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CASE REPORT

Abnormal origins of the long head of the biceps tendon can lead to rotator cuff pathology: a report of two cases

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Abstract Previous case reports have highlighted various anomalous origins of the long head of the biceps tendon (LHBT) that do not originate from the superior glenoid labrum or supraglenoid tubercle. Yet, these cases were all reported as incidental findings and were not thought to cause any significant shoulder pathology. We present the magnetic resonance (MR) imaging and clinical treatment of two cases where aberrant intra-articular origins of the long head of the biceps tendon from the anterior edge of the supraspinatus tendon may have contributed to symptomatic rotator cuff pathology. Arthroscopy confirmed MR findings of partial articular-sided supraspinatus lesions in close proximity to the anomalous origins and treatment with tenodesis of the LHBT successfully relieved symptoms. Although rare occurrences with subtle and potentially misleading imaging findings, it is important to be aware of aberrant origins of the LHBT that may contribute to concomitant rotator cuff pathology.

Keywords Aberrant biceps origin · Shoulder imaging · Rotator cuff pathology

Introduction

The normal course of the long head of the biceps brachii tendon (LHBT) has been described to originate from the supraglenoid tubercle and superior glenoid labrum before coursing through the glenohumeral joint [1–4]. The intra-articular portion then exits the capsule anterior and superior to the humeral head in the rotator interval between the tendons of the supraspinatus and subscapularis, taking with it a thin investment of capsular tissue, which accounts for the LHBT tendon sheath filling with fluid in the presence of an effusion or during arthrography [3–5]. Various reports have shown that the long head of the biceps originates from the supraglenoid tubercle in 25–50 % of cases and from the superior labrum in 50–75 % of cases [3, 4]. There have also been previous reports of aberrant origins of the LHBT, including supernumerary heads, congenital absence of the tendon, bifurcate "Y" origins with limbs to the rotator cable and medial to the supraglenoid tubercle, intra- and extra-articular origins, and origins arising from the rotator cuff and rotator cable [6–18]. Yet, the clinical significance of these aberrant origins is unknown, as subtle signs make diagnosis with magnetic resonance (MR) imaging difficult and previous surgical case reports have described them as incidental findings without clear contributions to further shoulder abnormality [12–18].

We present the MR findings and clinical descriptions of two young, active patients with rotator cuff abnormality that resulted from an aberrant origin of the LHBT combined with high level physical performance in the shoulder joint. In both cases the LHBT can be seen on MR arthrography to originate intra-articularly from the anterior edge of the supraspinatus tendon near its insertion on the greater tuberosity, and may have contributed to partial articular-sided rotator cuff injury.

Case report

Case 1

A 26-year-old right hand-dominant woman presented to the clinic with a history of worsening right shoulder pain when

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performing overhead activities for the past 7 years. She was a volleyball player in high school and college and at presentation was very active as a personal trainer. Her increasing pain was preventing her from performing activities needed for work. She had undergone two trials of corticosteroid injection before presentation, with no significant relief. Examination showed a full range of motion of her shoulders bilaterally. She had mildly weaker strength in her right supraspinatus compared with the left side, but all other rotator cuff testing revealed full strength. She had a mildly positive O'Brien's test [19] on the affected side, but no other positive findings on examination.

At our institution, we routinely obtain magnetic resonance arthrography when labral or a biceps injury is suspected to better elucidate any structural abnormality. All MR arthrograms are performed at 3 T (Signa, GE Healthcare). The following sequences are used:

1. Axial fat-saturated T1-weighted (echo time [TE]: 10 ms, repetition time [TR]: 700 ms, echo train length [ETL]: 4)
2. Axial fat-saturated intermediate-weighted (TE: 55 ms, TR: 4,200 ms, ETL: 8)
3. Coronal oblique fat-saturated T1-weighted (TE: 15 ms, TR: 630 ms, ETL: 4)
4. Coronal oblique T1-weighted (TE: 15 ms, TR: 630 ms, ETL: 4)
5. Coronal oblique fat-saturated intermediate-weighted (TE: 52, TR: 4,100 ms, ETL: 8)
6. Intermediate-weighted sagittal oblique fat-saturated (TE: 55 ms, TR: 4,200 ms, ETL: 8)
7. Abduction external rotation (ABER) fat-saturated T1-weighted (TE: 10 ms, TR: 700 ms, ETL: 4)

