Return of an Intact Hook Test Result

Clinical Assessment of Biceps Tendon Integrity After Surgical Repair

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Background: The hook test is a sensitive and specific tool that has been previously described for diagnosing distal biceps tendon ruptures in an efficient, cost-effective manner. However, its application in postoperative evaluations after surgical repair of distal biceps tendon ruptures is not documented.

Hypothesis/Purpose: We hypothesized that the hook test result returns to normal at some point postoperatively after distal biceps repair. This information could be used in decision making during follow-up examinations with both normal and abnormal findings.

Study Design: Cohort study (diagnosis); Level of evidence, 3.

Methods: We retrospectively reviewed records of distal biceps repair. Between July 1, 2003, and July 1, 2016, a total of 56 patients underwent distal biceps repair and also had clear documentation of the results of the hook test during the postoperative period. Hook test results consisted of “intact,” “abnormal,” or “absent.” The timing of the return to a normal hook test result was recorded.

Results: Overall, 51 of 57 (89%) repairs were documented to have the hook test result return to “intact.” The test result returned to intact by a mean of 10 weeks after surgery (range, 2 weeks to 15 months). The biceps tendon was intact according to the hook test at the 4-month follow-up in 45 of the 51 patients (88%) in whom it ultimately returned. The hook test result was abnormal in 5 repairs in 5 patients with only a short-term follow-up, ranging from 2 to 7 weeks postoperatively. One patient with an abnormal hook test result at 2 weeks postoperatively underwent revision and was confirmed to have a partial tear of the biceps insertion. His hook test result returned to intact 3 months after revision repair.

Conclusion: The hook test result returns to normal in patients who undergo distal biceps repair in the primary and revision settings with adequate follow-up. The vast majority of patients have a normal hook test result by 4 months postoperatively. An abnormal hook test result at 4 months postoperatively may indicate a failed repair and should prompt further investigation.

Keywords: muscle injuries; general sports trauma; anatomy; clinical assessment/grading scales

A distal biceps tendon rupture remains challenging to diagnose, with a delay in diagnosis commonly reported.5-9,13 Our experience indicates that a significant number of distal biceps tendon avulsions were initially missed before referral. A prompt diagnosis is important, as complications after surgical treatment of an acute distal biceps avulsion increase as the time interval between injury and surgery increases.1,7,9,12,14 The diagnosis of a rerupture after surgical repair is even less clear, as little has been written about it. The hook test, developed by the senior author (S.W.O.), is a sensitive and specific tool that can be utilized in the clinical setting to reliably diagnose distal biceps tendon avulsions preoperatively.11 Although history alone may at times strongly suggest the recovery of function, a physical examination of the biceps muscle and tendon is an important factor in postoperative monitoring. Determining the integrity of the biceps tendon becomes important in setting expectations after surgery and evaluating patients with...
prolonged pain or weakness. To date, little is known regarding the utility of the hook test in the postoperative setting. We hypothesized that the hook test result returns to “intact” at some point during the postoperative period after distal biceps repair. Further, we sought to elucidate the timing in which the hook test result returns to baseline, which can provide useful information to guide clinical decision making in follow-up examinations with both normal and abnormal findings.

METHODS

We reviewed a total of 125 distal biceps repairs in 120 consecutive patients who were evaluated and explored surgically by the senior author for a known or possible partial or complete avulsion of the distal biceps tendon from January 1, 1996, to July 1, 2016. An independent reviewer (G.D.P.), not involved in the care of these patients, reviewed the records and operative notes for documentation of the hook test result throughout the perioperative period. The hook test had become a standard component of the senior author’s postoperative physical assessment of biceps repairs by July 1, 2003. Thus, 48 patients who underwent biceps tendon repair before this date were excluded. Sixteen patients undergoing allograft reconstruction were excluded. Eleven patients did not have documentation of the hook test result by the senior author during follow-up examinations; while it is the senior author’s practice to examine all patients at follow-up, documentation is occasionally performed by a resident physician or physician assistant. The remaining 56 patients (57 repairs) were personally examined by the senior author, who also performed the hook test and dictated the clinical note on each patient personally.

Thus, a total of 56 patients undergoing 57 repairs formed the study cohort for this report. Partial, complete, and revision tendon repairs were included. Routine follow-ups were scheduled at approximately 6 weeks, 3 to 4 months, and 1 year, unless there was felt to be a need for closer monitoring. Each patient was placed into a soft dressing and sling postoperatively. These were removed by the patient on postoperative day 3, and elbow motion was initiated. Patients were allowed to progress range of motion as tolerated. Patients were instructed not to lift more than a glass of water or to twist a screwdriver or make a similar motion with force for a period of 6 weeks.

