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Results of Biceps Tenotomy in The Treatment of Shoulder Impingement and Rotator Cuff Tears

Ahmet Nadir Aydemir[1], Selim Ergün[1], Levent Berkem[2], Oğuz Şükrü Poyanlı[3], İrfan Esenkaya[4], Hüsnü Kaya Akan[3]

[1]Marmara University Pendik Training and Research Hospital, Department of Orthopedics and Traumatology, İstanbul
[2]Haseki Training and Research Hospital Orthopedics and Traumatology Clinic, İstanbul
[3]Göztepe Training and Research Hospital, 1. Orthopedics and Traumatology Clinic, İstanbul
[4]Medeniyet University Medical Faculty, Department of Orthopedics and Traumatology, İstanbul

ÖZET

Omuz sıkışma sendromu ve rotator manşet yırtığı cerrahi tedavisine biceps tenotomisinin etkileri

Amaç: Bu çalışmada omuz sıkışma sendromu ve rotator manşet yırtığı cerrahi tedavisinde yapılan biceps tenotomisinin tedavi sonuçları üzerine olan etkisi değerlendirilmiştir.

Gereç ve Yöntem: 23 omuz değerlendirmeye alınmıştır. Ortalama yaşları 55.1 olan hastalar ortalama 32.6 ay takip edildi. Hastalar teşhislerine ve yapılan cerrahi müdahaleye göre dört ayrı gruba ayrılmıştır. Grup 1 subakromiyal dekompresyon uygulanan 5 omuz, Grup 2 subakromiyal dekompresyon ve biceps tenotomisi uygulanan 7 omuz, Grup 3 subakromiyal dekompresyon ve rotator manşet tamiri uygulanan 5 omuz, Grup 4 subakromiyal dekompresyon, rotator manşet tamiri ve biceps tenotomisi uygulanan 6 omuzdan oluşmaktadır. Çalışmada grup 2, kontrol grubu olarak değerlendirilen grup 1 ile, grup 4 de kontrol grubu olarak değerlendirilen grup 3 ile karşılaştırılmıştır. Gruplar operasyon öncesi ve sonrası Constant ve UCLA (University of California, Los Angeles) omuz skorları ile değerlendirilmiştir. Sonuçlar, anlamlılık $p<0.05$ düzeyinde olacak şekilde değerlendirilmiştir.

Bulgular: Grup 3 hariç tüm gruplarda ameliyat öncesine göre anlamlı düzelme görülmüştür.

Sonuç: Omuz sıkışma sendromu ve rotator manşet yırtığı cerrahisi tedavisinde eklenen artroskopik biceps tenotomisi basit, hızlı ve ameliyat sonrası ek rehabilitasyona gerek duyulmaması nedeniyle de tedavide iyi bir seçenek olarak düşünülebilir.

Anahtar kelimeler: Rotator kılıf, tenotomi, omuz sıkışma sendromu

ABSTRACT

Results of biceps tenotomy in the treatment of shoulder impingement and rotator cuff tears

Objective: Outcomes of biceps tenotomy with surgical treatment of rotator cuff tears and subacromial impingement was evaluated.

Materials and Methods: Twenty-three shoulders were evaluated. Average age was 55.1 and patients were followed up meanly for 32.6 months. Patients were randomized into 4 groups according to their diagnosis and surgical treatment. Group 1 had 5 shoulders subacromial decompression performed alone, group 2 had 7 shoulders with additional biceps tenotomy. Group 3 had 5 shoulders subacromial decompression and rotator cuff repair performed, group 4 had 6 shoulders with additional biceps tonotomy. Group 2 was compared with group 1 as a control group and group 4 with group 3. Groups were compared according to their own preoperative and postoperative Constant and UCLA rating scales. The level of significance was set at $p<0.05$.

Results: Except group 3, postoperative significant increase in scores was detected in all groups.

Conclusion: As a result, arthroscopic tenotomy of long head of biceps tendon is easy and quick, with less need of post operative rehabilitation compared to tenodesis.

Key words: Rotator cuff, tenotomy, shoulder impingement syndrome

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Yazışma adresi / *Address reprint requests to:* Dr. Selim Ergün
Marmara University, Pendik Training and Research Hospital, Orthopedics and Traumatology Clinic, İstanbul

Telefon / *Phone:* +90-533-601-1472

Elektronik posta adresi / *E-mail address:* drselimergun@gmail.com

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INTRODUCTION

Shoulder has the widest range of joint motion in human body, that is why we see much more problems of shoulder in compare to other joints. Subacromial impingement and rotator cuff pathologies are the most frequent ones. Working conditions, sports injuries and degenerative changes are some of the reasons for these pathologies.

