Original article

Contribution of MRI and CT arthrography to the diagnosis of intra-articular tendinopathy of the long head of the biceps

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\section*{Abstract}

Introduction: Clinical diagnosis of biceps tendinopathy is difficult to make because of the poor sensitivity of existing clinical tests. The goal of this study was to determine whether MRI or CT arthrogram could contribute to the diagnosis of tendinopathy in the intra-articular portion of the long head of biceps (LHB), while using macroscopic findings during shoulder arthroscopy as a reference.

Material and methods: A prospective, single-centre study was performed over a 4-month period. The radiology part of the study was carried out by a radiologist experienced in shoulder imaging. The arthroscopy part of the study was conducted while the biceps was being evaluated for treatment purposes. The study included 87 patients having an average age of 45.7 years (range 17–78). Fifty-eight patients underwent CT arthrography and 38 underwent an MRI. Seven patients underwent both imaging exams. One patient was removed from the study because of a spontaneous LHB rupture. The demographics of the two study populations were equivalent.

Results: For the diagnosis of tendinopathy of the intra-articular portion of the long head of biceps, the CT arthrogram had a sensitivity of 71.43%, specificity of 100%, positive predictive value of 100% but a negative predictive value of 67.74%. For the diagnosis of tendinopathy of the intra-articular portion of the long head of biceps, the MRI had a sensitivity of 42.85%, specificity of 75%, positive predictive value of 50% but a negative predictive value of 69.23%.

Conclusion: This study showed that radiological diagnosis of tendinopathy of the long head of biceps remains challenging. Nevertheless, CT arthrography is more sensitive and specific than MRI in identifying this disorder.

Level of evidence: III (case-control study).

\section*{1. Introduction}

The long head of the biceps brachii muscle (LHB) is often the cause of pain in the shoulder [1]. Various clinical studies have demonstrated the benefit of excising it, especially during rotator cuff repair [2–4]. This procedure is now often performed in combination with suprascapular repair or during palliative treatment of massive rotator cuff tears. Excising the LHB tendon can provide the patient with pain relief [3,4]. But patients without rotator cuff disorders frequently have chronic shoulder pain with an unclear etiology. Involvement of the LHB is often difficult to prove, given the low relevance of clinical examinations [1,5]. Although various radiological exams allow us to properly identify disorders of the LHB in the bicipital groove or its pulley, few imaging modalities allow us to identify abnormalities in the intra-articular portion of the LHB [6]. We performed a comparative clinical and radiological study to determine the effectiveness of MRI and CT arthrography in the diagnosis of tendinopathy in the intra-articular portion of the long head of biceps tendon.

\section*{2. Material and methods}

Over a four-month period, patients who were scheduled to undergo shoulder arthroscopy and had undergone preoperative imaging (CT arthrography or MRI) in our facility were included in this prospective study. Patients with a preoperative diagnosis...
of spontaneous rupture of the long head of biceps tendon were excluded from the study.

During the arthroscopy, the condition of the intra-articular portion of the LHB in two regions was noted: medial insertion segment at the glenoid and the horizontal segment before entering into the groove. Any subluxation of the biceps within the bicipital groove was also recorded. The appearance of the biceps was labelled as healthy, inflamed, degenerated or fissured (Fig. 1). Any macroscopic abnormality of the biceps was considered pathological and labelled as tendinopathy.

Independent of these surgical observations, a radiologist evaluated the appearance of the biceps tendon in the same regions to look for insertion tendinopathy or tendinopathy in the horizontal intra-articular segment. For the MRI exam (Magnetom AR1, 1.5 T), tendon pathology was defined as an abnormal signal in one of the explored segments or at the insertion. For the CT arthrography, findings of remodelling, fissuring or degeneration in the explored segments were recorded. This data was compared for both groups. Statistical testing was carried out with open-source Spago software (version 4.55).

3. Results

Of the 87 patients included in the study, 40 were women (46%) and 47 were men (54%). The average age was 45.7 years (range 17–78). Surgical rotator cuff repair was performed on 37 patients, arthroscopic glenohumeral stabilization in 28 patients, isolated biceps disorder treatment in 7 patients, acromioclavicular joint resection in 4 and bursectomy with acromioplasty and biceps tenotomy in the remaining patients. Fifty-eight patients underwent preoperative CT arthrography and 38 underwent MRI. One patient was excluded from the study because of a spontaneous LHB rupture between imaging and surgery.

During the arthroscopic evaluation, 47 patients had abnormal findings in the long head of biceps tendon. Six patients had tendon fissures, 17 had degenerative tendon remodeling, 1 had biceps detachment along with a Bankart lesion, 1 had an isolated detachment, 1 had a spontaneous biceps rupture between the time of the

Fig. 1. Arthroscopic view of tendinopathy-related fissures in the intra-articular portion of the long head of biceps.

Fig. 2. CT arthrogram of biceps tendon: A–C. Healthy appearing area. D. Partial detachment of biceps at its insertion (SLAP lesion).
radiology exam and the surgical procedure, and 21 had insertional tendinopathy evidenced by remodelling at the attachment.

Of the patients who underwent CT arthrography, 32 had a normal-appearing tendon and 26 had a pathological one (Fig. 2). Of the 26 patients with abnormal findings on CT arthrography, 8 were macroscopically abnormal based on the arthroscopy assessment and 18 were macroscopically normal. Of the 32 patients with normal tendons on CT arthrography, 28 had a macroscopically normal tendon in the arthroscopy assessment and 4 had a pathological LHB tendon. Most of the abnormal findings in the CT arthrogram were located at the insertion (n = 10) (Fig. 2C). This corresponded to arthroscopic SLAP lesions in 4 of the 10 cases. In seven cases, the tendon appeared degenerated and splintered on the CT arthrogram; this corresponded to macroscopic biceps tendon degeneration in 4 of the cases.