Magnetic resonance arthrography revealed a partial articular-sided supraspinatus tendon avulsion (PASTA) as well as an aberrant origin of the long head of the biceps tendon. The main part of the LHBT did not originate from the superior labrum or supraglenoid tubercle, but instead from the anterior edge of the supraspinatus tendon near its insertion on the greater tuberosity. Some thin fibers of the LHBT, however, tracked from the abnormal insertion at the supraspinatus tendon to the superior labrum. The MRI findings were subtle as partial volume effects in this area limit exact evaluation of the course of the biceps tendon intra-articularly and were initially interpreted as abnormal morphology of the superior labrum and LHBT consistent with sequelae of remote injury. After correlation with arthroscopy, closer inspection of the MR arthrogram did demonstrate the flared proximal LHBT as it originates from the anterior supraspinatus (Fig. 1a). The abduction external rotation images also showed an intact superior labrum with an absent biceps–labral anchor (Fig. 1b) and a fat-saturated T2 MR arthrogram (Fig. 1c) clearly depicted the PASTA lesion.

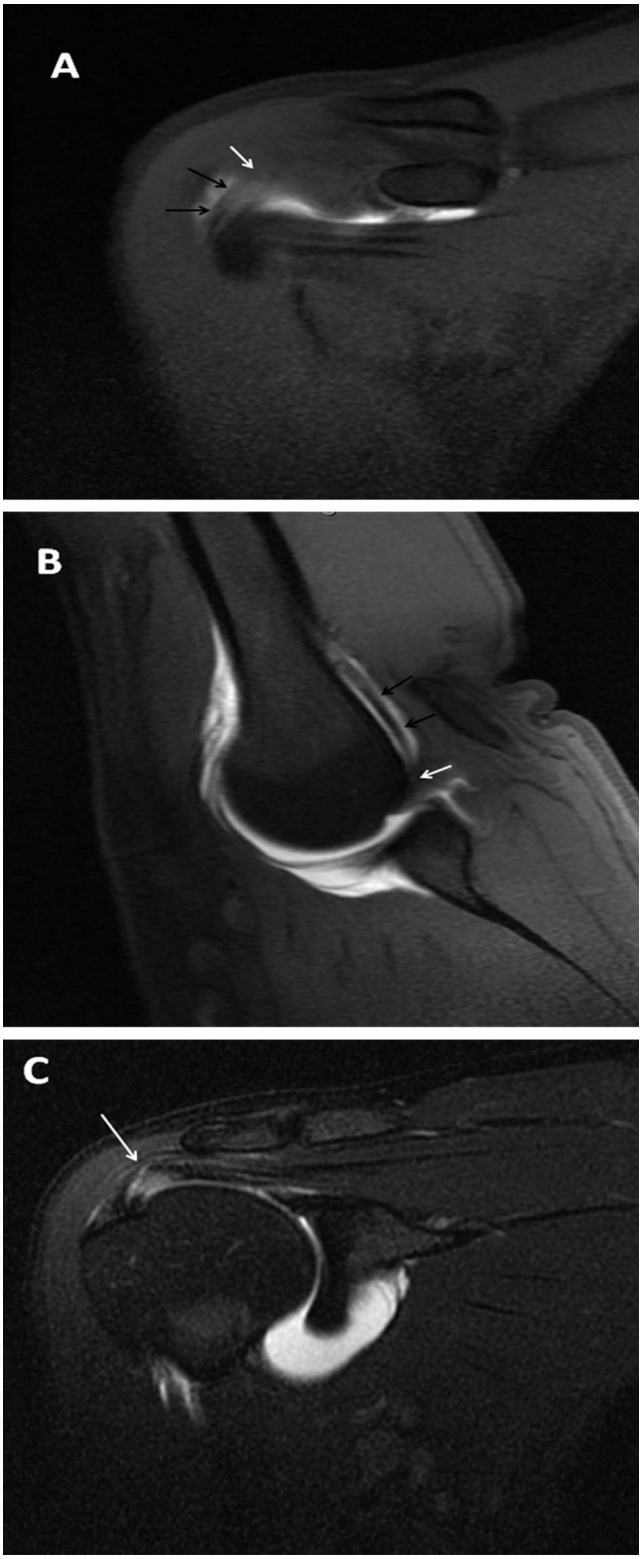
The patient elected for a diagnostic arthroscopy with rotator cuff repair and possible tenodesis of the long head of the biceps. Examination under anesthesia revealed no significant anterior, posterior or inferior translation. During arthroscopy the LHBT was noted to originate intra-articularly and directly adjacent to the leading edge of the supraspinatus insertion and the area of the PASTA lesion (Fig. 2). After debridement of the supraspinatus insertion, it appeared that the aberrant origin of the LHBT was adding further stress to the anterior edge of the supraspinatus tendon. At that point the LHBT was tenotomized from its origin on the supraspinatus tendon and in situ repair of the PASTA lesion was performed. An open suprapectoral tenodesis was then performed for the LHBT. At 2-month follow-up the patient was doing well and was without problems.

