

# Arthroscopic Proximal Subpectoral Tenodesis of the Long Head of the Biceps



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**Abstract:** Biceps tenodesis is a common treatment method for biceps pathology. When tenodesis is located in intra-articular or suprapectoral areas, the biceps is fixed proximally to the zone of degeneration and inflammation, which can cause residual pain as a possible postsurgical complication. The main advantage of this method is that this technique is comparatively easy and can be performed arthroscopically. Typically, in terms of professional athletes, the best post-biceps tenodesis results are observed after undergoing subpectoral tenodesis because of the solid fixation and localization distally to any kind of biceps tendon degeneration and inflammation zone. However, subpectoral tenodesis has several disadvantages, as it is an open procedure that can lead to possible scar and hematoma formation, infection, bioabsorbable screw reaction, neurovascular injury, and fractures. Soft-tissue tenodesis to the proximal part of pectoralis major tendon is a well-known step in shoulder arthroplasty surgery and shows acceptable results. We suggest a technique of proximal subpectoral arthroscopic tenodesis, which combines the advantages of the location in the subpectoral zone with an all-suture anchor and that of soft-tissue tenodesis to the pectoralis major tendon, which can be performed fully arthroscopically, improving results in terms of healing by increasing the contact area.

Typically, tenodesis is performed intra-articularly, suprapectorally, or subpectorally. Residual pain is described in some cases after intra-articular and suprapectoral tenodesis.<sup>1,2</sup> Intra-articular and suprapectoral tenodesis are usually not effective if there is significant inflammation in the biceps groove or if the suprapectoral part of the biceps is of poor quality or significantly injured. In these cases, subpectoral tenodesis is the preferred method.<sup>3</sup> The advantage of this method includes quick recovery, and it is popular in professional athletes.<sup>4</sup> The main disadvantages of this method are the open approach, scar formation, elongation of the biceps, and

biceps asymmetry that can occur because the tendon part of the biceps is fixed under the distal part of the pectoralis major tendon. In addition, the possibility of bone fractures due to the use of interference screws has been described.<sup>5,6</sup> Advantages of anchor fixation in biceps tenodesis have been described by Papp et al.<sup>7</sup> New-generation suture anchors, which are smaller in size and have increased pullout strength compared with other types of anchors, may be used in tenodesis treatments.<sup>8,9</sup> The technique also has several disadvantages, like the micromotion of the biceps during healing and delayed recovery. To overcome this disadvantage, we describe an arthroscopic technique that combines all-suture anchor fixation to bone and additional soft-tissue fixation to the proximal part of the pectoralis major tendon. Soft-tissue tenodesis to the proximal part of pectoralis major tendon is a well-known step in shoulder arthroplasty surgery.<sup>10</sup> Moreover, the suggested technique helps to increase the healing contact area.

There are 2 options to place an anchor under the pectoralis major tendon. The first is the placement of the drill guide for anchor under inferior boarder of the pectoralis major. The second logical option is to reach the same fixation site arthroscopically under the superior boarder of pectoralis major tendon—proximal subpectoral tenodesis. Preparation of this area is well-known for arthroscopic pectoralis major repair or arthroscopic latissimus dorsi transfer.