Studies show us that either subacromial impingement or rotator cuff tears are usually accompanied by lesions of long head of biceps brachii tendon (LHBT). Lesions of the LHBT are common and when not treated, they may be responsible for persistent pain, as well as functional impairment of the shoulder. LHBT lesions might be alone but more frequently they are associated with more complex disorders, such as shoulder instability or supraspinatus tendon tears.

The long head of biceps brachii tendon which arises from the superior labrum at the supraglenoid tubercle above the humeral head and has a long tendinous portion which traverses a substantive route within the shoulder and then extra-articular before joining the musculo-tendinous junction at the level of the humeral neck. LHBT has a weak depression effect in association with the intact cuff depressing the humeral head. If there is massive rotator cuff tear, depressing and stabilizing effect of supraspinatus on humeral head will be diminished and humeral head will move proximally. LHBT will try to prevent this migration. Stabilizing and even a little depressing effects of LHBT have been shown in biomechanical studies on cadaver (1,2). Kido et al. showed the active depressor effect of LHBT in shoulders with rotator cuff tears (3). While depressing the shoulder, LHBT will impinge between acromion and humeral head. Besides, tendinits will occur because of inflammation. This situation is an important additional factor on shoulder pain in patients with rotator cuff tears. The decision about whether to proceed with conservative or surgical management of LHBT lesions might depend on the associated shoulder disorders and the duration of the symptoms.

In presence of chronic impingement and rotator cuff tears which do not respond to conservative managements (rotator cuff strengthening exercises, subacromial steroid injections, etc.), surgery may be the choice of treatment. Purpose of the surgery either arthroscopic or open, is subacromial decompression, removal of the bony spurs beneath the acromion and repair of the rotator cuff tear if possible.

Surgical management of lesions of LHBT is tenotomy or tenodesis of the tendon. However functional outcome after tenotomy is a contradiction. Many studies including electromyographic (EMG) measurements show the long head of biceps muscle as an elbow controlling muscle rather than shoulder. Based on this evidence, tenotomy of long head of biceps will have few limitationon shoulder joint movements (4-6).

In this study we aimed to show clinical effects of tenotomy of LHBT on patients who referred our clinic with shoulder pain and diagnosed with subacromial impingment syndrome with or without a rotator cuff tear.

MATERIAL AND METHODS

Between the years 2005-2010, inGöztepe Training and Research Hospital, forty three shoulders of forty two patients (male and female patients, aged 30 years and older) diagnosed withsubacromial impingement syndrome with an intact rotator cuff tendon or a rotator cuff tear (partial or full thickness tears), accompanying LHBT lesions (tenosynovitis, subluxation, dislocation or partial rupture of the tendon), met the criteria for enrollment, and treated surgically due to the failure of conservative treatment. However only twenty three shoulders of twenty two patients could be followed up and included for the study. Patients with following criteria were excluded: *(1)* previous surgery of the affected shoulder, *(2)* mental handicap, *(3)* a lack of willingness to return for all scheduled follow-up visits, *(4)* any previous upper extremity neurological disorder or diagnosis based upon physical examination, *(5)* acute (<3 months) complaints.

This study would seek to compare the efficacy of biceps tenotomy in the treatment of subacromial impingement syndrome and rotator cuff tears. The end point would be the postoperative differences in Constant and UCLA shoulder scores between the groups in follow-up. Patients were catogorized according to their diagnoses and surgical managements. Average age was 55.1 and patients were followed up for average 32.6 months. Patients were randomized into four groups according to their diagnosis and surgical treatments. Group 1 was

composed of five shoulders and only subacromial decompression was performed; Group 2 was composed of seven shoulders, subacromial decompression and tenotomy of LHBT were performed; Group 3 was composed of five shoulders, subacromial decompression and rotator cuff repair were performed; Group 4 was composed of six shoulders, subacromial decompression, rotator cuff repair and tenotomy of LHBT were performed (Table 1, 2). In this study, rotator cuff tear patterns were radiologically classified by senior author according to Magnetic Resonance Imaging (MRI) views. Classification was done according to Southern California Orthopaedic Institute rotator cuff classification system (SCOI) (Table 1), and rotator cuff repair was done only in patients with class A3, A4, B3, B4, or C1 to C4 rotator cuff tears. However patient selection for tenotomy of LHBT was done randomly. By the way all patients in group 1 and group 2 had the same radiological (MRI) features preoperatively, also in group 3 and group 4 as well.