Case 2

A 39-year-old right hand-dominant man presented to the clinic with 2 years of worsening left shoulder pain when performing overhead activities. The patient did not have any specific injuries, but was very active playing recreational baseball and lifting weights regularly. The patient reported similar symptoms in his right shoulder, but his left side was worse. Examination showed the full range of motion of his shoulders bilaterally. He had full strength in all rotator cuff muscles bilaterally, but there was mild pain with strength testing of the supraspinatus bilaterally. He also had positive O'Brien's tests bilaterally, but no other positive findings on examination.

Magnetic resonance arthrography revealed an aberrant origin of the long head of the biceps tendon and partial articular-sided supraspinatus tendon avulsion (Fig. 3). In this case, the LHBT did not originate from the superior labrum either, but instead from the supraspinatus tendon at its anterior edge (Fig. 3a). Findings were similar to the other case; Fig. 3b impressively documents how the biceps tendon fuses with the supraspinatus muscle. The tendon was flared as the proximal fibers coalesced into an intact extra-articular tendon, which coursed normally into the bicipital groove. Inspection of the labrum revealed no evidence of a tear. A fat-saturated, intermediate-weighted sequence was the best sequence, with a combination of sections in different orientations (in particular coronal and sagittal) needed to accurately diagnose this abnormality. There was not one specific plane that offered the best visualization, but a thorough review through multiple planes and a good clinical history were needed to help identify the abnormality.

The patient elected for a diagnostic arthroscopy with possible rotator cuff repair and tenodesis of the long head of the biceps in his left shoulder since that was more symptomatic initially. Examination under anesthesia revealed no significant anterior, posterior or inferior translation. During arthroscopy, the LHBT was noted to also originate adjacent to the anterior edge of the supraspinatus tendon (Fig. 4). In this case the PASTA lesion was debrided and an open tenodesis performed



◀ **Fig. 1** MRI arthrography of case 1 (sequence parameters are provided in the text). **a** Coronal T1 fat-saturated MR arthrogram image shows the origin of the long head of the biceps tendon (LHBT) fanning out from the anterior supraspinatus muscle (*white arrow*) and traversing its expected extra-articular path into the bicipital groove (*black arrows*). **b** Abduction external rotation (ABER) T1 fat-saturated MR arthrogram image shows the LHBT in the bicipital groove (*black arrows*) and the aberrant origin from the supraspinatos (*white arrow*). Also note the intact labrum at the expected location of the biceps anchor. **c** Coronal intermediate-weighted fat-saturated MR arthrogram image shows partial articular-sided supraspinatus avulsion (PASTA), labeled with a *white arrow*

