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The Effect of Repair of the Lacertus Fibrosus on Distal Biceps Tendon Repairs

A Biomechanical, Functional, and Anatomic Study

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Background: To date, repair of the lacertus in distal biceps tendon ruptures, recommended by some, has not been evaluated. The goal of these biomechanical experiments was to evaluate the degree to which its repair increases the strength of a distal biceps tendon repair.

Hypothesis: An intact or repaired lacertus fibrosus will increase the strength of a distal biceps tendon repair.

Study Design: Controlled laboratory study.

Methods: Four matched pairs of fresh-frozen human cadaveric upper extremities were prepared by isolating the lacertus fibrosus and the distal biceps tendon. The extremity was placed in a custom-built rig with the distal biceps brachii clamped and affixed to a stepper motor assembly. The distal biceps tendon was sharply removed directly from the radial tuberosity and repaired through a bony tunnel in all specimens. One side of each pair was randomized to also receive repair of the lacertus. The specimens were pulled at a constant rate until failure.

Results: The mean failure strength, defined as maximal strength to 15 mm of displacement, was higher in specimens with a repaired lacertus (250.2 N vs 158.2 N; $P = .012$), as was mean maximum strength (256.8 N v. 164.5 N; $P = .0058$). Mean stiffness was not significantly different (16.36 N/mm vs 13.8 N/mm; $P = .58$). All specimens failed due to fracture at the bony bridge.

Conclusion: Repair of the lacertus strengthened distal biceps tendon repair in a controlled laboratory setting.

Clinical Relevance: Repair of the lacertus fibrosus as an adjunct to distal biceps tendon repair strengthens the repair in the laboratory setting. Clinical testing is needed to verify that this increased strength improves clinical results. Surgeons should be cautioned to protect the underlying neurovascular structures during repair of the lacertus fibrosus and to avoid an overly tight repair.

Keywords: lacertus fibrosus; biceps tendon repair; bicipital aponeurosis; biomechanics; failure strength

Tears of the distal biceps tendon most commonly occur with a flexed elbow subjected to sudden eccentric load, usually in males aged 40 to 60 years. Nonoperative treatment results in weakness of both forearm supination and elbow flexion, and surgical management has been established as a superior treatment.[1,25]

During distal biceps tendon repair, the lacertus fibrosus, also called the bicipital aponeurosis, is usually found to be torn.[7] Some have described the lacertus simply as a fascial cover of the underlying neurovasculature and recommend its excision or use as reinforcing material.[19] Others have hypothesized that the lacertus contributes significantly to elbow flexion.[7] Support for this idea is found in a report of a patient with weakness in elbow flexion who was found intraoperatively to have a torn lacertus and an intact distal biceps tendon.[22] Therefore, some have suggested that there are potential benefits to the concomitant repair of the lacertus during repair of the radial biceps tendon,[7,9,22] although no study to date has evaluated this method. Because repair might risk injury to the underlying neurovasculature, it should be undertaken only if there is a proven benefit to doing so. We found evidence in support of repairing the lacertus by demonstrating that the lacertus is a tendinous structure that distributes some of the force of the biceps brachii away from the radial head. We therefore sought in this study to evaluate, in a controlled

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laboratory setting, whether repairing the lacertus significantly strengthens repair of the distal biceps tendon.

METHODS

Four pairs of fresh-frozen human cadaveric upper extremities were used for this study. Each arm was thawed, dissected, affixed to a custom-built rig, tested, and digitized. Each arm was removed from the rig and the biceps tendon sharply elevated directly off the radial tuberosity, creating a defect in the location consistent with the typical method of clinical avulsion.[19] The lacertus was lacerated midway between its origin from the biceps brachii and its insertion into the flexor-pronator group, perpendicular to its fibers.

The radial biceps tendon was repaired in all specimens according to the technique of Boyd and Anderson.[5] A No. 5 Ethibond suture (Ethicon Inc, Johnson & Johnson, Somerville, New Jersey) was placed in the distal biceps tendon in a whipstitch suture pattern, placing 5 throws on each side of the distal 2.5 cm of the tendon. With use of a bur, a bony trough 7 mm in length and 3 mm in width was made in the radial tuberosity. Two 2.7-mm drill holes were placed 1 cm from the center of the lateral edge of the bony tunnel as well as 1 cm away from one another (forming an equilateral triangle). Digital calipers were used to ensure consistent spacing of the drill holes with respect to the bony tunnel and measurements were confirmed, after conclusion of the experiment, to be accurate within 1 mm in all cases. The tendon was brought into the bony trough and the 2 ends of the suture tied over the bony bridge. One side of each pair was randomized to receive repair of the lacertus in addition to repair of the distal biceps tendon. When the lacertus was repaired, No. 2 Ethibond sutures were placed in a simple interrupted fashion 5 mm apart over the length of the lacertus to reapproximate the tendon at its resting length.

