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# Soft tissue debridement around the subscapularis tendon and effects on postoperative shoulder joint early range of motion

## *Subskapularis tendonu etrafında yumuşak doku debridmanı ve ameliyat sonrası omuz eklem erken hareket açıklığına etkileri*

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**Abstract**

**Purpose:** Shoulder joint range of motion (ROM) limitation and pain are the most common clinical conditions and complaints of patients who undergo shoulder arthroscopy. Identifying the possible causes of pain and limitation of the joint motion in the early postoperative period, positively affect both the success of the surgery and patient satisfaction. This study aims to evaluate the effect of soft tissue debridement around the subscapularis muscle tendon on postoperative shoulder ROM.

**Materials and methods:** 155 patients who underwent arthroscopic subacromial decompression for subacromial impingement were investigated and after excluded cases, 97 patients were eligible for this study. The patients were divided into two groups. Group 1 included 54 patients who underwent subscapular soft tissue debridement with RF device and Group 2 included 43 patients who were only operated for subacromial impingement. Postoperative shoulder early ROM and pain scores at the third-month follow-up were used. The data were compared to evaluate the effect of debridement of the surrounding soft tissue adhesions around the subscapularis tendon.

**Results:** The patients who underwent arthroscopic subscapular debridement had a better active internal and external rotation range at third-month follow-up as well as the pain score. There was a statistically significant difference between the two groups in terms of early ROM and pain ($p$=0.001). When the type of adhesion is investigated, it is found that this statistically significant difference is mostly between debridement and non-debridement patients who had synovial hypertrophy ($p$=0.001). Patients who had a combination of synovial hypertrophy and pulley formation also benefited greatly from debridement like synovial hypertrophy alone.

**Conclusion:** Arthroscopic debridement of soft tissue around the subscapularis tendon showed better early ROM and less pain at postoperative third-month follow-up. We believe that debridement of the contiguous soft tissue with an RF device around the subscapularis tendon during arthroscopic shoulder surgery will most likely improve postoperative results and, therefore, should be added.

**Keywords:** Shoulder arthroscopy, soft tissue debridement, subscapularis tendon, postoperative shoulder range of motion.

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**Öz**

**Amaç:** Omuz eklem hareket açıklığı (ROM) kısıtlaması ve ağrı, omuz artroskopisi geçiren hastaların en sık görülen klinik durumları ve şikayetleridir. Ameliyat sonrası erken dönemde ağrı ve eklem hareketi kısıtlamasının olası nedenlerinin belirlenmesi hem cerrahi başarısını hem de hasta memnuniyetini olumlu yönde etkiler. Bu çalışma, subskapularis kas tendonunun çevresindeki yumuşak doku debridmanının ameliyat sonrası omuz hareket açıklığına etkisini değerlendirmeyi amaçlamaktadır.

**Gereç ve yöntem:** Subakromiyal sıkışma sendromu nedeniyle artroskopik subakromiyal dekompresyon yapılan 155 hasta incelendi ve uygun olmayan vakalar hariç tutulduktan sonra 97 hasta çalışmaya dahil edildi.

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Hastalar iki gruba ayrıldı. Grup 1, RF cihazı ile subskapular yumuşak doku debridmanı yapılan 54 hastayı içerirken; Grup 2, sadece subakromiyal sıkışma için ameliyat edilen 43 hastayı içeriyordu. Ameliyat sonrası üçüncü ayda erken omuz hareket açıklığı ve ağrı skorları değerlendirildi. Subskapularis tendonu çevresindeki yumuşak doku yapışıklıklarının debridmanının etkisini değerlendirmek için veriler karşılaştırıldı.
**Bulgular:** Artroskopik subskapular debridman yapılan hastalarda, üçüncü ay takiplerinde aktif iç ve dış rotasyon hareket açıklığı ile ağrı skorları daha iyi bulundu. Erken hareket açıklığı ve ağrı açısından iki grup arasında istatistiksel olarak anlamlı bir fark vardı (*p*=0,001). Yapışıklık türü incelendiğinde, bu istatistiksel farkın çoğunlukla sinovyal hipertrofisi olan debridman ve debridman yapılmayan hastalar arasında olduğu görüldü (*p*=0,001). Sinovyal hipertrofi ve pulley oluşumu kombinasyonu olan hastalar da, sadece sinovyal hipertrofisi olan hastalar gibi debridmandan büyük ölçüde fayda sağladı.
**Sonuç:** Subskapularis tendonu etrafındaki yumuşak dokunun artroskopik debridmanı, ameliyat sonrası üçüncü ay takiplerinde daha iyi erken hareket açıklığı ve daha az ağrı ile ilişkilendirildi. Artroskopik omuz cerrahisi sırasında subskapularis tendonu etrafındaki yumuşak dokunun RF cihazı ile debridmanının ameliyat sonrası sonuçları büyük olasılıkla iyileştireceğini ve bu işlemin eklenmesi gerektiğini düşünüyoruz.

