Biomechanical Evaluation of Coracoid Tunnel Size and Location for Coracoclavicular Ligament Reconstruction

Sean T. Campbell, M.D., Nathanael D. Heckmann, M.D., Sang-Jin Shin, M.D., Ph.D., Lawrence C. Wang, M.P.H., Mallika Tamboli, B.A., Joel Murachovsky, M.D., James E. Tibone, M.D., and Thay Q. Lee, Ph.D.

Purpose: The purpose of this study was to determine the effect of coracoid tunnel size and location on the biomechanical characteristics of cortical button fixation for coracoclavicular ligament reconstruction. **Methods:** Thirteen matched pairs of cadaveric scapulae were used to determine the effects of coracoid tunnel size, and 6 matched pairs were used to determine the effects of coracoid tunnel location. For tunnel size, a 4.5-mm hole was drilled in the base of the coracoid of one scapula and a 6-mm hole was drilled in the contralateral scapula. For tunnel location, 2 holes were drilled: (1) The first group received a hole centered in the coracoid base and a hole 1.5 cm distal from the first, along the axis of the coracoid. (2) The second group received holes that were offset anteromedially from the first set of holes (base eccentric and distal eccentric). A cortical button—suture tape construct was placed through each tunnel, and constructs were then loaded to failure. **Results:** For tunnel size specimens, load at ultimate failure was significantly greater for the 4.5-mm group compared with the 6-mm group (557.6 ± 48.5 N *v* 466.9 ± 42.2 N, $P < .05$). For tunnel location, load at ultimate failure was significantly greater for the centered-distal tunnel group compared with the eccentric-distal group (538.1 ± 70.2 N *v* 381.0 ± 68.6 N, $P < .05$). **Conclusions:** A 4.5-mm tunnel in the coracoid provided greater strength for cortical button fixation than a 6-mm tunnel. In the distal coracoid, centered tunnels provided greater strength than eccentric tunnels. **Clinical Relevance:** When performing cortical button fixation at the coracoid process for coracoclavicular ligament reconstruction, a 4.5-mm tunnel provides greater fixation strength than a 6-mm tunnel. The base of the coracoid is more forgiving than the distal coracoid regarding location.

Injuries to the acromioclavicular joint are common among athletes and often occur as a result of a direct blow to the acromion with the upper extremity adducted.[1-6] A wide variety of surgical techniques has been described, with many focusing on reconstruction of the injured coracoclavicular (CC) ligaments.[7-14] These CC reconstruction techniques often call for a tunnel drilled in the coracoid process to allow for fixation using a cortical button device.

Recent clinical studies have reported complication rates with CC reconstruction techniques as high as 23% to 80%.[15-17] CC ligament reconstruction with a coracoid tunnel technique presents visualization challenges and has been reported to have a steep learning curve. Therefore it is no surprise that coracoid fracture is one of the iatrogenic complications arising from drilling in the coracoid.[16] However, there have been relatively few studies attempting to identify the ideal tunnel location and size for cortical button fixation in the coracoid. One biomechanical study showed that smaller tunnels were superior to larger tunnels, but much of the work was performed in synthetic bone models.[18] Other work has shown through computer simulation that drilling at the base of the coracoid may reduce the risk of

From the Orthopaedic Biomechanics Laboratory, VA Healthcare System (S.T.C., N.D.H., S.-J.S., L.C.W., M.T., T.Q.L.), Long Beach; Department of Orthopaedic Surgery, University of Southern California (N.D.H.), Los Angeles; Department of Orthopaedic Surgery, University of California, Irvine (J.E.T., T.Q.L.), Irvine, California, U.S.A; and Department of Orthopaedics and Traumatology, Faculdade de Medicina do ABC (J.M.), Santo André, Sao Paulo, Brazil.

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Address correspondence to Thay Q. Lee, Ph.D., Orthopaedic Biomechanics Laboratory, VA Long Beach Healthcare System (09/151), 5901 E 7th St, Long Beach, CA 90822, U.S.A. E-mail: tqlee@med.va.gov

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Fig 1. A 4.5-mm tunnel in the base of the coracoid process used for tunnel-size testing.

intraoperative coracoid fracture, but did not comment on the relation between tunnel location and postoperative fracture or coracoid strength.[19]

To our knowledge, there have been no comprehensive biomechanical studies evaluating the effect of coracoid tunnel size and location for cortical button fixation in CC ligament reconstruction. Therefore the purpose of this study was to determine the effect of coracoid tunnel size and location on the biomechanical characteristics of cortical button fixation for CC ligament reconstruction. We hypothesized that tunnels of smaller size, centered in the coracoid, will result in greater fixation strength for cortical button fixation.