Finally, for load-to-failure testing, the motor was run at a constant rate of 1 mm/sec until complete failure of the repair. Output from the strain gauge and motor were recorded simultaneously in real time and imported into a spreadsheet for analysis. All tests were video-recorded for later review. Stiffness, defined as the slope of the force-displacement curve in the linear region after the toe region of the graph, was calculated (Figure 1). Load to failure, defined as the maximal strength noted before 15 mm of displacement by the motor, was recorded.

The data were incorporated into a spreadsheet and paired Student t tests used to compare specimens before and after repair of the lacertus.

RESULTS

The mean age of the donors (3 men and 1 woman) from whom the specimens were retrieved was 76.5 years (range, 64-83 years). The cause of death was coronary artery disease in 2, lung cancer in 1, and congestive heart failure in 1.

The strength of repair is shown in Figure 2. The mean maximum strength was significantly higher in elbows with a repaired lacertus (256.8 ± 75.7 N) than in patients with

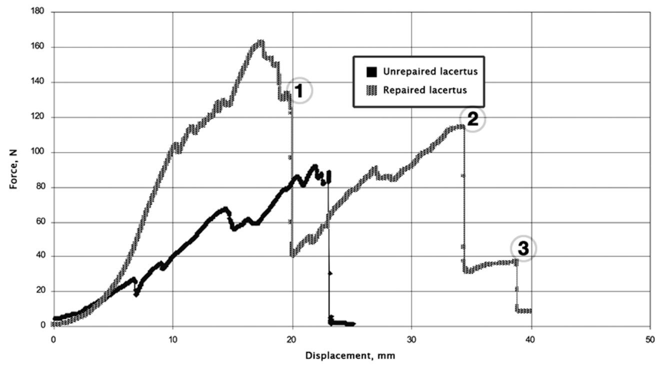

Figure 1. Load to failure of one of the matched pair of specimens, which was typical of all specimens. In the repaired lacertus, after initial failure at point 1 (failure of the distal biceps tendon by bone tunnel breakage in all cases), the force continued to rise and fall as the sutures sequentially tore (points 2 and 3).

an unrepaired lacertus (164.5 ± 64.6 N; P = .0058). The mean failure strength was also significantly higher in specimens with a repaired lacertus (250.2 ± 75.7 N) than in patients with an unrepaired lacertus (158.2 ± 75.0 N; P = .012). All failures occurred via fracture of the bony bridge. Review of the video recording also revealed that there was minimal separation of the tendon from the bony canal in all cases before failure. The sutures were noted to sequentially tear from the lacertus after failure of the bony bridge over a large distance.

Mean stiffness was higher in the group with the repaired lacertus (16.36 ± 8.13 N/mm) than in the group with the unrepaired lacertus (13.8 ± 4.9 N/mm), but this difference was not significant (P = .58) (Figure 3).

DISCUSSION

There is no consensus as to whether a torn lacertus should be repaired during the repair of a distal biceps tendon rupture. In 1953, Congdon and Fish[7] concluded that repair "is justified by the fact that the aponeurosis has considerable effectiveness in forearm flexion." Repair has been advocated or described by other authors as well.[9,22] Despite numerous studies evaluating the strength of various methods of distal biceps tendon repair,[10,11,13-16,20,24] to date there has been no study of concomitant repair of the lacertus fibrosus.

Whether the lacertus plays a significant role in elbow biomechanics is important in deciding whether to repair this structure when torn. We believe that the lacertus diverts force away from the radial biceps tendon, supporting a functional role of the lacertus in elbow flexion. The functional role of the lacertus is at times clinically apparent as well. Le Huec et al[17] found in their series of patients with distal biceps tendon avulsions that all those with retraction of >8 cm of the biceps brachii muscle had a ruptured lacertus, causing a more obvious clinical deformity. Nielsen[22] reported the only case, to our knowledge, of a torn lacertus with an intact distal biceps tendon. The

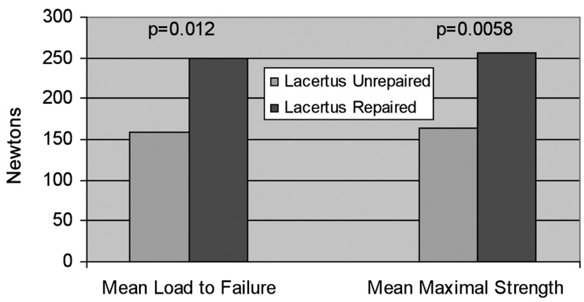

Figure 2. Mean load to failure and mean maximum strength of unrepaired and repaired lacertus.