**Anahtar kelimeler:** Omuz artroskopisi, yumuşak doku debridmanı, subscapularis tendonu, ameliyat sonrası omuz hareket açıklığı.

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## Introduction

Limited range of motion is a common complication of shoulder arthroscopy, which leads to substantial loss of function and patient satisfaction [1, 2]. In the literature, the incidence of this complication is reported between 4.9% and 32.7% [3, 4]. Postoperative loss of joint motion may be related to postoperative prolonged immobility or independent factors such as anatomical variations and intra-articular lesions [5].

The subscapularis is the largest and strongest muscle of the rotator cuff [6]. The main role of the subscapularis muscle in joint movements is internal rotation, and it also plays an important role in abduction, flexion, and adduction of the shoulder joint in various positions [6]. Although subscapularis pathologies have been noticed for a long time, they have become more recognized with the widespread use of arthroscopic interventions due to the hard access to the subscapularis tendon without capsulotomy in open surgeries [7, 8]. The radiological diagnosis of the lesions is difficult, and the learning curve is also steep, yet arthroscopic interventions continue to gain importance, and intra-articular lesions become easier to evaluate. As we search the literature, the subscapularis muscle pathologies and their relationship with the surrounding tissues have not been fully enlightened.

Shoulder arthroscopy is applied in an algorithmic observation. The anatomical structures are inspected step by step, and any lesion is considered for surgical intervention. While examining the rotator interval and anterior intra-articular structures, a variety of adhesions is frequently encountered around the subscapularis tendon, which may obstruct tendon movement, as these adhesions also result in early postoperative pain and shoulder stiffness [9]. As to our knowledge and arthroscopic observation, structures that cause limitation in ROM usually appear as severe synovitis, various pulley and hammock-like structures, or a combination of all.

In patients who underwent shoulder arthroscopy, a high rate of active shoulder joint motion limitation is encountered at early clinical follow-ups. Patients generally have severe pain and restriction during active internal and external rotation. In the literature, although some studies investigating possible joint stiffness can be seen [3, 10], there are a limited number of studies investigating the possible intra-articular reasons limiting ROM except adhesive capsulitis [9]. When the reasons causing the pain and early limited ROM are examined and possible causes resolved, the surgeons may most likely experience better clinical results and less pain for the patients.

As to our clinical experience, we occasionally observed rotation limitation in patients who underwent arthroscopic subacromial decompression at early follow-up examinations. Therefore, we decided to investigate the ROM limiting factors of the subscapularis muscle and the effectiveness of debridement of the surrounding soft tissue of the subscapularis muscle tendon in patients operated on in our clinic for subacromial impingement. None of the other pathologies, such as rotator cuff tears, labral pathologies, adhesive capsulitis, and rheumatologic diseases that may cause restriction in range of motion, were included in the study in order to investigate the effects of the subscapular soft tissue adhesions alone. Within this study, we aimed to evaluate the effect of debridement of the soft tissues around the subscapularis tendon in patients treated with arthroscopic surgery for subacromial impingement syndrome on short-term functional outcomes and pain scores.