Methods

Nineteen matched pairs of fresh-frozen cadaveric shoulders were used. Thirteen matched pairs (mean age, 64.5 years; range, 45 to 79 years; 10 male and 3 female specimens) were used to determine the effects of tunnel size, and 6 matched pairs (mean age, 62.3 years; range, 43 to 73 years; 5 male and 1 female specimen) were used to determine the effects of tunnel location. Specimens were thawed and dissected free of all soft tissues while observing of the bony anatomy of the scapula, and were kept moist with 0.9% saline solution throughout testing.

Effects of Coracoid Tunnel Size for Cortical Button Fixation

One shoulder from each of the 13 matched pairs was randomly assigned to the 4.5-mm small-tunnel group, whereas the contralateral shoulder was assigned to the 6-mm large-tunnel group. The middle of the base of the coracoid was identified by measuring the medial-lateral length of the superior aspect of the base with digital calipers and determining the midpoint, which was used as the landmark for tunnel placement. Tunnels were drilled with an acromioclavicular TightRope drill guide (Arthrex, Naples, FL) and cannulated drill (either 4.5 mm or 6 mm as described earlier) and subsequently cleared of excess soft tissue (Fig 1).

Effects of Coracoid Tunnel Location for Cortical Button Fixation

One shoulder from each of the 6 matched pairs was randomly assigned to the centered group, and the contralateral shoulder was assigned to the eccentric group. The centered group had 4.5-mm tunnels drilled at 2 locations: one at the bisected width of the base (base-centered [BC] tunnel) and the second 1.5 cm distal along the long axis of the coracoid (distal-centered [DC] tunnel). Shoulders in the eccentric group had two 4.5-mm tunnels drilled at the same distances along the coracoid axis, but both holes were offset anteromedially a maximum of 5 mm or enough to preserve a 2-mm cortical side wall (base-eccentric [BE] tunnel or distal-eccentric [DE] tunnel). Anteromedial placement was chosen over anterolateral placement because it was thought to be a closer anatomic match for the native CC ligament insertion site in tunnels at the coracoid base.[20] Tunnels were created using the drill and guide described earlier (Fig 2).

Biomechanical Testing

For all specimens, the pre-threaded polyester fibers were removed from a 12.2- × 4-mm continuous-loop EndoButton cortical button (Smith & Nephew, Memphis, TN). FiberTape suture tape (Arthrex) was passed through the 4 holes of the cortical button such that the 2 limbs of the suture tape passed upward through the outermost holes. The cortical button—suture tape

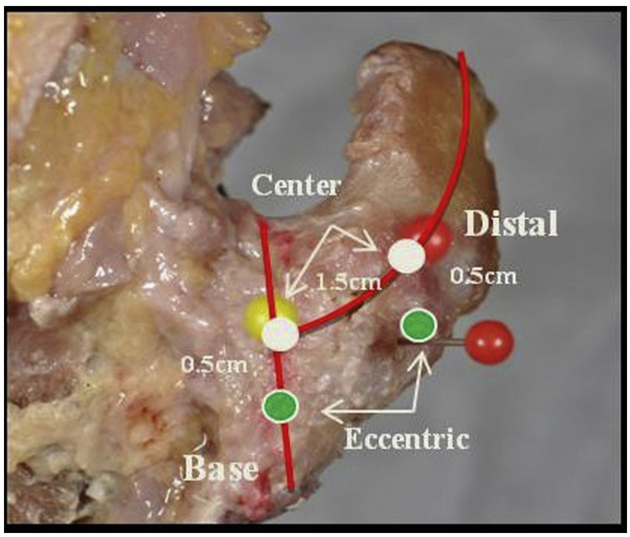

Fig 2. Placement of coracoid tunnels for location testing. The white dots represent the locations of the base-centered and distal-centered tunnels; the green dots represent the locations of the base-eccentric and distal-eccentric tunnels.