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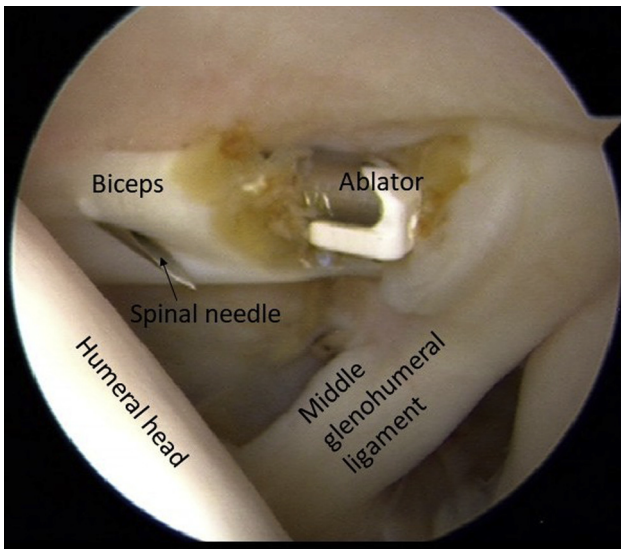
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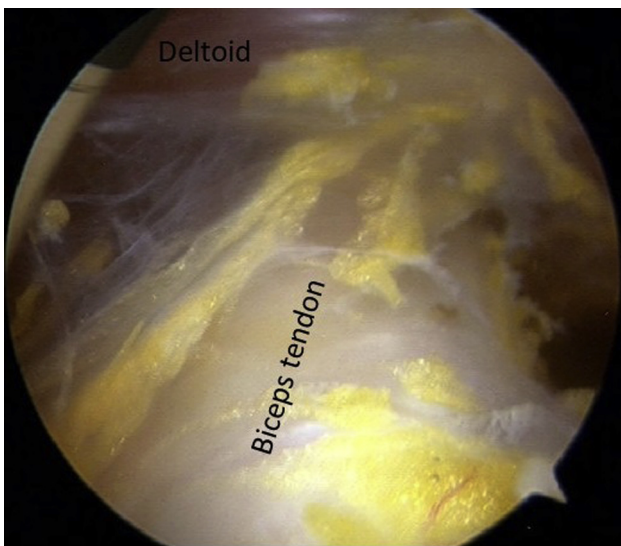


**Fig 1.** Intra-articular fixation of the biceps with a spinal needle and tenotomy of the left shoulder. View from the posterior portal.

We suggest a technique of proximal subpectoral arthroscopic tenodesis, which combines the advantages of the location in the subpectoral zone with an all-suture anchor and that of soft-tissue tenodesis to the pectoralis major tendon, which can be performed fully arthroscopically, improving results in terms of healing by increasing the contact area.

### Surgical Technique

The proximal subpectoral arthroscopic tenodesis technique is performed with a patient in the beach-chair position and the injured arm under 1.5 kg of traction. This technique implements 3 standard portals:

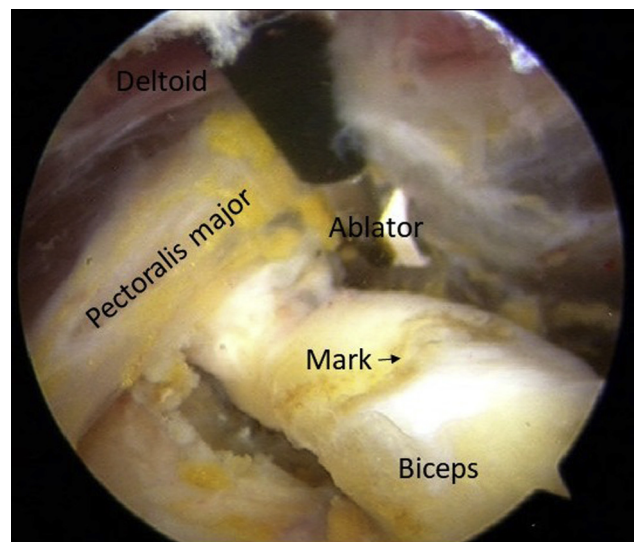


**Fig 2.** Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal. Identification of the biceps groove and the superior edge of the pectoralis major.