Surgical Technics and Post-operative Rehabilitation

All patients were operated in beach chair position and under general anesthesia. First diagnostic arthroscopic view of subacromial area was performed. Subacromial decompression was performed to all patients arthroscopically. Then after, tenotomy of LHBT was also performed arthroscopically in group 2 and group 4. Rotator cuff repairs were performed with mini-open technique. However, one patient with massive-retracted rotator cuff tear could not be repaired and only subacromial decompression and tenotomy of LHBT was performed. Popeye sign was detected in two patients after tenotomy of LHBT. Hemovac drain was used in every patient. Patients with rotator cuff repairs were follwed up by arm sling with a 30 degree abduction pillow, and others with an only arm sling. All patients were taken to physical theraphy and follow-up program at the second day postoperatively.

Evaluations were done with Constant and UCLA shoulder scala tests preoperatively and postoperatively. Statistical analyses were done by the use of NCSS 2007 pack program. Group datas were evaluated by Wilcoxon test. Mann-Whitney-U test was used to compare datas in between groups and Chi-Square test to compare qualitative datas. Statistical significance was determined at a p value less than 0.05.

RESULTS

All the twenty two patients were followed up post-operatively at a mean 32.6 months period. Ten of twenty three shoulders in this study were in the group without tenotomy of LHBT and remaining thirteen shoulders were in the group with tenotomy of LHBT. Groups showed no significant differences in age population, except group 3 (49.6±4.56) was younger than group 4 (65.17±10.63), ($p<0.05$).

Post-operative Constant scores had a statistically significant increase when compared to pre-operative ones in group 1 (19.4±11.74 to 67.6±9.92; $p<0.05$), group 2 (33±20.08 to 69.14±17.14; $p<0.05$) and group 4 (20.83±5.38 to 67.33±22.54; $p=0.028$) (Table 3, 4). However, group 3 didn't have a similar increase between preoperative (31.4±24.38) and postoperative (73.8±10.38) Constant scores ($p>0.05$). When Constant scores of groups 1 and 2 were compared with each other

Table 1: Southern California Orthopaedic Institute Rotator Cuff Classification System (18)

Comprehensive classification including the size position and quality of tendon.

Location

A - Articular surface
B - Bursal surface
C - Complete tear

Partial thickness tears (A or B)

0 - Normal
1 - Minimal superficial bursal or synovial irritation or slight capsular fraying over a small area
2 - Fraying and failure of some rotator cuff fibres in addition to synovial bursal or capsular injury.
3 - More severe rotator cuff injury fraying and fragmentation of tendon fibres often involving the whole of a cuff tendon, usually <3cm
4 - Very severe partial rotator cuff tear that contains a sizeable flap tear and more than one tendon

Full thickness rotator cuff tears (C)

C1 - Small complete tear, pinhole sized
C2 - Moderate tear <2cm of only one tendon without retraction
C3 - Large complete tear with an entire tendon with minimal retraction usually 3-4 cm
C4 - Massive rotator cuff tear involving 2 or more rotator cuff tendons with associated retraction and scarring of the remaining tendon.

Table 2: Patient properties (M: Male, F: Female, D: Subacromial decompression, D+R: Subacromial decompression and rotator cuff repair)

Patient	Age	Gender	Side	Operation	Tenotomy of LHBT	Preop constant	Postop constant	Preop UCLA	Postop UCLA	Follow up (months)
1	60	M	R	D	-	26	73	7	34	67
2	60	M	R	D	-	12	65	6	34	25
3	38	M	R	D	-	37	58	16	17	42
4	48	F	L	D	-	10	60	5	31	22
5	67	M	R	D	-	12	82	7	35	19
6	65	F	R	D	+	31	37	14	15	68
7	55	M	L	D	+	67	85	20	35	54
8	56	M	L	D	+	16	86	7	35	64
9	52	F	L	D	+	8	72	7	32	48
10	47	F	R	D	+	36	79	11	35	30
11	31	F	R	D	+	49	63	14	15	47
12	50	F	L	D	+	24	62	10	35	32
13	45	M	R	D+R	-	8	86	7	35	46
14	47	M	R	D+R	-	63	63	19	19	16
15	57	F	R	D+R	-	23	65	7	26	28
16	49	M	L	D+R	-	51	83	13	31	11
17	50	F	R	D+R	-	12	72	6	35	10
18	78	M	L	D+R	+	24	71	8	35	44
19	65	F	R	D+R	+	20	71	10	35	10
20	56	F	R	D+R	+	12	83	6	35	32
21	78	M	R	D+R	+	19	25	7	10	10
22	54	F	R	D+R	+	22	65	9	29	13
23	60	F	R	D+R	+	28	89	10	32	12