Biceps avulsions were defined as complete if there were no tissues in continuity between the end of the biceps tendon and the radial tuberosity, such that the tendon could be retrieved from the wound without surgical release of tissues. The avulsion or tear was defined as partial if the tendon end was held in proximity to the tuberosity, even if by a few small fibers, such that surgical release was required to retrieve the tendon from the wound or pull it off the tuberosity. All but 1 patient with partial tearing had an abnormal preoperative hook test result. That patient had abundant heterotopic ossification in the antecubital fossa, which prevented preoperative hook testing. Twelve repairs were performed as revision surgery of previous tendon repairs. In the revision cases, the hook test was performed in a blinded fashion. In other words, the findings of the hook test were determined before magnetic resonance imaging (MRI) or before viewing the MRI scans if the patients brought them.

Hook Test

A detailed description of how to perform the hook test has been previously described by the senior author.11 Subsequently, we discovered that it can be performed more reliably with the shoulder abducted 90° and the patient looking at the palm of the hand (Figures 1 and 2). The main advantage is that in the abducted position, looking at the palm of the hand requires the patient to actively supinate to the
limit of supination. This contracts the biceps and relaxes the brachialis. In muscular patients, brachialis contraction with the arm at the side can block the examiner's finger from getting behind the biceps tendon and can therefore cause a false positive (“absent”) result.

Briefly, the patient is asked to raise the arm in front of the face and to “look at your palm” (actively flex the elbow to 90° and supinate the forearm) while sitting or standing and to fully supinate the forearm to its end point. For examining the right elbow, the examiner's right index finger is brought in from the lateral side of the antecubital fossa beneath the lateral edge of the biceps tendon, often to the level of the distal interphalangeal joint, permitting the examiner to pull the elbow downward. (Bottom left) Hook test result of “intact”: With an intact biceps tendon, the examiner’s finger can hook behind the biceps tendon, often to the level of the distal interphalangeal joint, allowing the examiner to pull the arm downward. Importantly, the brachialis tendon will usually feel like a biceps tendon, but it cannot be “hooked.” (Image used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

There are 3 categories into which patients can be grouped based on their hook test result: intact, abnormal, or absent. This represents a change in the conventional terminology originally described in 2007. An intact tendon is a tight cord-like structure, behind which the examiner can “hook” a finger from the lateral side and pull the patient’s arm downward without the patient experiencing pain. The “resisted” hook test is a further modification from our original description of the hook test. It is performed by instructing the patient with “Do not let me move your hand,” then pronating the forearm against the patient’s resistance. The “resisted” hook test is used to diagnose partial tears. If the initial hook test result was “intact,” a resisted hook test result that is painful (abnormal) is indicative of a partial tear. On the other hand, if the initial hook test result was “absent,” a resisted hook test that causes the biceps tendon to stand out and be able to be “hooked” is indicative of a partial tear. In the first instance, the resisted hook test result is considered abnormal and indicative of a partial tear because it is painful; in the second, it is abnormal because the tendon initially appeared to be absent because of either laxity from retraction of a partial tear or because of painful inhibition of biceps contractions due to a partial tear. (Image used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

Figure 2. (Top) The hook test is most reliably performed with the arm positioned in 90° of shoulder elevation, 90° of elbow flexion, and full active supination. Asking the patient to “Look at your palm” requires firm contraction of the biceps muscle while relaxing the underlying brachialis. The examiner’s index finger hooks behind the biceps tendon from the lateral side. (Bottom left) Hook test result of “intact”: With an intact biceps tendon, the examiner’s finger can hook behind the biceps tendon, often to the level of the distal interphalangeal joint, permitting the examiner to pull the elbow downward. (Bottom right) Hook test result of “absent”: With complete detachment of the distal biceps tendon, there is no tendon behind which the examiner can hook the finger to pull the elbow downward. Importantly, the brachialis tendon will usually feel like a biceps tendon, but it cannot be “hooked.” (Image used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

Figure 3. “Resisted” hook test: While the patient is actively supinating the forearm to look at his palm, the examiner instructs him, “Do not let me move your hand,” and then pronates the forearm against the patient’s resistance. This is done to diagnose partial tears. If the initial hook test result was “intact,” a resisted hook test result that is painful (abnormal) is indicative of a partial tear. On the other hand, if the initial hook test result was “absent,” a resisted hook test that causes the biceps tendon to stand out and be able to be “hooked” is indicative of a partial tear. In the first instance, the resisted hook test result is considered abnormal and indicative of a partial tear because it is painful; in the second, it is abnormal because the tendon initially appeared to be absent because of either laxity from retraction of a partial tear or because of painful inhibition of biceps contractions due to a partial tear. (Image used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.)

