Review Article

Sonography and MRI Appearance of Proximal Long Head Biceps Tendon

Thanis Saksirinukul

Thanis Saksirinukul

Imaging center, Bangkok Hospital Headquarters, Bangkok, Thailand

*Address Correspondence to author:
Thanis Saksirinukul, MD
Imaging center, Bangkok Hospital Headquarters
2 Soi Soonvijai 7, New Petchburi Rd.,
Bangkok 10310, Thailand.
email: thanis.sa@bangkokhospital.com

Received: August 18, 2023
Revision received: September 18, 2023
Accepted after revision: September 19, 2023
BKK Med J 2023;19(2): 128-133.
DOI: 10.31524/bkkmedj.2023.23.001
www.bangkokmedjournal.com

Abstract

This article delves into the intricate anatomical structure and diagnostic imaging of the proximal long head biceps tendon, shedding light on its complexities and pathologies. Employing both ultrasound (us) and magnetic resonance imaging (MRI), the study illustrates the normal appearance of the tendon and explores detailed imaging findings for identifying abnormalities. The discussion encompasses tendinopathy, tears, biceps reflection pulley lesions, and superior labrum anterior-to-posterior lesions. By elucidating these aspects, the article aims to enhance diagnostic accuracy and inform treatment planning for a spectrum of conditions involving the proximal long head biceps tendon.

The proximal long head biceps tendon is a complex anatomical structure in shoulder imaging. Pathologies of the biceps tendon and adjacent structures, such as rotator cuff tendons and labrum, can affect treatment options and strategies. Secondary biceps tendon injury is more common than primary biceps tendon injury -biceps tendon injury is coexisted with rotator cuff tendon tear in 90% approximately.[1] Diagnostic imaging as MRI is the preferred modality for visualizing all parts of the biceps tendon and detecting abnormalities. Ultrasound is also easily accessible and can provide good visualization of some parts of the proximal biceps tendon. This article discusses how to identify abnormalities on both MRI and ultrasound findings, for diagnosis and treatment planning.

keywords: biceps tendon, ultrasound, MRI, SLAP, biceps pulley, biceps sling, biceps tendinopathy, biceps tear

Normal ultrasound and MRI appearance of proximal long head biceps tendon

Normal anatomy

The proximal long head biceps tendon originates at the supraglenoid tubercle (anchor) and passes over the superior humeral head anteromedially—the intra-articular part—to the rotator interval. After passing through the rotator interval, the tendon travels downward to the bicipital groove of the humeral head—the extra-articular part (Figure 1). The normal diameter of the proximal long head biceps tendon is 5-6 mm on average, with oval or flat contours being common normal shapes. The total average length is 9 cm.[2]

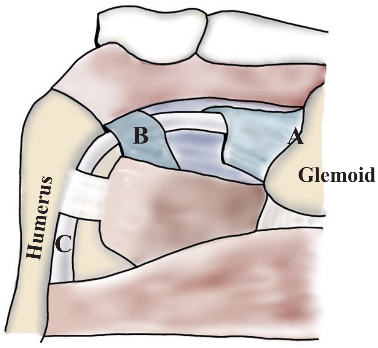

Figure 1: The illustration shows normal anatomy of proximal long head biceps tendon (white) originating from supraglenoid tubercle, passing through rotator interval and down to bicipital groove (A = supraglenoid tubercle, B = rotator interval, C = bicipital groove)

Normal ultrasound findings

Ultrasound can accurately visualize the extra-articular part of the biceps tendon in the groove, as well as pathologies of the rotator interval and biceps pulley on both static and dynamic images. However, visualization of the intra-articular part of the tendon via ultrasound is limited due to overlying bony structures such as the acromion and distal clavicle.

On ultrasound, the proximal long head biceps tendon appears as homogeneous hyperechogenicity with a preserved fibrillation pattern on both short and long axes (Figure 2). Physiologic fluid in the bicipital groove can be seen as a small fluid curving around the posterior side of the tendon. One pitfall of ultrasound focusing on musculoskeletal structures is anisotropy artifact, which can also occur for the biceps tendon, especially on short axis views of the groove part. A slight angulation of the ultrasound probe can result in anisotropy artifact, causing the biceps tendon to appear as low echogenicity, which can be misinterpreted as tendinopathy. Correcting probe positioning will reveal the true echo of the tendon.[3]