## Materials and methods

A retrospective study was carried out with the approval of our institutional review board (Mugla Sitki Kocman University, Human Research Ethics Committee (decision number:157, decision date:22.07.2020). We examined the data of 155 patients who underwent arthroscopic shoulder surgery due to subacromial impingement syndrome between January 2016 and January 2020. 97 patients, who had various types of adhesions around the subscapularis tendon and soft tissue pathologies thought to cause limitation in joint movements, were included in this study.

According to our surgical observations, we occasionally observed postoperative rotation limitation in patients who underwent arthroscopic subacromial decompression at short-term follow-up examinations. Therefore, we aimed to investigate the possible causes of postoperative ROM limitation other than systemic diseases. Considering that soft tissue adhesions around the subscapularis -being one of the key muscles that actively works during shoulder rotational movements- may cause the ROM limitation, we retrospectively scanned the surgical video records of patients who underwent arthroscopic decompression due to subacromial impingement and divided them into two groups in terms of subscapular soft tissue debridement. In the first group, we included the cases that had debridement around the subscapularis with the radiofrequency device (VAPR VUE® Radiofrequency Electrode System; DePuy Mitek Sports Medicine, Raynham, MA, USA), and the cases that did not have it the second group. We performed the study retrospectively by analyzing the physical examination records (ROM degrees) that we routinely noted during the postoperative follow-ups of the patients and using the patients surgical video images. One of the key points in our study is that we did not study patients with adhesive capsulitis (frozen shoulder); we evaluated patients with local adhesions around the subscapularis tendon that we encountered during arthroscopic subacromial impingement decompression. In addition to frozen shoulder, patients with rotator cuff ruptures, cuff arthropathies, rheumatoid arthritis, and patients who received revision arthroscopy were excluded from the study. Also, patients with comorbid disorders such as diabetes mellitus, thyroid disorders, connective tissue disorders, history of stroke, Dupuytren's contracture, and Parkinson's disease were excluded, as these disorders may cause major ROM limitation themselves. As to our clinical observations, these subscapular pathologies determined in arthroscopy were thought to be caused by severe synovitis, soft tissue pulley formations or a combination of all. Although it is not an obvious cause of adhesion and is considered a variant of normal anatomical structure, hypertrophic (cord-like) MGHL was also evaluated in our study due to its close neighborhood to the subscapularis tendon. Cord-like MGHL ligaments (hypertrophic MGHL) are sometimes encountered as pulley-shaped adhesions and sometimes as soft tissues extending between the insertion of the tendon and the MGHL itself [11]. In our arthroscopic examinations, we observed that some fibers of the MGHL hang the subscapularis muscle as a hammock – which we describe as a "pulley", that may create limitations during the movements of the tendon.

In 54 of these patients (Group 1), we had released the soft tissue pathologies (synovial hypertrophy, pulley formations, etc.) around the subscapularis tendon with the radiofrequency device (RF) in addition to subacromial decompression, while in 43 patients (Group 2), only subacromial decompression had been done and no debridement had been performed to soft tissues around the subscapularis tendon. The patients were evaluated at postoperative second week, first month, third month, and sixth-month follow-ups, and active internal and external rotation ROM data and pain scores of third-month follow-ups were chosen for “short-term results” for this study.

Both patients in Group 1 (debridement +) and Group 2 (debridement -) were classified into 6 subgroups according to the adhesive soft tissue types (Table 1): Synovial hypertrophy (subgroup-1), pulley (subgroup-2), hypertrophic or cord-shaped MGHL (subgroup-3), synovial hypertrophy + pulley (subgroup-4), pulley + hypertrophic MGHL (subgroup-5), and synovial hypertrophy + pulley + hypertrophic MGHL (subgroup-6). A sample arthroscopic image of the subgroups in preoperative and postoperative manner is shown in Figure 1-7. The subgroup bar chart can be seen for both groups in Figure 8.