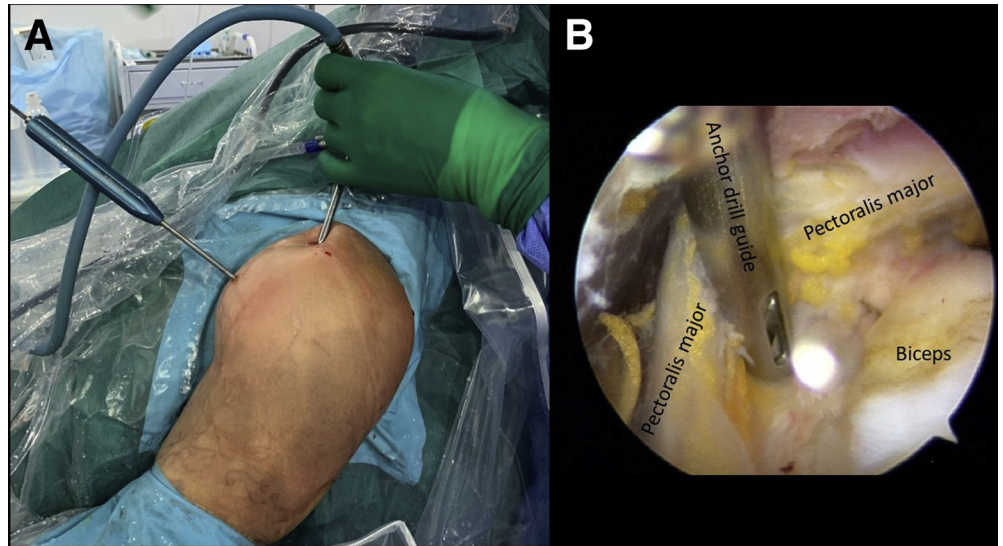
**Fig 3.** Extra-articular view of the left shoulder. Creation of the suprapectoral portal. Arthroscope is inserted through the anterior superior portal, and the ablator is placed through the suprapectoral portal.

the posterior portal; anterosuperior and lateral portal; and an additional suprapectoral portal, which is located 3 to 4 cm inferior to the standard anterior-superior



**Fig 4.** Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal. The long head of the biceps is marked 1 to 2 cm proximal to the tenodesis site.

**Fig 5.** All-suture anchor insertion under the superior third of the pectoralis major tendon. (A): Extra-articular view of the left shoulder. (B) Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal.



portal in the projection of the cross-section of the biceps groove at the insertion site of the superior edge of the pectoralis muscle tendon.

After diagnostic arthroscopy, the biceps tendon is fixed with a spinal needle. Then, after the tenotomy of the long biceps head (Fig 1), an arthroscope is inserted

into the anterior-superior portal and placed into the subdeltoid space (Fig 2). After mobilization of the tendon, the biceps is marked at 1 to 2 cm proximal to the tenodesis site using an ablator, and the spinal needle is removed (Figs 3 and 4).

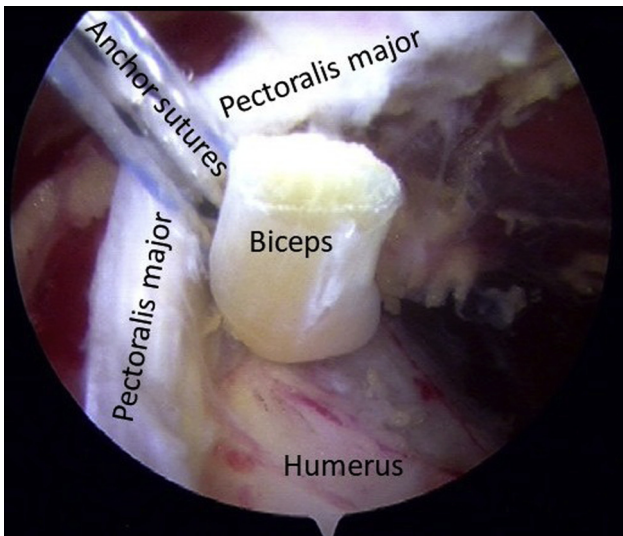
Next, a double-loaded all-suture anchor is inserted under the proximal part of the pectoralis major tendon via the additional suprapectoral portal, 15 mm distally to the superior boarder of the pectoralis major tendon (Fig 5). Anchor should not be located more than 25 mm



**Fig 6.** Extra-articular view of the left shoulder. Using a grasper, the long head of the biceps is captured and pushed through the suprapectoral portal.



**Fig 7.** Extra-articular view of the left shoulder. The biceps tendon is sutured to both threads of the anchor with several Krackow stitches.