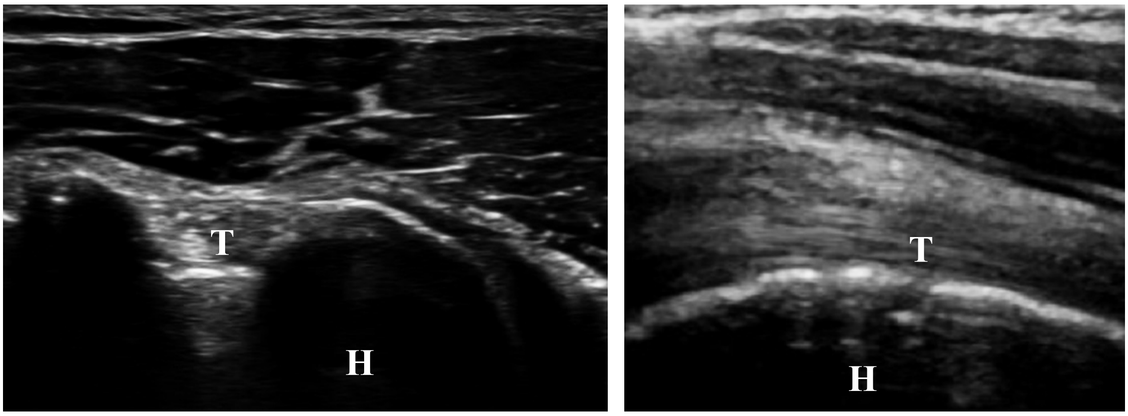

Figure 2: Short (A) and long (B) axes of long head biceps tendon on sonography in the bicipital groove. The normal biceps tendon reveals fibrillation pattern with homogeneous hyperechogenicity and trace fluid located posteriorly to the tendon in the groove (T = biceps tendon, H = humeral head)

Normal MRI findings

MRI is the modality of choice for visualizing the proximal biceps tendon. All three parts of the tendon can be directly visualized, along with associated adjacent structures. However, MRI has its disadvantages, including static images, time-consuming studies, and cost. Additionally, claustrophobic patients are contraindicated.

On MRI, the proximal long head biceps tendon appears as homogeneous low signal with a preserved smooth contour, either oval or flat (Figure 3). As mentioned earlier, small physiologic fluid can easily be seen in the groove. The vinculum is an anatomical variant often seen in the groove. It is a thin membrane between the groove and tendon that contains vascular supply (Figure 4). The vinculum can prevent pop-eye deformity when a complete tear of the biceps tendon occurs.[2]

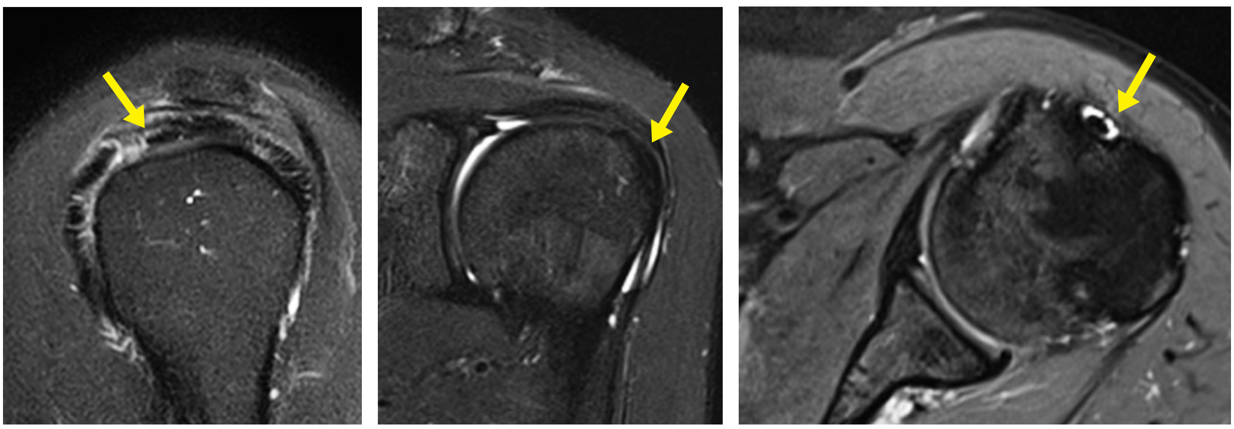

Figure 3: Sagittal (A), coronal (B) and axial (C) T2WFS images of the shoulder demonstrate normal long head biceps tendon of all three parts—intra-articular, rotator interval and groove part, respectively, as homogeneous low signal and preserved contour (Arrow = biceps tendon).