**Table 1.** Number of patients in terms of each group, subgroup type and debridement application

| Ssc Debridement | Soft Tissue Pathology Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | Synovial Hypertrophy (Subgroup-1) | Pulley (Su-bgroup-2) | Hypertrophic MGHL (Subgroup-3) | Syn + Pull (Su-bgroup-4) | Pull + H.MGHL (Subgroup-5) | Syn + Pull + H.MGHL (Subgroup-6) | Total |
| **Group-1 (Debridement +)** | 18 (33%) | 12 (22.2%) | 8 (14.8%) | 6 (11.1%) | 3 (5.5%) | 7 (12.9%) | 54 |
| **Group-2 (Debridement -)** | 17 (39.5%) | 8 (18.6%) | 6 (13.9%) | 4 (9.3%) | 3 (6.9%) | 5 (11.6%) | 43 |
| **Total** | 35 (36%) | 20 (20.6%) | 14 (14.4%) | 10 (10.3%) | 6 (6.1%) | 12 (12.3%) | 97 |

Ssc: subscapularis, syn: synovial hypertrophy, pull: pulley, H.MGHL: hypertrophic MGHL

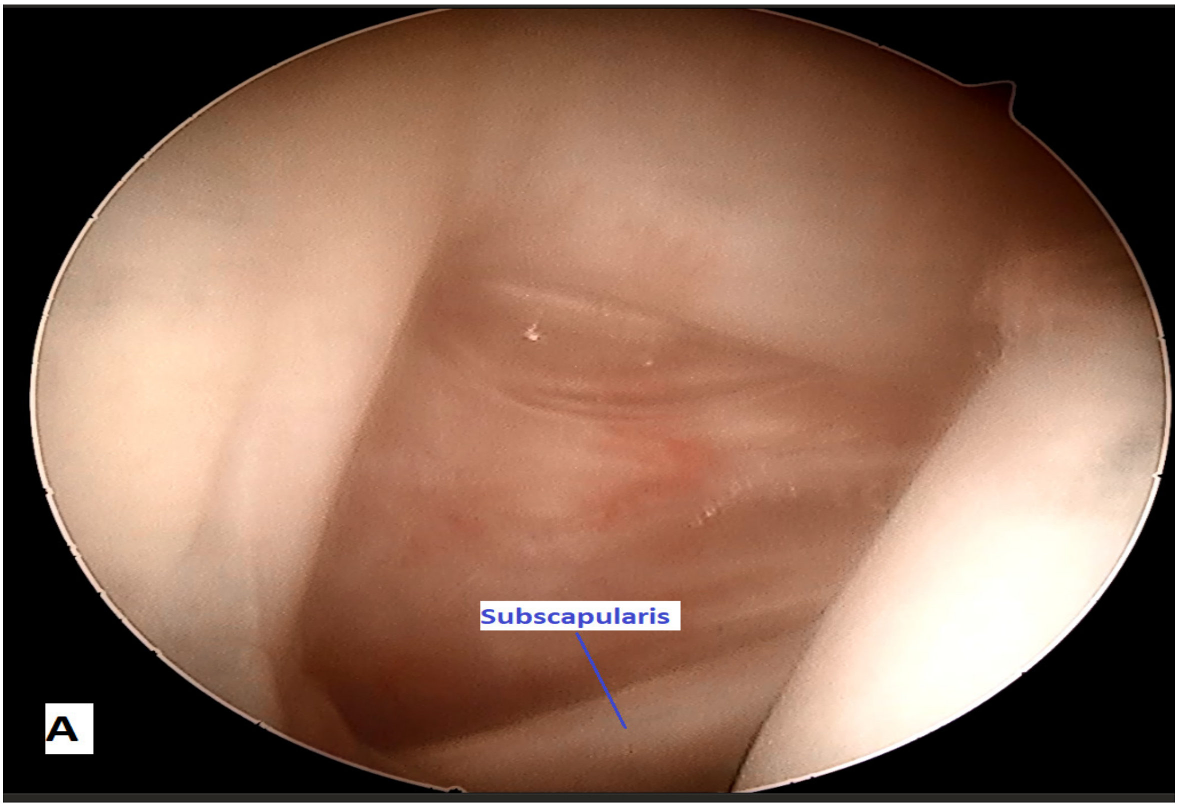


**Figure 1.** A- Normal arthroscopic anatomy

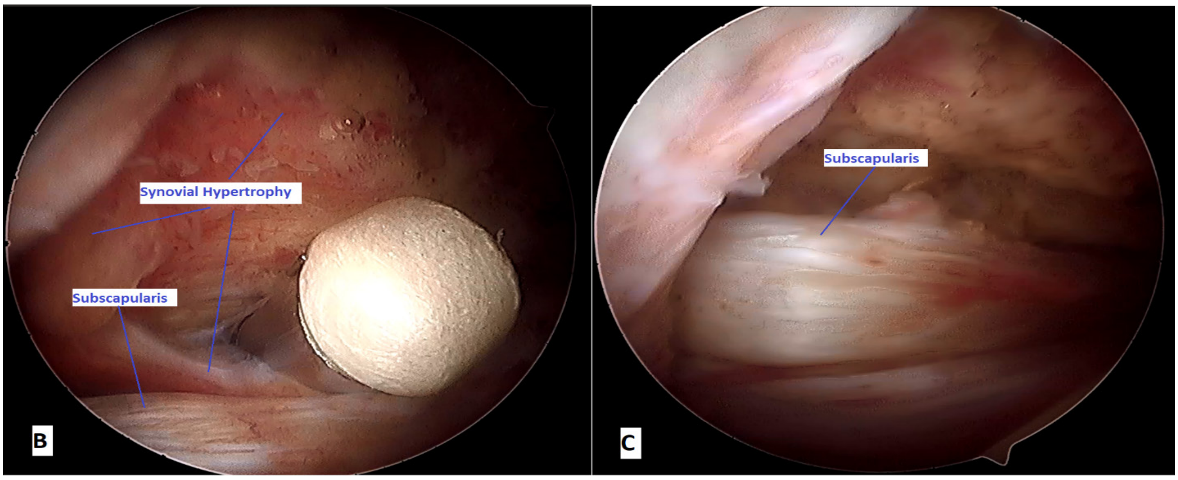


**Figure 2.** B- Arthroscopic image of synovial hypertrophy around subscapularis tendon before debridement, C- Arthroscopic image of subscapularis tendon after debridement

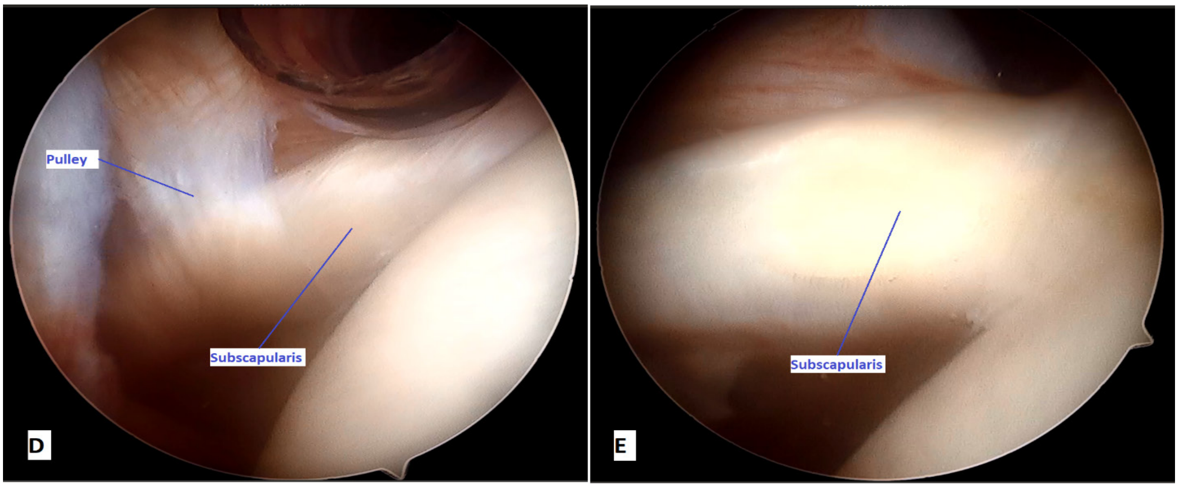


**Figure 3.** D- Arthroscopic image of pulley formation around subscapularis tendon before debridement, E- Arthroscopic image of subscapularis tendon after debridement