Table 3: Constant score comparison between groups 1 and 2

	Group 1		Group 2			
Constant	**Mean±SD**	**Median**	**Mean±SD**	**Median**	**MW**	**p**
Pre-operative	19.4±11.74	12 (11-31.5)	33±20.08	31 (16-49)	11	0.290
Post-operative	67.6±9.92	65 (59-77.5)	69.14±17.14	72 (62-85)	14	0.570
Z	-2.02		-2.37			
P	0.043		0.018			

Table 4: Constant score comparison between groups 3 and 4

	Group 3		Group 4			
Constant	**Mean±SD**	**Median**	**Mean±SD**	**Median**	**MW**	**p**
Pre-operative	31.4±24.38	23 (10-57)	20.83±5.38	21 (17.25-25)	13.5	0.784
Post-operative	73.8±10.38	72 (64-84.5)	67.33±22.54	71 (55-84.5)	14	0.854
Z	-1.83	-2.20				
P	0.068	0.028				

according to their pre- and post-operative Constant values, no statistically significant difference was detected. Group 3 and 4 also did not have a statistically significant difference in between pre- and post-operative Constant scoreswhen compared to each other (Table 3, 4).

As such in Constant score, post-operative UCLA scores showed smilar increase when compared to pre-operative ones in group 1 (8.2±4.44 to 30.2±7.53; p<0.05), group 2 (11.86±4.6 to 28.86±9.53; p<0.05) and group 4 (8.33±1.63 to 29.33±9.77; p<0.05). However, group 3 didn't show a statistically significant increase in between preoperative (10.4±5.55) and postoperative (29.2±6.8) UCLAscores.When UCLA scores of groups 1 and 2 were compared with each other according to their pre- and post-operative scores, no statistically significant difference was detected. Group 3 and 4 also did not have a statistically significant difference in pre- and post-operative UCLA scores when compared to each other (Table 5, 6).

Table 5: UCLA score comparison between groups 1 and 2

	Group 1		Group 2			
UCLA	**Mean±SD**	**Median**	**Mean±SD**	**Median**	**MW**	**p**
Pre-operative	8.2±4.44	7 (5.5-11,5)	11.86±4.6	11 (7-14)	8	0.116
Post-operative	30.2±7.53	34 (24-34.5)	28.86±9.53	35 (15-35)	15	0.673
Z	-2.03	-2.38				
P	0.042	0.018				

Table 6: UCLA score comparison between groups 3 and 4

	Group 3		Group 4			
UCLA	**Mean±SD**	**Median**	**Mean±SD**	**Median**	**MW**	**p**
Pre-operative	10.4±5.55	7 (6.5-16)	8.33±1.63	8.5 (6.75-10)	14.5	0.926
Post-operative	29.2±6.8	31 (22.5-35)	29.33±9.77	33.5 (24.25-35)	13	0.702
Z	-1.83	-2.20				
P	0.068	0.028				

Figure 1a: Pre-operative anteroposterior (AP) radiography of the right shoulder shows osteophytes in subacromial space.

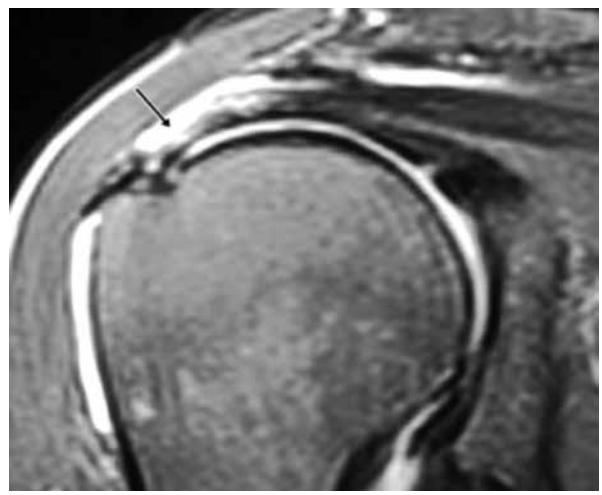

Figure 1b: Pre-operative MRI of the right shoulder. Coronal slide shows edema in subacromial bursa and partial tear in supraspinatus tendon.