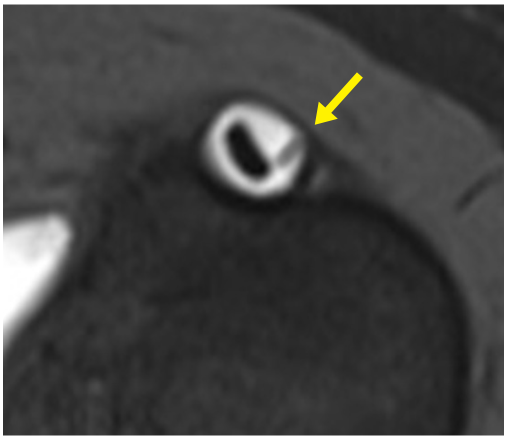

Figure 4: The vinculum is observed as a thin membrane between the groove and biceps tendon that contains vascular supply (Arrow).

Normal ultrasound and MRI findings of biceps reflection pulley

Another challenging anatomical part of the biceps tendon is its pulley system in rotator interval part - space between anterior rim of supraspinatus tendon and superior rim of subscapularis tendon. This part is a capsuloligamentous complex composed of coracohumeral ligament (CHL) located superficially to biceps tendon, superior glenohumeral ligament (SGHL) forming a sling-like structure medially to it, with biceps tendon in center. Some studies show a third ligament, coracoglenoid ligament (CGL), forming anterosuperior part of complex.[2,4,5] Both ultrasound and MRI images reveal these ligaments as thin and smooth structures surrounding biceps tendon in rotator interval part (Figure 5).

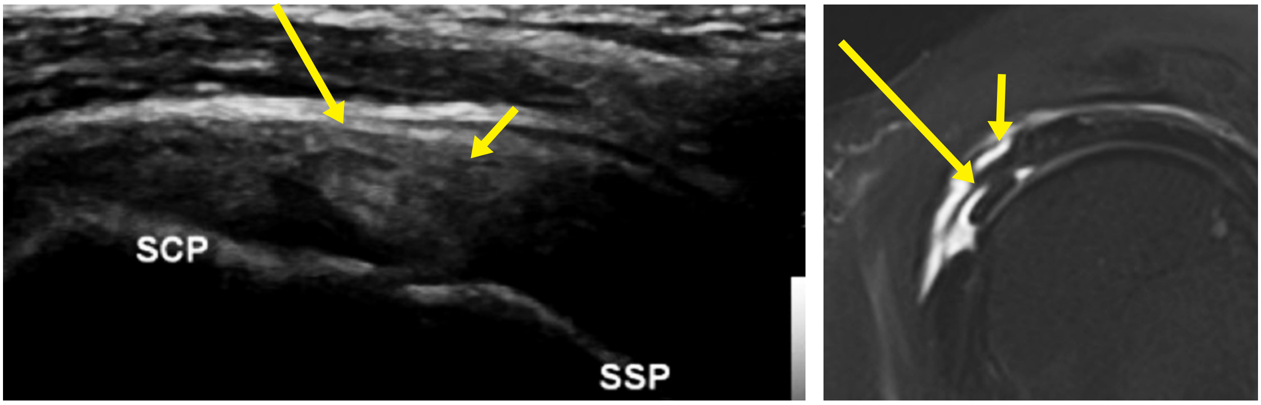

Figure 5: A short axis view of ultrasound (A) and sagittal T2WFS image (B) demonstrate biceps pulley system as thin and smooth band around biceps tendon composed of superior glenohumeral ligament (long arrow) and coracohumeral ligament (short arrow).

Long head biceps tendon pathologies

Tendinopathy

Biceps tendinopathy is a common pathology. It is believed that repetitive stress leads to tendon degeneration, resulting in tendinopathy, fraying, partial tear, and eventually complete tear. The most common location for tendinopathy is the proximal two-thirds of the tendon, including the intra-articular and rotator interval part.

