Effectiveness of Internal Fixation of Type 2 Coronoid Fractures on Elbow Kinematics and Stability with and without Collateral Ligament Repair

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Introduction: Previous biomechanical studies have demonstrated a significant destabilizing effect of Type 2 coronoid fractures on the stability of the elbow(1-2). While open reduction and internal fixation (ORIF) of Type 2 coronoid fractures is recommended, the effectiveness has not been confirmed biomechanically. Also, the importance of concomitant collateral ligament repair in the setting of these fractures has not been established. The purpose of this study was to determine whether elbow stability and kinematics could be restored with ORIF of Type 2 coronoid fractures and to evaluate the role of collateral ligament repair.

Materials and Methods: Varus passive elbow motion and simulated active and passive dependent motion was performed on six cadaveric arms. An in-vitro elbow motion simulator, was used to simulate active elbow flexion with the forearm in both supination and pronation. Position of the ulna with respect to the humerus was recorded using an electromagnetic tracking system. The maximum varus and rotational instability were measured in varus and the gravity dependent orientations. The protocol was repeated with the coronoid intact, with 50% of the coronoid removed (Type 2 Fracture), and after ORIF. All coronoid states were tested with the MCL and LCL detached and repaired using a transosseous suture technique.

Results: VARUS: When the forearm was pronated and the LCL was not repaired the arm demonstrated significant varus angular instability irrespective of whether the type II coronoid fracture was fixed (48.5°±2.6) or not fixed (49.9°±3.3) (p<0.005)(Fig. 1-2).

This finding was even more apparent in supination, with varus angular instability measuring 53.6°±4.1 when the coronoid was fixed and 56.1°±3.3 when it was removed (P<0.005)(Fig. 1). In pronation, varus angular stability was similar to the intact elbow when the LCL was repaired and the MCL was not, even if the type 2 coronoid was not fixed (1.1°±2.5, p=0.1) (Fig 1.). However, there was a significant increase in internal rotation (18.2°±6.6) (P<0.005) (Fig. 2). Repair of both the LCL and MCL was necessary to restore both varus (5.9°±1.3, p=0.7) and rotational stability (7.0°±3.0, p=0.8), irrespective of whether the coronoid was fractured or repaired.

Maximum internal rotation of the ulna with respect to the humerus with the arm positioned in varus and the forearm in pronation (P) and supination (S). Varus stability is restored when both the LCL and MCL are repaired and with isolated repair of the LCL irrespective of whether the type II coronoid was fractured (#) or fixed (ORIF). Conditions marked with (*) are significantly different from the intact arm (P<0.05).

In contrast, with the forearm in supination, repair of both collateral ligaments and internal fixation of the coronoid were required for both angular (5.6°±1.4, p=0.6) and rotational (6.3±3.0, p<0.01) stability to be similar to the intact elbow. (Fig. 1-2). DEPENDENT POSITION: The elbow was rotationally unstable if the MCL was not repaired, even with ORIF of the coronoid and repair of the LCL (38.4°±2.4 with passive pronation and 10.4°±3.8 with passive supination, p<0.05). This instability persisted during active flexion with the forearm supinated (8.1°±4.3, p<0.05) but was restored with forearm pronation (6.4°±4.1, p=0.9) Repair of both the LCL and MCL restored passive and active kinematics and stability in the dependent position, whether the coronoid was fractured or repaired. Angular and rotational stability was better during active flexion than passive flexion for all conditions studied.

Discussion: These findings suggest that ORIF of Type 2 coronoid fractures should be performed if possible and accompanied by repair of the MCL and LCL where significant injury to these ligaments is present. In order to achieve both varus and dependent rotational and angular stability, in supination and pronation, it was necessary to repair both collateral ligaments and fix the type 2 fracture. When comminuted type 2 coronoid fractures are not amenable to fixation, initial elbow stability can be achieved with LCL and MCL repair alone if the forearm is maintained in pronation during rehabilitation. However, clinical studies are needed to determine whether collateral ligament repair alone is sufficient to maintain stability over time. When considering rehabilitation following surgical treatment of Type 2 coronoid fractures, this study suggests that active motion in the dependent position with the forearm pronated optimizes elbow stability during healing. Varus positioning of the arm should be avoided in the postoperative period if secure fixation of the LCL, MCL and coronoid has not been achieved.