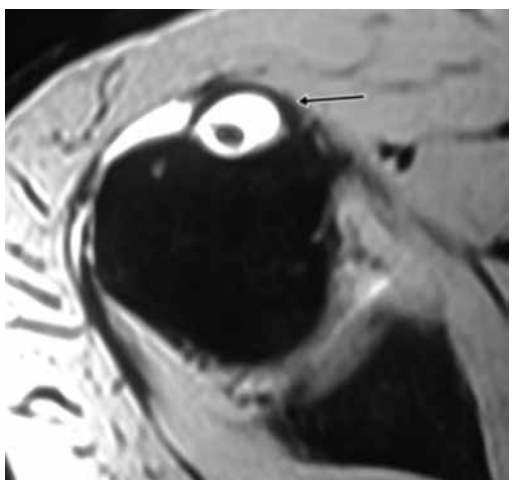

Figure 1c: Pre-operative MRI of the right shoulder. Axial slide shows biceps tendon sheath fluid collection.

Figure 1d: Post-operative AP radiography of the right shoulder shows burrred osteophytes in subacromial space.

Figure 2a: Pre-operative anteroposterior (AP) radiography of the right shoulder shows osteophytes in subacromial space.

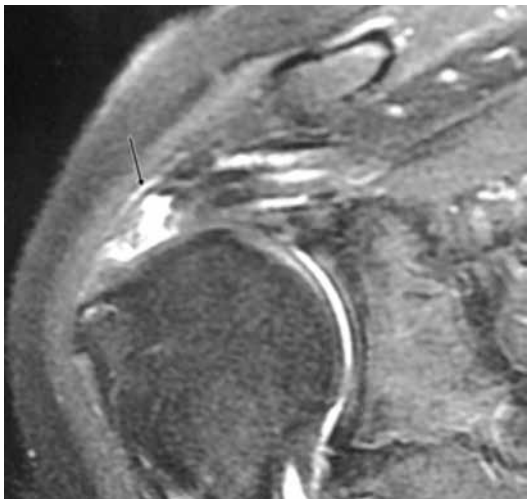

Figure 2b: Pre-operative MRI of the right shoulder. Coronal slide shows edema in subacromial bursa and full-thickness tear in supraspinatus tendon.

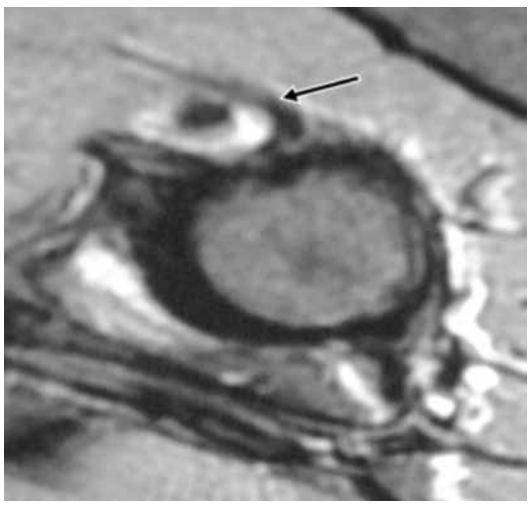

Figure 2c: Pre-operative MRI of the right shoulder. Axial slide shows biceps tendon sheath fluid collection.

Figure 2d: Post-operative AP radiography shows anchors used in rotator cuff repair.

Case Samples

Case 1; 60 years old male patient, subacromial decompression was done on right shoulder (Figure 1 a,b,c,d,).

Case 2; 65 years old female patient, subacromial decompression, rotator cuff repair and LHBT tenotomy were done (Figure 2 a,b,c,d).