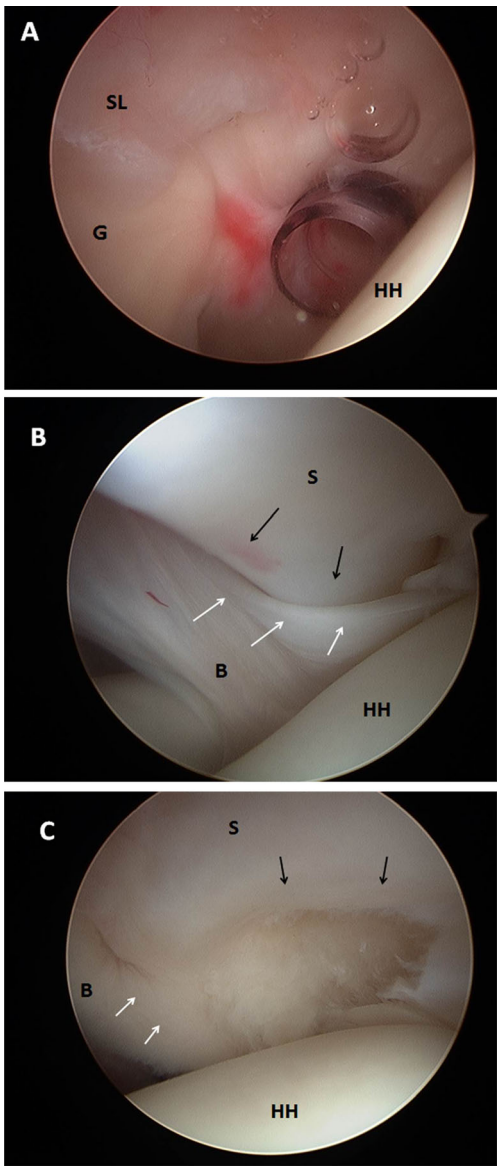


Fig. 2 Intraoperative arthroscopy images of case 1. *HH* humeral head, *G* glenoid, *SL* superior labrum, *B* long head of the biceps tendon, *S* supraspinatus tendon. **a** View of the superior glenoid from the standard posterior arthroscopy portal, with absence of the long head of the biceps tendon (LHBT) from the superior labrum. **b** *White arrows* label the LHBT as it originates from the anterior edge of the supraspinatus (*black arrows*). **c** Partial articular-sided supraspinatus tendon avulsion (PASTA) (*black arrows*) adjacent to the origin of the LHBT (*white arrows*)

for the LHBT as it appeared that the anomalous origin of the LHBT was also contributing to stress at the anterior edge of the supraspinatus tendon. One-year follow-up revealed the patient to be doing well without pain or symptoms in his left shoulder. However, he began to have increasing symptoms with his right