The most specific imaging sign of biceps tendinopathy is an increase in the thickness of the biceps tendon, especially in the intra-articular part, with an average thickness of more than 5 mm. The best MRI view for detecting this condition is a sagittal view of fluid-sensitive sequences (Figure 6). The contour of the biceps tendon should also be carefully evaluated. The signal of the tendon itself is not reliable due to magic angle artifact and some studies have shown that intrasubstance signal does not correlate with histology grade. Biceps tendinopathy can lead to a specific condition known as hourglass biceps tendon, where the tendon increases in size in the intra- articular part, resulting in impingement and inability to pass through the pulley (Figure 7).[2,6,7]

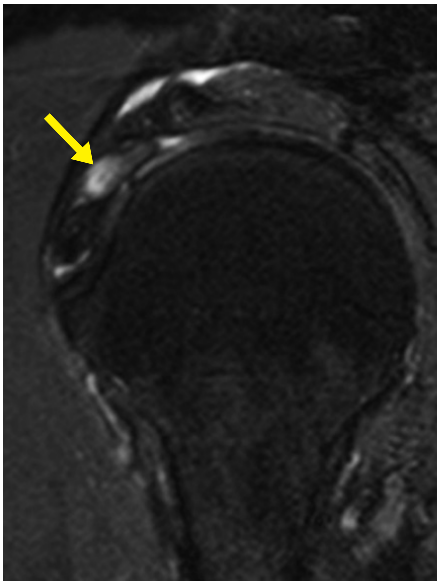

Figure 6: Sagittal T2WFS image reveals focal thickening with increased signal of biceps tendon at rotator interval, which the increased thickness is the most specific sign for biceps tendinopathy.

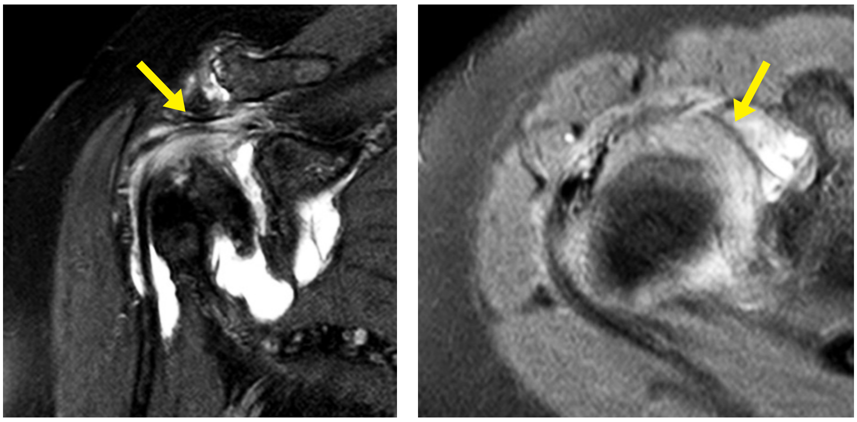

Figure 7: Coronal T2WFS and axial PDWFS images show hourglass biceps tendon at intra-articular part, resulted in impingement and inability to pass through the pulley.

Ultrasound findings of biceps tendinopathy include decreased echogenicity and increased thickness of the tendon. Additional findings include increased surrounding vascularity on Doppler ultrasound and increased surrounding fluid in the tendon sheath (Figure 8). However, ultrasound can only provide limited evaluation of the intra-articular part, which is a more common location for pathology. One benefit of ultrasound is its ability to perform dynamic studies, which can sometimes demonstrate indirect impingement - limited movement of the biceps tendon.[2]

Long head biceps tendon tear

Long head biceps tendon tears often occur 1.2 to 3.0 cm from their origin (supraglenoid tubercle) due to a hypovascular zone of the tendon. There are two types of biceps tendon tears: partial and complete.

The direct imaging sign of a tendon tear on both ultrasound and MRI is discontinuity of the fiber, with both partial and total disruption and another specific pattern as longitudinal splitting tear. Ultrasound is superior in detecting complete tears compared to partial tears. [1,2] However, dynamic scanning with ultrasound can provide further help in better delineating the tear. Additional findings include abnormal contour and some laxity (Figure 9).