DISSCUSSION

In a series by Gill et al. including 30 patients with a mean age of 50 years, it was reported that simple arthroscopic tenotomy of LHBT provides a significant pain reduction and an increase in function (7). Klinger et al. evaluated 41 shoulders with irrepairable massive rotator cuff tear and performed 24 subacromial debridement alone and 17 subacromial debridement together with tenotomy of LHBT (8). In both groups, they found a statistically significant increase inpostoperative Constant scores whencompared to the preoperative ones. However there was no statistically significant difference when groups (debridment alone vs. debriment+tenotomy) were compared with each other. Similarly in our study, patients with tenotomy of LHBT showed a significant improvement in postoperative Constant scores compared to the preoperative values. We also observed an improvement in the Constant scores of the patient

groups with tenotomy of LHBT but this improvement was not statistically significant. In our study, mean follow up time was 32.6 months, which is consistent with the study of Klinger et al. Postoperative mean Constant and UCLA scores were found to be inceased in all groups compared with the preoperative values. This increase was again consistent with the literature. Klinger et al. also found the incidence of pain in the early postoperative period was higher in biceps tenotomy group. Whereas in our study, an inter-group pain assessment was not performed in the early postoperative period (8). Maynou et al. in their series including 40 patients, have implemented biceps tenotomy procedure in all patients with irreparable full thickness rotator cuff tear and found successful mid-term follow-up results (9). Boileau et al. in their study have also found similar results showing that biceps tenotomy or tenodesis is useful for the patients with irreparable rotator cuff tear (10). The success of the operation is found to be lower in patients with atrophic teres minor muscle.

Tenosynovitis of LHBT has been charged of being one of the major cause of pain in shoulders with subacromial impingement and rotator cuff pathologies. The two most common procedures for LHBT lesions are tenotomy and tenodesis (11). There is no consensus regarding the most effective surgical procedure. Age, activity level and cosmetic results are the factors affecting the choice of either tenotomy or tenodesis. Some authors have claimed that tenotomy is superior because it has the advantages of easier execution and, when performed alone, needs fewer restrictions during the postoperative period with an earlier return to activity and reported satisfactory results in most patients treated with this technique. On the other hand postoperative pain, muscle cramping and cosmetic deformity (retraction of the biceps tendon; popeye sign) are the possible complications of tenotomy. Similar good results in patients treated with tenodesis of the LHBT were reported. This technique is a bit laboring when compared to tenotomy, but seems to be able to prevent some of the mentioned complications (11,12). Koh et al. applied biceps tenodesis in 45 patients with a pathology in the long head of the biceps tendon, as well as tenotomy in 45 patients (13). When these two groups of patients were compared in terms of popeye sign, pain during the contraction of the arm and elbow flexion strength in the postoperative period; It was shown that popeye sign is significantly more common in the tenotomy group. No significant difference was observed between contraction pain and elbow flexion strength (13). In our study, we observed popeye sign in two patients of the tenotomy groups. There was no difference in terms of contraction pain and elbow flexion strength when compared to the healthy sides.

Most of the studies in literature about tenotomy in patients with rotator cuff pathologies have a common point about the clinically inconsiderable complications (11). In a cadaver study conducted by Ahmad et al., the incidence of cosmetic deformities after tenotomy procedure was found to be lower in hypertrophied tenosynovitis of the long head of the biceps. They observed that a more force is required to cleave the hypertrophied tendon compared to the intact one (14). In a study conducted by Kelly et al. it was reported that 70% of 160 patients have "Popeye" sign and 38% had the complaint of elbow pain and loss of strength (15). "Popeye" sign is a cosmetic problem described as a bulking of biceps on anterior and distal part of the arm, which was seen in 2 out of 23 shoulders and not considered as a problem by both these patients in our series. None of our patients had loss of the shoulder stability, radiological evidence of glenohumeral joint arthrosis, and loss of the strength of the elbow joint.

Another issue mentioned in the literature is the superior migration of the humeral head and possible resulting acromiohumeral and glenohumeral arthritis due to the removal of inhibitory effect of the tendon after tenotomy. In an article published by Szabo together with Boileau and Walch, it was showed that the fatty degeneration of the infraspinatus muscle is the most important factor in narrowing of the acromiohumeral distance after tenotomy or tenodesis of LHBT performed in a total of 379 shoulders. Additively, they showed that tenotomy of LHBT procedure have no effect on the progression of radiographic changes regarding the development of glenohumeral arthritis (16-18). In our series, despite the short follow-up period, none of the patients had a radiological evidence of progressive glenohumeral joint arthrosis.