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after surgery (range, 2 weeks to 15 months). Hook test result returned to intact by a mean of 10 weeks postoperatively for 51 of 57 repairs (50/56 patients). The return of an intact hook test result was clearly documented through a single posterior incision in 4 cases. The return repaired using the 2-incision technique in 17 cases and ranged from 4.5 months to 15 months postoperatively. For a patient had an intact hook test result at their return visit, which had an intact hook test result at that time. One of the 6 repairs returned to intact by 4 months. Therefore, these repairs were deemed to have an insufficient follow-up. Excluding patients with a limited follow-up, all repairs (51/51) ultimately returned to a normal hook test result (100%). Of 51 repairs with an intact hook test result at final follow-up, 45 (88%) returned for an evaluation by 4 months postoperatively, and all had an intact hook test result at that time.

RESULTS

The mean age of the study patients was 50 years (range, 30-79 years). Fifty-five patients were male, and 1 was female. Of the 57 repairs, 21 were for partial biceps tendon avulsions, and 36 were complete. All complete avulsions were repaired through a modified 2-incision technique according to Morrey et al. Partial avulsions were also repaired using the 2-incision technique in 17 cases and through a single posterior incision in 4 cases. The return of an intact hook test result was clearly documented postoperatively for 51 of 57 repairs (50/56 patients). The hook test result returned to intact by a mean of 10 weeks after surgery (range, 2 weeks to 15 months).

Timing of Return to Intact Hook Test Result

Twelve of 56 patients (12 repairs) were examined at 2 to 5 weeks. Of these, 8 (75%) had an intact hook test result. One patient had an absent hook test result at 2 weeks after experiencing a “pop” when stretching his arms overhead and had a complete rerupture of a revision repair. The other 3 patients’ examinations were limited because of peritendinous adhesions and scar formation in the antecubital fossa. Thirty-four of 56 patients (34 repairs) were available for an examination by 5 to 7 weeks. Of these, 28 (82%) had an intact hook test result. Fifty-one of 56 patients (52 repairs) were available for follow-up within 4 months. Of these patients, 45 (88%) had an intact hook test result. An additional 5 patients (5 repairs) did not follow up until after the standard re-examination interval. Each of these patients had an intact hook test result at their return visit, which ranged from 4.5 months to 15 months postoperatively. For a graphical representation of the hook test result returning to intact over time, see Figure 4.

Revision Repair

There were 12 revision repairs performed in 11 patients. Eleven of 12 repairs had the hook test result return to intact. One patient suffered a rerupture of his revision repair after 2 weeks, as mentioned above. He was diagnosed after presenting with an absent hook test result. After a second revision repair, his hook test result returned to intact at the 3-month follow-up. Of the 11 revision repairs in whom the hook test result returned to intact, 6 (55%) did so by 3 months; the remaining 5 repairs returned to intact by 4 months.

In all, 51 of 57 (89%) repairs were documented to have the hook test result return to intact. Three patients had a test result of abnormal at 2 to 3 months, which returned to intact at the 4-month re-examination. One of the 6 repairs without an intact return had an early rerupture at 2 weeks postoperatively. Among the remaining 5 repairs that did not have an intact hook test result documented, only a short-term follow-up was available, ranging from 2 to 7 weeks. Therefore, these repairs were deemed to have an insufficient follow-up. Excluding patients with a limited follow-up, all repairs (51/51) ultimately returned to a normal hook test result (100%). Of 51 repairs with an intact hook test result at final follow-up, 45 (88%) returned for an evaluation by 4 months postoperatively, and all had an intact hook test result at that time.

DISCUSSION

The hook test has been proven to be a useful tool for the prompt, reliable diagnosis of distal biceps tendon avulsions, with a sensitivity and specificity higher than those of MRI. The utility of the hook test in the postoperative setting has not been previously described. This has implications in rehabilitation and patient expectations and is especially important in the patient with prolonged discomfort or delayed or interrupted recovery. Our findings show that the hook test result does in fact return to intact in patients who undergo surgical repair of their biceps tendon. Among patients who returned at the recommended follow-up intervals, the hook test result had returned to intact by 4 months, with the exception of 1 rerupture, which subsequently returned to normal within 3 months of revision repair. There was a small subset of patients (n = 6) included in the final analysis that did not return at the usual 6-week and 3- to 4-month time points but rather at a range of 4 months to 3 years. Thus, it is difficult to say with certainty at what point their hook test result returned to normal. One can reason therefore that with an intact repair, the hook test result should return to normal by 4 months. Additionally, once the hook test result returned to intact, it remained intact in all patients with subsequent follow-up. We believe that an abnormal or absent hook test result after 4 months postoperatively should be cause for concern. Before that time, scar tissue in the antecubital fossa or
surrounding the tendon can limit the examiner’s ability to definitively hook the biceps tendon.