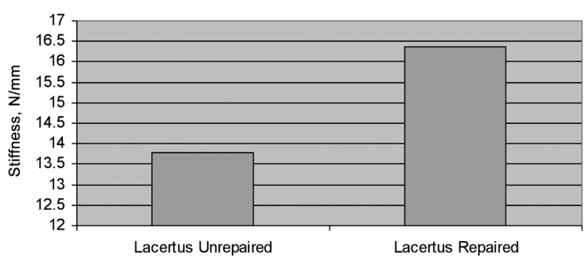

Figure 3. Mean stiffness of unrepaired and repaired lacertus fibrosus.

patient demonstrated significant weakness in elbow flexion, which improved after repair of the lacertus.

In this study, repair of the lacertus increased mean maximum strength and mean failure strength by 55% to 60%. Based on review of our video recordings, breakage of the bony tunnel was the primary mode of failure in all specimens. At the point of failure of the bony bridge, the lacertus was deformed (stretched) but still had complete contact of the sutured edges. The energy distributed away from the distal biceps tendon into the lacertus, causing its deformation, shielded the distal biceps tendon repair at the bony bridge. After failure of the bony bridge, the lacertus remained at least partially intact for several centimeters more, as the sutures pulled out or tore sequentially (Figure 1). This could potentially benefit a patient even past clinical failure by breakage of the bony bridge, as the biceps brachii muscle may retain some of its strength via its insertion through the lacertus onto the ulna, the deformity would be minimized, the soft tissues would maintain a more normal position, and revision, if needed, would likely be easier and not require as difficult a retrieval of the muscle. Additionally, use of other suture patterns (not evaluated in this study) besides simple interrupted, such as a horizontal mattress, might further augment the strength of the repair.

The increased strength that repair of the lacertus affords is likely of clinical significance. Several studies have documented the long-term loss of strength and range of motion common in traditional repair of the distal biceps tendon,[8,21,23] and immediate passive range of motion has been demonstrated clinically to be beneficial.[6] Therefore, a more aggressive postoperative rehabilitation protocol using active but protected range of motion may improve postoperative outcomes and has been suggested to be safe in a biomechanical study in which Ethibond was used for repair.[4] Our results suggest that repair of the lacertus could help further protect the repair during postoperative therapy, allowing active range of motion in the early postoperative period. Nevertheless, we believe that this should be evaluated further before it can be recommended for general clinical use. Finally, repair of the lacertus may lead to improved cosmetic outcomes by preventing postoperative pitting in the medial aspect of the antecubital fossa.

Clinical repair should be performed with caution. The underlying brachial vessels and median nerve necessitate care in repairing the lacertus to avoid direct damage, such as laceration. Additionally, because the lacertus has rarely been implicated in median nerve compression secondary to a narrowed space beneath the lacertus lacertus,[2,26] a tight repair, in which the width or length of the lacertus has been shortened by overly tightening the sutures used for repair, could mimic this condition and impinge on the underlying structures. This can be avoided by gentle approximation of the torn edges. Eames et al[9] recommended suturing the lacertus in pronation and extension, which could also minimize the risk of impinging on the underlying neurovasculature.

Besides repair through a bony tunnel, which was used in our study, other techniques have been described to repair an avulsed distal biceps tendon. Some have advocated repair of the distal biceps tendon to the brachialis muscle,[12] which could also be combined with repair of the lacertus. Repair of the distal biceps tendon using suture anchors, which would require a lengthened or additional incision to repair the lacertus, has been described with variable results.[3,18,24]

CONCLUSION

Repair of a torn lacertus fibrosus strengthens the repair of distal biceps tendon repair. Therefore, our results suggest that when the lacertus is found torn during treatment for distal biceps tendon avulsion, the edges should be approximated anatomically to strengthen the repair and potentially improve elbow function. Clinical testing is needed to verify that this increased strength improves clinical results. If the repair is undertaken, care should be taken to protect the underlying neurovasculature during repair and to prevent potential postoperative median nerve or brachial artery symptoms caused by overtightening the lacertus.

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