Of the patients who underwent MRI, 26 had normal-appearing tendon and 12 had a pathological one (Fig. 3). Of the 12 patients with abnormal findings on the MRI, 6 were macroscopically abnormal based on the arthroscopy assessment and 6 were normal. Of the 26 patients with normal tendons on MRI, 18 had a macroscopically normal tendon in the arthroscopy assessment and 8 had a pathological LHB tendon. Most of the abnormal findings on MRI corresponded to the appearance of degeneration (n = 8) (Figs. 3B–D); this corresponded to arthroscopic appearance of degeneration in 3 of the 8 cases. In four cases, there were signs of insertional tendinopathy on the MRI, which was confirmed in 2 of these cases during arthroscopy.

Statistical analysis showed that the two patient populations could be considered equal in terms of their age and pathology (P < 0.05).

For the diagnosis of tendinopathy of the long head of biceps, the CT arthrography had a sensitivity of 71.43%, specificity of 100%, positive predictive value of 100% but a negative predictive value of 67.74%. For the diagnosis of tendinopathy of the long head of biceps, the MRI had a sensitivity of 42.85%, specificity of 75%, positive predictive value of 50% but a negative predictive value of 69.23%.

4. Discussion

Release of the long head of biceps tendon is a common surgical procedure. It is performed either alone (tenotomy) or in combination with reattachment of the biceps to the humerus (tenodesis). This procedure is recommended in the context of rotator cuff repair, as biceps lesions often occur in combination with histological abnormalities of the supraspinatus tendon [1,4]. Both tenotomy and tenodesis are often used to treat chronic shoulder pain, even without confirmed etiology, but some morbidity is associated with these procedures. The Popeye sign was found in 30% of cases along with cramping in the muscle belly in nearly 38% of cases [5]. Tenotomy is beneficial during rotator cuff repair, but there are repercussions on the elbow’s ability to flex and forearm’s ability to supinate [3,4]. Nearly 90% of patients with massive rotator cuff tears improve once the biceps is released [1].

The above studies point to some morbidity being associated with biceps tenotomy. The pros and cons of this indication should be carefully weighed in younger patients, as it is preferable to preserve the biceps. If the clinical exam does not provide enough evidence to implicate the biceps in shoulder pain [7], it seems useful in younger patients with an intact rotator cuff and chronic shoulder pain to preoperatively determine if the biceps is causing the pain.
The current study was focused on isolated lesions of the intra-articular portion of the long head of biceps tendon. Although the long portion of the biceps can be evaluated properly with ultrasonography and CT arthrography where it enters or lies in the bicipital groove, the horizontal intra-articular portion is not so easy to evaluate [8,9]. Applegate reported that MRI had 100% sensitivity and 88% specificity for the diagnosis of biceps insertional tendinopathy (SLAP) [10]. But Applegate’s study only included a few patients and only looked at the biceps’ attachment area [11], while the current study look at the entire horizontal segment of the biceps. To our knowledge, no radiological studies have been performed specifically to look at the long portion of the biceps [12]. Based on the findings of the current study, CT arthrography seems to be the most relevant imaging modality to detect tendinopathy in the intra-articular portion of the long head of biceps.

During CT arthrography, 0.6 mm thick slices are taken and then 3D images reconstructed from these slices, which likely provides the best means to evaluate the biceps tendon. Moreover, use of a contrast agent results brings out any small lesions, making it easier to read and interpret than an MRI image. This also allows the radiologist to fully orient the structure in space and to examine the tendon volume. The main limitations of CT arthrography are related to irradiation and to the fact that only injuries “communicating” with the space where the contrast agent was injected can be investigated. Conversely, MRI is non-irradiating, which typically produces 3 mm slices and the resulting image is the sum of all the signals within a slice thickness. Three-dimensional reconstruction is not feasible with MRI. As a consequence, the biceps tendon may be difficult to discern because it is not differentiated from other hypo-intense structures such as bone cortex if no swelling is present.

The current study has several limitations.

The included population is heterogeneous in terms of the biceps injuries present. It would have been shrewder to only select cases with isolated tendinopathy of the intra-articular portion of the long head of biceps. However, this condition so rarely occurs in isolation – and is difficult to diagnose clinically – that it would have reduced the number of patients that could be included prospectively.

The images were only read once in a blinded manner. The radiologist who read the images has significant experience in musculoskeletal imaging, and this approach is consistent with the one used on other published studies [10].

The patients with biceps detachment (SLAP lesions) could have been evaluated separately from the ones with horizontal lesions. We felt that since the diagnosis and surgical treatment were the same, these two conditions are often interlinked. It has been shown that degenerative remodelling of the biceps is common, especially in cases of supraspinatus detachment, and that macroscopic changes are something not visible [13].

MR arthrography, which is not as easily accessible as the two aforementioned imaging modalities, can acquire 0.3 mm thick slices; this could make diagnostic imaging of tendinopathy in the long head of biceps more effective.

5. Conclusion

Imaging of the intra-articular portion of the long head of biceps continues to be tricky. We recommend informing the patient that the relevance of standard imaging modalities is still limited and that the intra-operative appearance of the tendon will be the major diagnostic criterion for biceps involvement. Although our study showed that CT arthrography was better than MRI at revealing tendinopathy in the intra-articular portion of the long head of biceps, development of MR arthrography could help us by further identifying this condition, which is often discovered accidentally during surgery.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References