**Fig 8.** Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal. The graft is fixed under the proximal third of the pectoralis major tendon.

distally from the superior boarder of pectoralis major tendon concerning the normal anatomy of muscular tendon junction described by Denard et al.<sup>2</sup> A grasper is then used to capture and move the long head of the biceps tendon through the same portal (Fig 6). Subsequently, the biceps tendon is sutured to both threads of the anchor with several Krackow stitches (Fig 7). The free ends of the sutures are passed through the biceps tendon as well (5 mm distal to the last Krackow stitch). Afterwards, the end of the biceps tendon is cut 1 cm proximal to the stitched portion of the tendon.

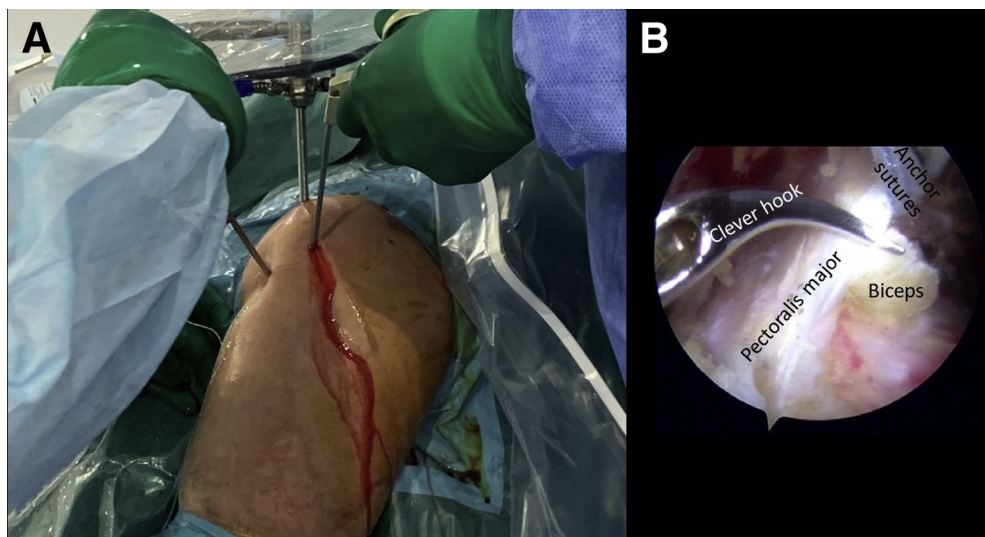
After pulling the free ends of the thread, the tendon can be easily slid into the subpectoral space and checked using the arthroscope. Thereafter, the tendon is fixed to the bone with knots (Fig 8). Next, the ends of the sutures are passed through the proximal part of the pectoralis major tendon via a Clever Hook (DePuy Synthes, Raynham, MA), placed through the lateral portal (Figs 9 and 10), and the sutures are fixed to the pectoralis major tendon with knots (Fig 11). Finally, all sutures are transported through the subpectoral portal, fixed, and inspected with an arthroscope.

Table 1 and Video 1 summarize the steps of this procedure. Fig 12 shows 4-month postoperative magnetic resonance image where good healing in the biceps tendon at the subpectoral area of a patient's left shoulder could be seen. No biceps asymmetry was observed (Fig 13).

## Discussion

The 2 principal treatment options for biceps tendinopathy are tenotomy and tenodesis.<sup>11</sup> The advantages of tenotomy include the rapid completion of the procedure and the lack of technical demand required, whereas its disadvantages include residual pain and Popeye-sign deformity, especially in men and athletic women.

Meta-analyses on biceps tenodesis generally show that arthroscopic intra-articular tenodesis results in a high incidence of bicipital groove pain.<sup>12</sup> This may be explained by the inflammation and biceps degeneration associated with intra-articular tenodesis, which can extend extra-articular to the bicipital groove and below.