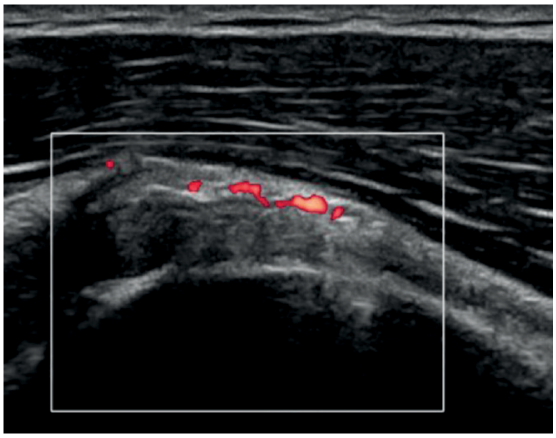

Figure 8: A long axis sonographic image of long head biceps tendon at the proximal groove shows focal thickening and decreased echo of the tendon, with increased surrounding vascularity on Doppler image.

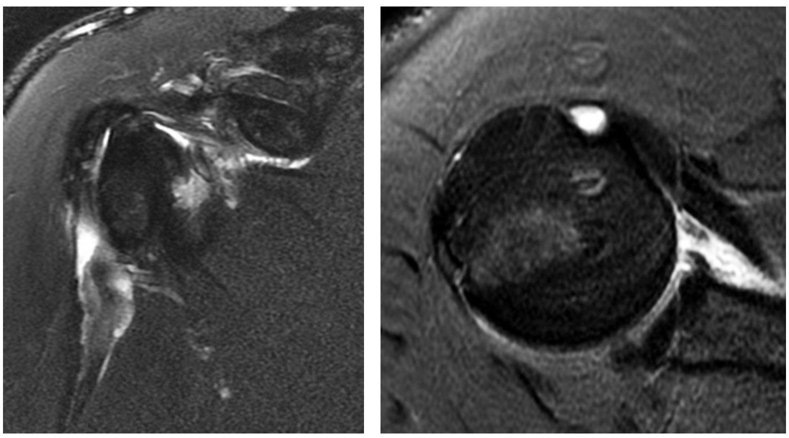

Figure 9: Coronal T2WFS (A) image depicts complete discontinuity of long head biceps tendon at the groove with some retraction. Axial PDWFS image (B) shows empty groove sign, reflected complete torn biceps tendon.

Biceps reflection pulley (sling) lesion and instability

The incidence of biceps reflection pulley lesions is about 7%. Causes include degeneration, direct trauma, repetitive micro-trauma (especially from overhead throwing motion), and injury associated with rotator cuff tear. As a result, detachment of the capsuloligamentous complex occurs, leading to anterior and upward translation of the humeral head - anterosuperior impingement (ASI).[5,8]

Habermeyer classified this pathology into four types in 2004. Type I consists of isolated pulley injury. Imaging findings include thickening and increased signal/echo of the pulley—CHL and SGHL on both ultrasound and MRI. Based on imaging findings alone, these findings can overlap with those of early adhesive capsulitis.

Type II consists of pulley lesion and supraspinatus tendon tear. MRI and ultrasound can accurately demonstrate associated supraspinatus tendon tear. Type III consists of pulley lesion and subscapularis tendon tear. Type IV consists of pulley lesion, supraspinatus tendon tear, and subscapularis tendon tear. Subscapularis tendon tear is seen in both types III and IV, especially at the upper facet footprint, resulting in demonstrable subluxation/ dislocation of long head biceps tendon depending on degree of subscapularis tendon tear.[2,8] The specific imaging finding for subluxation of biceps tendon is described as displacement sign on MRI. The biceps tendon subluxates medially to overly part of subscapularis tendon footprint due to sling injury (Figure 10). This sign has high sensitivity (86%) and specificity (up to 96%).[2,9]

A further specific indirect sign of biceps tendon subluxation is the chondral print sign, seen on both MRI and ultrasound images. This sign reveals focal cartilage and subchondral bone irregularity underneath the biceps tendon at rotator interval with some subchondral microcystic change and/or minimal marrow edema (only seen on MRI) (Figure 10).[2]

Superior labrum, anterior to posterior lesion (SLAP)

The general incidence of SLAP lesions is around 6%. The normal superior labrum can only be completely evaluated on MRI images. The normal superior labrum shows uniform low signal, triangular shape (mostly), and smooth rim. The average normal height of the superior labrum is 3 mm and its width is 4 mm. Common variants of the superior labrum must be recognized to avoid over-reading as a superior labral tear. These variants include sublabral recess (11 to 1 o'clock based on clock-fashioned orientation of the labrum), sublabral foramen (1-3 o'clock), Buford complex, cartilage undercutting, and pseudo-SLAP lesion.[10,11]