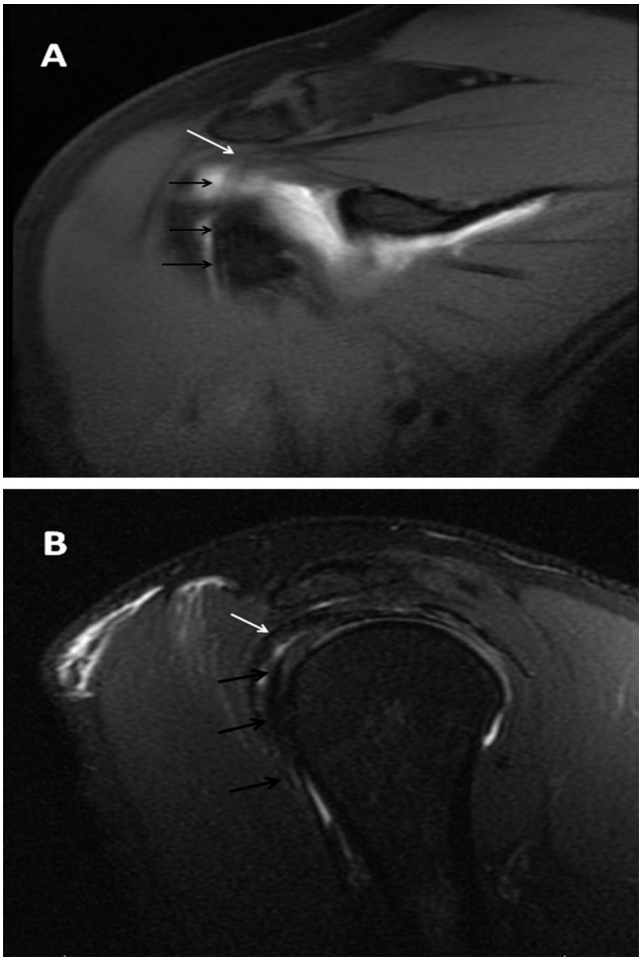


Fig. 3 Magnetic resonance arthrography of case 2 (sequence parameters are provided in the text). **a** Coronal T1 fat-saturated and **b** sagittal intermediate-weighted fat-saturated MR arthrogram images depict the long head of the biceps tendon originating from the anterior supraspinatos muscle (*white arrow*) and its extra-articular course into the bicipital groove (*black arrows*)

shoulder, and an MR arthrogram of the right side revealed a similar aberrant origin of the LHBT and PASTA lesion. The patient has not yet scheduled any intervention for his right shoulder.

Discussion

The two cases presented show similar variant origins of the LHBT on MR imaging and arthroscopy, with one patient carrying this variation bilaterally. In both cases, the origin of the LHBT from the anterior edge of the supraspinatus tendon likely contributed to partial articular-sided tears in the supraspinatus in the setting of high-level overhead activities. Treatment with tenodesis of the LHBT appeared to alleviate symptoms.

The high-quality MR arthrography in this case series was able to help diagnose the aberrant biceps origin. Intra-articular contrast is not a prerequisite for identifying the aberrant