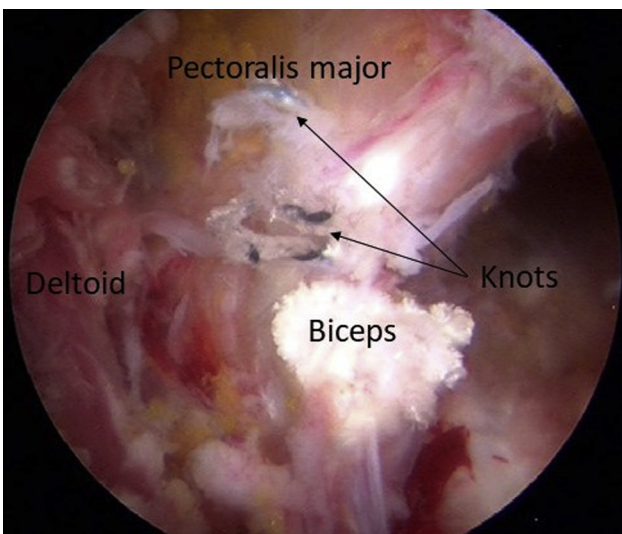
**Fig 9.** The ends of the sutures are passed through the upper third of the pectoralis major tendon via the standard lateral portal with a Clever Hook (DePuy Synthes, Raynham, MA) suture grasper. (A) Extra-articular view of the left shoulder. Arthroscope is placed through the anterior superior portal, the Clever Hook is placed through the anterior lateral portal, switching stick is placed through the suprapectoral portal as a retractor for better view. (B) Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal.



**Fig 10.** Arthroscopic view of subdeltoid space of the left shoulder through the anterior superior portal. The free ends of the sutures are passed through the pectoralis major tendon. \*Anchor sutures

Therefore, if tenodesis is performed proximal to the inflammation site, the inflammation can spread to the bicipital groove, resulting in bicipital groove pain. This explains why subpectoral tenodesis, in comparison, can provide excellent results in professional athletes.<sup>4</sup>

However, the disadvantages of subpectoral tenodesis include possible scar formation and biceps elongation due to the muscle part of the long head of the biceps being located under the inferior border of the pectoralis major tendon. Moreover, if the tendinous part is fixed, the muscle belly can be displaced distally and cause biceps asymmetry because muscle tendon junction is located



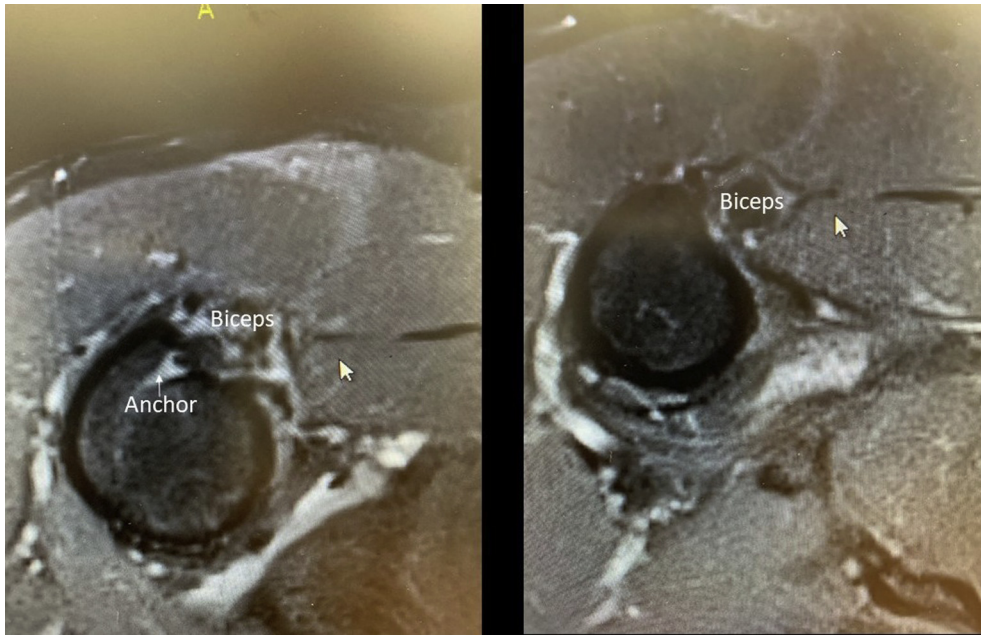
**Fig 11.** Arthroscopic view of subdeltoid space of the left shoulder after proximal subpectoral tenodesis. The biceps tendon is fixed to the all-suture anchor and proximal part of pectoralis major tendon.