The weak points of our study have been considered to be the small number of the patient population, the presence of a bias emerging from inter-evaluator variability of the muscle assessments, and the absence of an objective measurement criteria used to measure

compliance with home exercise program.

As a result of this study, in consistent with the other studies in the literature, tenotomy of LHBT can be performed in patients with subacromial impingement syndrome, rotator cuff pathology and biceps tendon complaints. Unnecessity of additional rehabilitation program and being an easier process than tenodesis can be considered as an advantage of the biceps tenotomy. Randomized prospective studies with a large number of patients are needed to show if biceps tenotomy is more advantageous than the other treatment procedures of biceps tendon.

REFERENCES

1. Kumar VP, Satka K, Balasubramaniam P. The role of the long head of the biceps brachii in stabilization of the head of the humerus. Clin Orthop1989; 244: 172-175.
2. Rodosky MW, Harner CD, Fu FH. The role of the long head of the biceps muscle and superior glenoid labrum in anterior stability of the shoulder. Am J Sports Med 1994; 22: 121-130.
3. Kido T, Ido T, Itoi E, et al. The depressor function of biceps on the head of the humerus in shoulders with tears of the rotator cuff. J Bone Joint Surg 2000; 820: 416-419.
4. Bradley JP, Tibone JE. Electromyographic analysis of muscle action about the shoulder. Clin Sports Med 1991; 10: 270-284.
5. Gowan ID, Jobe FW, Tibone JE, Perry J, Moynes DR. A comparative electromyographic analysis of the shoulder during pitching: Professional versus amateur pitchers. Am J Sports Med 1987; 15: 586-590.
6. Walch G. Arthroscopic tenotomy of the long head of biceps in rotator cuff ruptures. In: Gazielly DF, Gleyze P, Thomas T (Eds). The cuff. Paris: Elsevier, 1997: p. 350-355.
7. Gill TJ, McIrvin E, Mair SD, Hawkins RJ. Results of biceps tenotomy for treatment of pathology of the long head of the biceps brachii. J Shoulder Elbow Surg 2001; 10: 247-249.
8. Klinger HM, Spahn G, Baums MH, Steckel H. Arthroscopic debridement of irreparable massive rotator cuff tears: A comparison of debridement alone and combined procedure with biceps tenotomy. Acta Chir Belg 2005; 105: 297-301.
9. Maynou C, Mehdi N, Cassagnaud X, Audebert S, Mestdagh H. Clinical results of arthroscopic tenotomy of the long head of the biceps brachii in full thickness tears of the rotator cuff without repair: 40 cases Rev Chir OrthopReparatrice Appar Mot 2005; 91: 300-306.
10. Boileau P, Baqué F, Valerio L, et al. Isolated arthroscopic biceps tenotomy or tenodesis improves symptoms in patients with massive irreparable rotator cuff tears.J Bone Joint Surg Am 2007; 89: 747-757.
11. Hsu SH, Miller SL, Curtis AS. Long head of biceps tendon pathology: management alternatives. Clin Sports Med 2008; 27: 747-762.
12. Bicos J. Biomechanics and anatomy of the proximal biceps tendon. Sports Med Arthrosc Rev 2008; 16: 111-117.
13. Koh KH, Ahn JH, Kim SM, Yoo JC. Treatment of biceps tendon lesions in the setting of rotator cuff tears: Prospective cohort study of tenotomy versus tenodesis. Am J Sports Med 2010; 38: 1584-1590.
14. Ahmad CS, Di Sipio C, Lester J, Gardner TR, Levine WN, Bigliani LU. Factors affecting dropped biceps deformity after tenotomy of the long head of the biceps tendon. Arthroscopy 2007; 23: 537-541.
15. Kelly AM, Drakos MC, Fealy S, et al. Arthroscopic release of the long head of the biceps tendon: functional outcome and clinical results. Am J Sports Med 2005; 33: 208-213.
16. Szabo I, Boileau P, Walch G. The proximal biceps as a pain generator and results of tenotomy. Sports Med Arthrosc 2008; 16: 180-186.
17. Walch G, Edwards TB, Boulahia A, et al. Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: clinical and radiographic results of 307 cases. J Shoulder Elbow Surg 2005; 14: 238-246.
18. Snyder SJ (Ed). Shoulder Arthroscopy. Lippincott Williams and Wilkins; Philadelphia, 2003: p. 210-207.