The accuracy of MRI for SLAP detection is between 63-95%, but arthrographic MRI (direct MRI arthrogram) increases accuracy to 74-90%. However, MRI cannot precisely differentiate all types of SLAP lesions.[10]

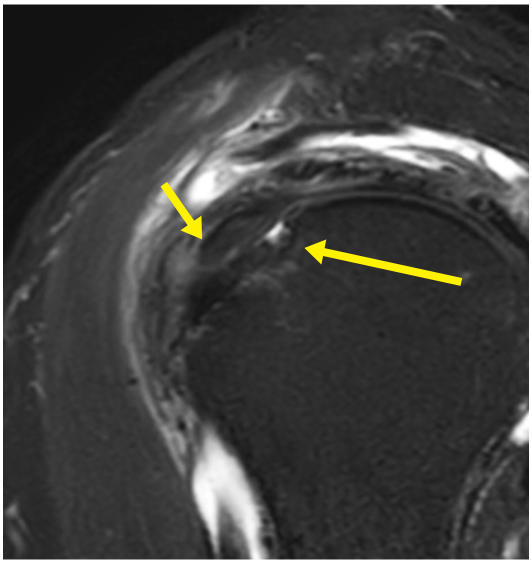

Figure 10: Sagittal T2WFS image shows displacement sign—the biceps tendon subluxates medially (short arrow) to overly part of subscapularis tendon footprint due to sling injury. Further indirect sign—chondral print sign (long arrow), reveals focal cartilage and subchondral bone irregularity underneath the biceps tendon at rotator interval with some microcystic change and/or minimal marrow edema.

SLAP lesions are mainly classified into four types. Type I consists of fraying of the superior labrum without an obvious tear. Type II, the most common type, involves stripping of the superior labrum from glenoid cartilage with biceps anchor involvement. Type III involves a bucket-handle torn superior labrum without biceps extension. Type IV involves a bucket-handle torn superior labrum with biceps anchor extension.[1,10,11]

The proposed sign for a superior labrum tear on MRI is the Oreo sign. There are two types of Oreo signs: single Oreo cookie and double Oreo cookie. The single Oreo sign shows a single hyperintense line vertically in the superior labrum, which could be either a sublabral recess or type II SLAP lesion. A tip for differentiating these two entities on coronal images is that a sublabral recess usually orients medially and more anteriorly, while a labral tear orients laterally and extends posteriorly to the biceps anchor (Figure 11).[10]

Additional findings for a labral tear include abnormal contour, margin, or presence of a labral cyst. On arthrographic MRI, gadolinium contrast insinuation into the labral tear can be visualized on T1W images. Some studies have proposed a cut-off width between the labrum and glenoid cartilage of about 2 mm for conventional MRI and 2.5 mm on arthrographic MRI.[10,11]