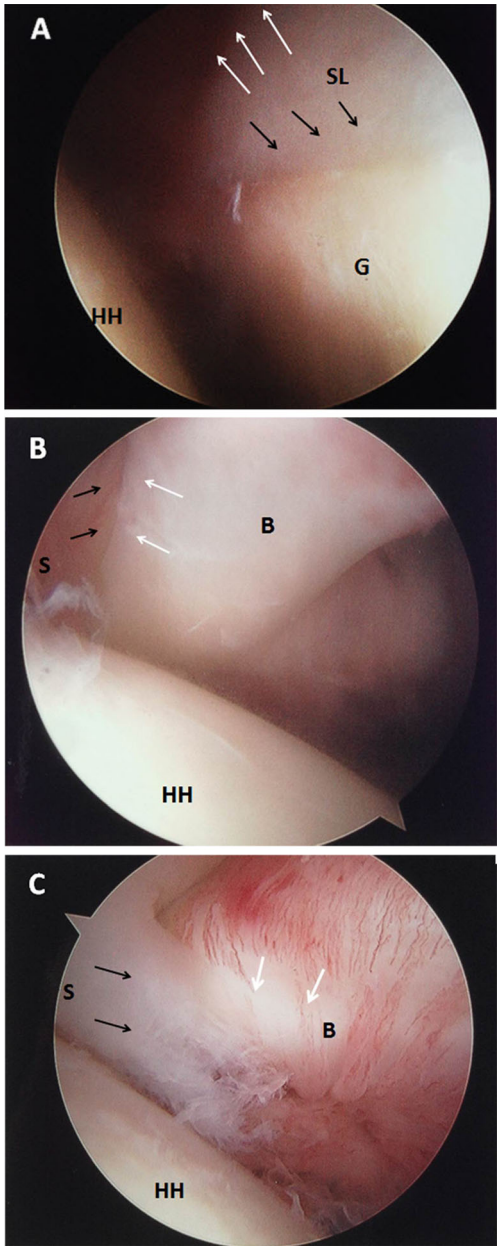


Fig. 4 Intraoperative arthroscopy images of case 2. *HH* humeral head, *G* glenoid, *SL* superior labrum, *B* long head of biceps tendon, *S* supraspinatus tendon. **a** View of superior glenoid from standard posterior arthroscopy portal with absence of the long head of the biceps tendon (LHBT) from the superior labrum. The humeral head is labeled on the left side of the picture and can be seen articulating with the glenoid on the right. The superior labrum is anchored at the superior rim of the glenoid and labeled by *black arrows*. *White arrows* show that there is no LHBT originating from the superior labrum. **b** *White arrows* label LHBT as it originates from the anterior edge of the supraspinatus (*black arrows*). In this image, the LHBT is seen originating from the supraspinatus and then traveling distally into the bicipital groove. **c** PASTA lesion (*black arrows*) adjacent to the origin of the LHBT (*white arrows*). The frayed tissue indicated by the *black arrows* represents the articular-sided defect of the supraspinatus tendon as it inserts on the greater tuberosity. Next to this tissue is the aberrant origin of the LHBT indicated by *white arrows*

anatomy, but distention of the joint, either in the presence of an effusion or with gadolinium, greatly increases the ease of identification. When the joint is not distended, the supraspinatus tendon and anterior capsule are in close apposition to the labrum and biceps anchor, and it may be almost impossible to diagnose this abnormality. Careful attention to the exact course of the LHBT should be a routine part of every MR shoulder evaluation. If a reader is not aware of the aberrant anatomy described above, he or she will likely erroneously diagnose the absence of the tendon at the biceps anchor as high-grade tendinosis or a complete tear.

Routine fluid-sensitive, fat-saturated, intermediate-weighted, and T1-weighted sequences in all three planes can highlight the abnormal course of the LHBT when present. The aberrant LHBT tendon fibers appeared striated and flared at their origin, blending with the anterior supraspinatus tendon and capsule, and were particularly well seen on sagittal and coronal imaging. Axial images were the least helpful in visualizing the abnormality. Confirming the abnormality in two or more planes can give the reader greater confidence in diagnosing this uncommon, but now well-documented anomaly. Additionally, absence of a torn tendon stump at the biceps anchor will be further evidence that the anomaly is congenital.

Our findings are contrary to those of previous studies that reported asymptomatic aberrant origins of the LHBT [12–18]. Although there have been reports of variations of these origins including bifurcate, extra-articular, intra-articular, and arising from the rotator cable, no previous case studies have attributed abnormality to the anomaly. We believe that in these two cases the aberrant origin of the LHBT from the supraspinatus tendon contributed to partial tearing of the rotator cuff.

Lang et al. [18] reported an incidental finding of an aberrant origin of the LHBT from the rotator cable during arthroscopy and debridement of a partial articular-sided supraspinatus lesion. They treated the PASTA lesion with debridement, did not address the origin of the anomalous biceps, and reported good results in their patient. In our case series, the aberrant origin of the LHBT from the intra-articular aspect of the rotator cuff was very close in proximity to the PASTA lesion and likely contributed to it in these young active individuals. Counting the case report by Lang et al. and our patient with bilateral lesions, a total of 4 cases of PASTA lesions in conjunction with an aberrant origin of the LHBT from the anterior aspect of the rotator gives reason to believe that the two entities may be related and that their appearance together is more than just coincidence.

To date, there is no direct evidence that the variant origin of the LHBT can cause a rotator cuff tear. We hypothesize that repetitive stress on the articular surface of the rotator cuff from activities of the biceps might contribute to a tear. The aim of this study is to present the MR findings and clinical history of two cases with these associated findings and our results from treatment with biceps tenodesis. Proper treatment of the anomalous biceps tendon is still unclear. Further cadaveric, biomechanical, and imaging studies are needed to better elicit the relationship between an aberrant origin of the LHBT and rotator cuff abnormality.

In summary, abnormal origins of the LHBT are uncommon and difficult to diagnose both clinically and with MR imaging. In our 2 cases, the aberrant origin of the biceps from the anterior intra-articular surface of the supraspinatus was associated with articular-sided rotator cuff abnormality. It is important in these cases to carefully review diagnostic imaging and discuss treatment options with the patient to address the anomalous biceps tendon.

Conflict of interest statements Alan L. Zhang, his immediate family, and any research foundation with which he is affiliated, did not receive any financial payments or other benefits from any commercial entity related to the subject of this article. The author declares that he has no conflict of interest.

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