**Table 1.** Steps of the Arthroscopic Proximal Subpectoral Tenodesis Procedure

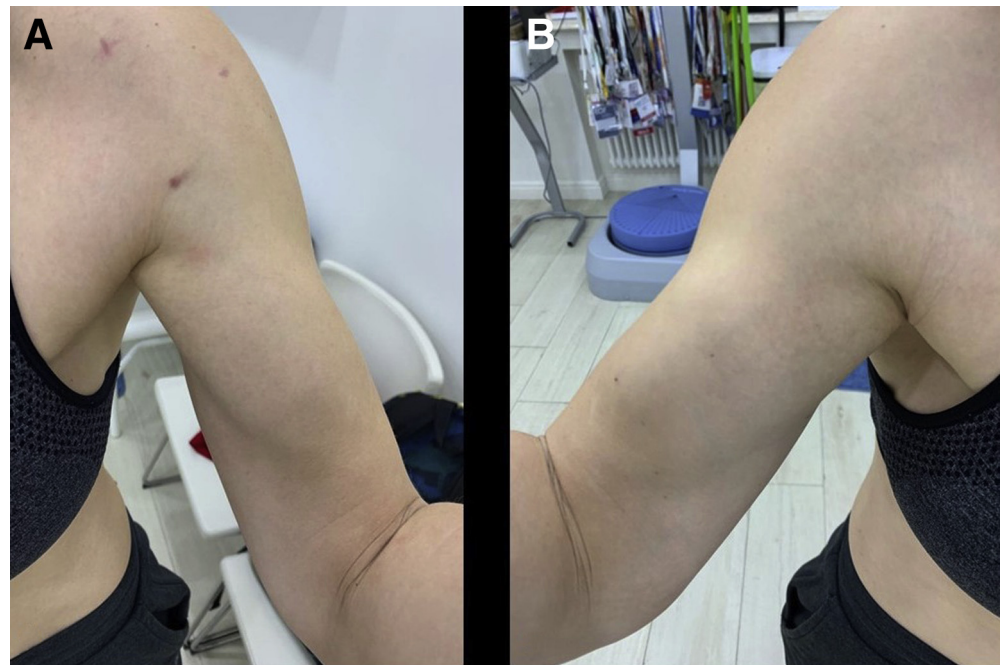
Step Number	Step Description
Step 1	Intra-articular fixation of the biceps with a spinal needle and tenotomy of the long head of the biceps
Step 2	Placement of the arthroscope in the subdeltoid space and identification of the biceps groove and the superior edge of the pectoralis major
Step 3	Creation of the suprapectoral portal
Step 4	Marking the biceps 1-2 cm proximal to tenodesis site with an ablator
Step 5	All-suture anchor insertion under the superior third of the pectoralis major tendon
Step 6	Capturing the long head of the biceps with a grasper and pushing it through the suprapectoral portal
Step 7	Extra-articular suturing of the tendon with Krackow stitches
Step 8	Repositioning of the tendon by pulling the free ends of the sutures
Step 9	Initial graft fixation
Step 10	Placement of the free ends of sutures under the pectoralis major tendon
Step 11	Passing the ends of the sutures through the upper third of the pectoralis major tendon via the standard lateral portal with a Clever Hook suture grasper
Step 12	Making the knots on the pectoralis major tendon through the suprapectoral portal and final inspection

20 mm proximally to the lower boarder of pectoralis muscle tendon, and 2.5 cm distally from the superior boarder of pectoralis major.<sup>2</sup> It is very difficult to retract the lower boarder of pectoralis tendon from the small incision and it should be significantly extended, which is not good for cosmetic results and scar formation.