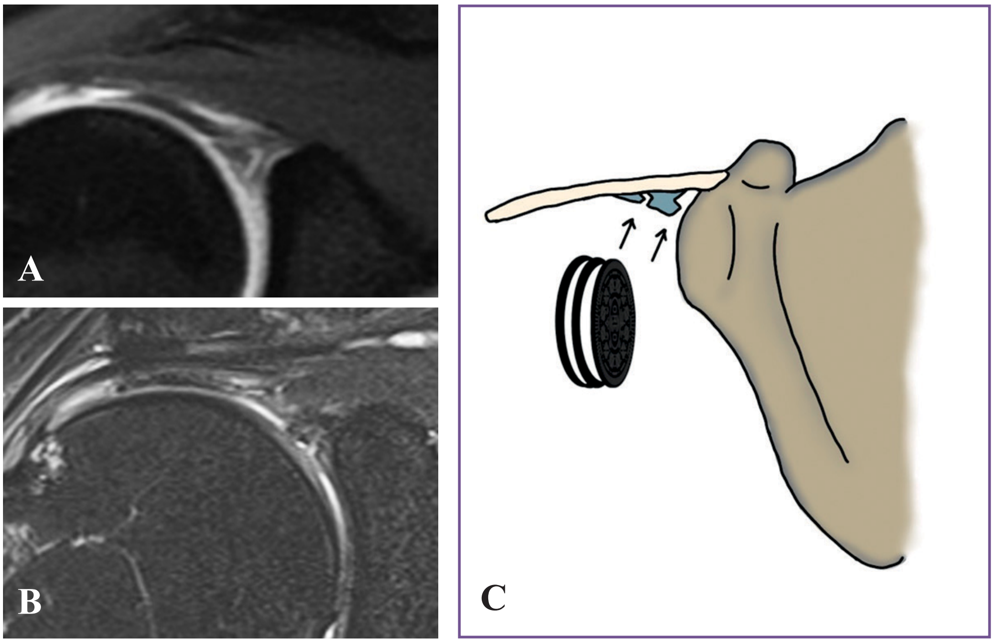

Figure 11: Coronal T1WFS image of arthrographic MRI (A) shows double Oreo cookies sign as seen gadolinium insinuating along sublabral recess medially and superior labral tear laterally. As seen on coronal T2WFS image (B), the double Oreo cookies show as two hyperintense lines in the superior labrum -tear and sublabral recess. The illustration of double Oreo cookies (C) is demonstrated.

Conclusion

The proximal long head of the biceps tendon holds significant anatomical importance in shoulder imaging, and a thorough comprehension of its intricacies and pathologies is essential for accurate diagnosis. This investigation emphasizes MRI's effectiveness in revealing intra-articular biceps tendon pathology and the condition of the biceps reflection pulley. Key observations highlight increased thickness in tendinopathy, fiber discontinuity in tears, biceps sling lesion resulting in subluxation of the biceps tendon and associated rotator cuff tendon tear, and the discriminative identification of labral tears and sublabral recess in SLAP lesions.

Acknowledgements

Special thanks to Arisara Sukgrarongka for the anatomical and pathological illustrations that were included in this article.

References

1. Panico L, Roy T, Namdari S. Long Head of the Biceps Tendon Ruptures: Biomechanics, Clinical Ramifications, and Management. *JBJS Rev* 2021;9(10). doi: 10.2106/JBJS.RVW.21.00092.
2. Zappia M, Chianca V, Di Pietto F, et al. Imaging of long head biceps tendon. A multimodality pictorial essay. *Acta Biomed* 2019;90(5-S):84-94. doi: 10.23750/abm.v90i5-S.8351.
3. Jacobson JA. Shoulder US: anatomy, technique, and scanning pitfalls. *Radiology* 2011;260(1):6-16. doi: 10.1148/radiol.11101082.
4. Vinson EN, Wittstein J, Garrigues GE, et al. MRI of selected abnormalities at the anterior superior aspect of the shoulder: potential pitfalls and subtle diagnoses. *AJR Am J Roentgenol* 2012;199(3):534-45. doi: 10.2214/AJR.12.8789.
5. Petchprapa CN, Beltran LS, Jazrawi LM, et al. The rotator interval: a review of anatomy, function, and normal and abnormal MRI appearance. *AJR Am J Roentgenol* 2010;195(3):567-76. doi: 10.2214/AJR.10.4406..
6. Motamedi D, Everist BM, Mahanty SR, et al. Pitfalls in shoulder MRI: part 2--biceps tendon, bursae and cysts, incidental and postsurgical findings, and artifacts. *AJR Am J* Roentgenol 2014;203(3):508-15. doi: 10.2214/AJR.14.12849.
7. Kim JY, Rhee SM, Rhee YG. Accuracy of MRI in diagnosing intra-articular pathology of the long head of the biceps tendon: results with a large cohort of patients. *BMC Musculoskelet Disord.* 2019;20(1):270. doi: 10.1186/s12891-019-2654-5.
8. Nakata W, Katou S, Fujita A, et al. Biceps pulley: normal anatomy and associated lesions at MR arthrography. *Radiographics.* 2011;31(3):791-810. doi: 10.1148/rg.313105507.
9. Schaeffeler C, Waldt S, Holzapfel K, et al. Lesions of the biceps pulley: diagnostic accuracy of MR arthrography of the shoulder and evaluation of previously described and new diagnostic signs. Radiology. 2012;264(2):504-13. doi: 10.1148/radiol.12112007.
10. Mohana-Borges AV, Chung CB, Resnick D. Superior labral anteroposterior tear: classification and diagnosis on MRI and MR arthrography. *AJR Am J Roentgenol* 2003;181(6):1449-62. doi: 10.2214/ajr.181.6.1811449.
11. De Coninck T, Ngai SS, Tafur M, et al. Imaging the glenoid labrum and labral tears. *Radiographics* 2016;36(6):1628-47. doi: 10.1148/rg.2016160020.