(C)** percent torque recovered; **(D)** insertion point strain. Δ and ◇ symbols indicate $p < 0.05$ for measures within docking and double button groups, respectively. ΔΔ and ◇◇ indicate significant differences of $P < 0.001$.

(8.93 ± 3.9 Nm) and double button (9.56 ± 3.5 Nm) groups (p = 0.739).

## Discussion

Results of this study confirmed our hypothesis, that the double button technique provides elbow biomechanics that are comparable to the docking technique. This experiment indicates that both reconstruction techniques restore a degree of joint function, but pre-injury joint stiffness is not recapitulated with either surgical repair. It is unclear if additional graft tensioning during the reconstruction would provide improved post-operative biomechanics. The loss of stiffness and strength during cyclic testing may not be indicative of clinical experience, as patients are asked to wear a sling and guard the joint to allow for healing. Finally, it should be noted that this model only simulated one motion and the advanced age of the donors in this study is not indicative of the younger patient population that typically suffers this injury.

## Significance/Clinical Relevance

The results of this study support the hypothesis that the double button technique for UCL reconstruction is non-inferior to the docking technique. This data also suggests that while both reconstruction techniques restore joint stability, neither can fully restore pre-injury joint stiffness.

## Acknowledgements

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## References

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