The most popular methods for biceps fixation in the subpectoral area are the use of suture anchors and interference screws. The advantages of interference screw fixation include simplicity, the maintenance of muscle tendons and soft-tissue units, and the prevention of length–tension relationships. However, interference screw fixation has several complications, such as unsuccessful tenodesis, hematoma formation, seroma formation, infection, bioabsorbable screw reaction, persistent bicipital pain, neurovascular injury, and fractures.<sup>13</sup> Further, while all-suture anchors can be used for tenodesis as an alternative method for fixation,<sup>14</sup> this method also has several disadvantages, such as micromotion and the delayed healing of the biceps. To overcome this disadvantage, we describe an arthroscopic technique that combines all-suture anchor fixation and soft tissue fixation to the proximal part of the pectoralis major tendon. Soft-tissue tenodesis to the proximal part of pectoralis major tendon is a well-known step in shoulder arthroplasty surgery.<sup>10</sup> Moreover, the suggested technique helps to increase the healing contact area.



**Fig 12.** Four-month post-operative magnetic resonance image shows good healing in the biceps tendon at the sub-pectoral area of a patient's left shoulder. Axial view.



**Fig 13.** Comparison of the left and right shoulder at 4 months after the procedure. No biceps asymmetry is observed. (A) Left shoulder (operated). (B) Right shoulder (nonoperated).

**Table 2.** Advantages and Disadvantages of Proximal Subpectoral Arthroscopic Tenodesis

Advantages	Disadvantages
Arthroscopic approach	Possible residual deformity of the biceps
Combines soft tissue and anchor fixation	Potential risk of nerves injury during the soft-tissue fixation step
Larger area of healing	
The biceps is sutured extra-articularly with Krackow stitches, increasing strength of fixation, which significantly simplifies the procedure	
Lower risk of complications than interference screw fixation	

**Table 3.** Pearls and Pitfalls of Our Proximal Subpectoral Arthroscopic Tenodesis Technique

Pearls	Pitfalls
Creation of the suprapectoral portal for anchor placement is critical to the success of our procedure	In the case of a poor-quality pectoralis major tendon, additional fixation can be skipped
Good visualization of the anterior and posterior surfaces of the entire pectoralis major tendon is critical to the success of the procedure	During the perforation of the pectoralis major tendon with Clever Hook, the tip of the grasper should always be under the surgeon's direct view to avoid the potential risk of nerve injury
If soft-tissue bridges obstruct the view after the initial biceps fixation, the bridges should be released via an ablator for a better view	Anchor should not be located more than 25 mm distally from the superior boarder of pectoralis major tendon concerning the normal anatomy of muscular tendon junction
Solid additional fixation of the biceps to the pectoralis major tendon is not critical because anchor fixation in most cases is enough for good healing	

We divided subpectoral tenodesis in proximal and distal depending on the direction of the fixation device. If it is inserted under the superior boarder, it is proximal subpectoral tenodesis, if it is inserted classic distal way under inferior boarder of pectoralis major tendon, it is distal subpectoral tenodesis.

Our technique, the proximal subpectoral arthroscopic tenodesis, can be performed fully arthroscopically, which is the main advantage of it. Moreover, it combines the advantages of subpectoral tenodesis, all-suture anchor fixation, and soft-tissue fixation to the pectoralis major tendon to significantly increase the healing area and diminish micromotions. In addition, it improves biomechanical properties such as stiffness and fixation strength. Moreover, the biceps is sutured extra-articularly with Krackow stitches, increasing the strength of fixation, which significantly simplifies the procedure and decreases the operative time. Finally, our procedure poses a lower risk of complications than interference screw fixation. However, there are several disadvantages to this technique. First, possible residual deformity of the biceps may occur. Moreover, there is a potential risk of radial nerve injury during the soft tissue fixation step. The advantages and disadvantages of this method are summarized in [Table 2](#).

[Table 3](#) describes the pearls and pitfalls that we had experienced during the implementation of our technique.

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