We chose to include partial biceps tendon ruptures in our analysis. This certainly did affect the hook test in the preoperative setting. Returning to a normal result still remains applicable; however, as in all cases of partial ruptures, the biceps tendon was detached from the tuberosity, debrided, and fixed using the same transosseous technique. All partial ruptures included in this series were treated surgically, and thus, it is not known if nonoperatively treated partial ruptures experience a return of a normal hook test result.

The return of a hook test result to intact in revision biceps repairs was no different from primary repairs in this cohort. All but 1 revision repairs had an intact hook test result by the 4-month mark. The 1 patient who did not suffer a partial retear in the revision setting. This was identified by a painful abnormal hook test result 2 weeks after his repair and confirmed with MRI. After the repair of this rupture, he had an intact hook test result at his 3-month follow-up.

This study has several limitations. The retrospective nature of this review resulted in the exclusion of patients who did not have appropriate documentation in the electronic medical record. However, the senior author began to prospectively collect these data early in the series. Additionally, there was a small group that was lost to follow-up. Intact repair at final follow-up was not confirmed with MRI. However, the hook test has previously been described as a reliable surrogate for the evaluation of distal biceps ruptures. Patients in our study primarily underwent a 2-incision transosseous fixation technique. Therefore, our results may not be generalizable to single-incision repairs or repairs using alternative fixation methods such as cortical buttons or suture anchors. This was a single-surgeon study, which may make the results less generalizable, and it highlights the importance of performing the hook test as described. An intact lacertus fibrosus may also confuse the examiner, highlighting the importance of actually “hooking” the tendon rather than simply palpating for a tendon in the antecubital fossa. The contralateral “normal” elbow should always be tested for comparison. Last, only 1 patient had a rerupture in the early postoperative setting, and therefore, conclusions about the interpretation of the hook test in the setting of reruptures may be limited.

The hook test can be a useful tool in the examiner’s armamentarium when assessing for reruptures in a patient with an abnormal hook test result. While this is an uncommon complication of distal biceps repair,2,3 it is important to identify these patients, as this often necessitates reoperations.3 This test is especially useful in assessing the patient with a painful repair. When more common complications have been ruled out (superficial infection, sensory nerve palsy, or heterotopic ossification), an abnormal hook test result at ≥4 months postoperatively should prompt further investigation for a failed repair. Advanced imaging or surgical intervention before 4 months may be warranted in the setting of concerning clinical features such as postoperative trauma or infections. An abnormal hook test result is one that does not meet the criteria for intact or absent. This would include a painful tendon that can be hooked but also a tendon that can only be hooked during the resisted hook test (ie, cannot be hooked with resisted supination of the forearm).

To avoid misunderstandings, the clinician must pay close attention to our definitions. Biceps avulsions were defined as complete if there were no tissues in continuity between the end of the biceps tendon and the radial tuberosity, such that the tendon could be retrieved from the wound without surgical release of tissues. Thus, if any surgical release was required to retrieve the tendon from the wound, we did not consider the avulsion to be complete. Devereaux and ElMaraghy4 reported 100% specificity and sensitivity for the hook test to detect 30 acute biceps avulsions but reported 8 false negatives in 18 chronic avulsions. Unfortunately, they did not use the same definition for complete avulsions as we originally reported. They stated that “the presence of a pseudo-tendon, often seen in chronic presentations, can also provide a ‘hookable’ cord and be mistaken for an intact tendon.” Such a pseudotendon has to be surgically released to retrieve the tendon, and therefore, we would have defined those as partial, not complete, tears, and thus, they would not have been false positives according to the original definition. However, it is not the terminology, but the correct application of the definitions of any given clinical test, that matters in reporting the hook test. To this end, the replacement of our 2 original terms (normal and abnormal) with the 3 terms proposed herein (intact, abnormal, and absent) should hopefully avoid such confusion.

CONCLUSION

Our results suggest that the hook test result should return to normal (intact) after primary and revision repairs of both partial and complete distal biceps tendon ruptures. An absent or abnormal hook test result at the 4-month mark is worrisome for a failed repair, and further investigation should be pursued. Regardless of timing, once the hook test result has returned to intact, any subsequent absent or abnormal hook test result should raise suspicion.

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