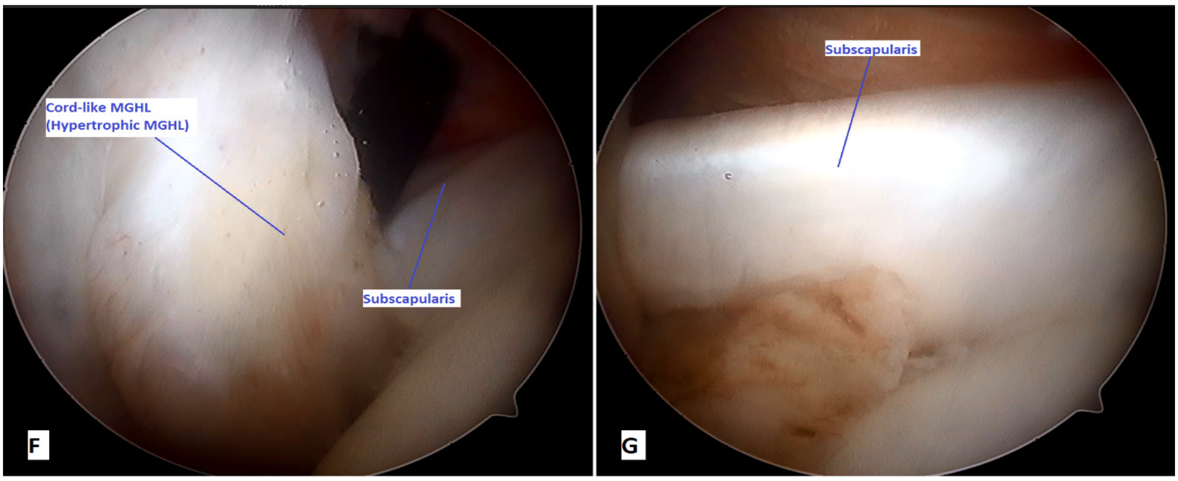


**Figure 4.** F- Arthroscopic image of cord-like MGHL nearby subscapularis tendon before debridement, G- Arthroscopic image of subscapularis tendon after debridement

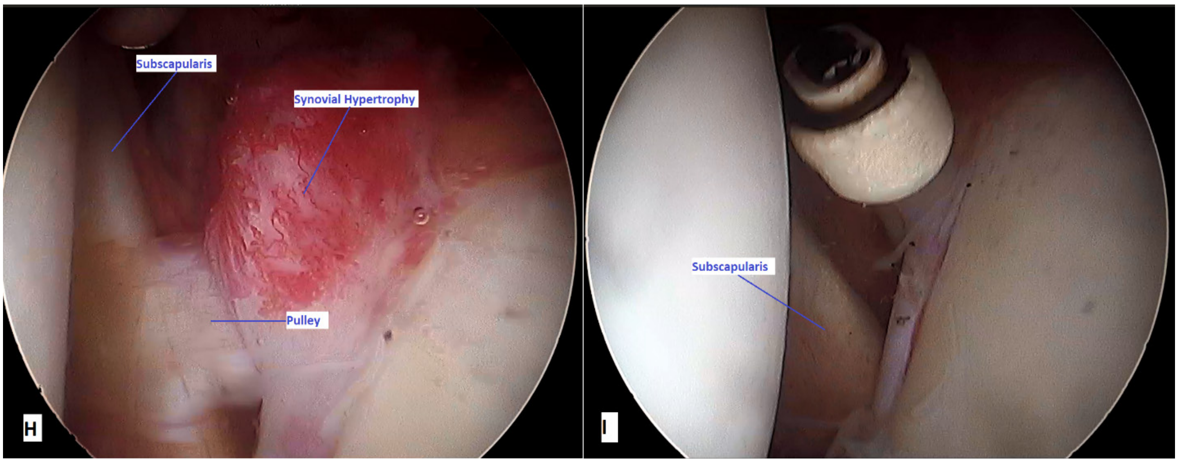


**Figure 5.** H- Arthroscopic image of synovial hypertrophy and pulley formation around subscapularis tendon before debridement, **I**- Arthroscopic image of subscapularis tendon after debridement

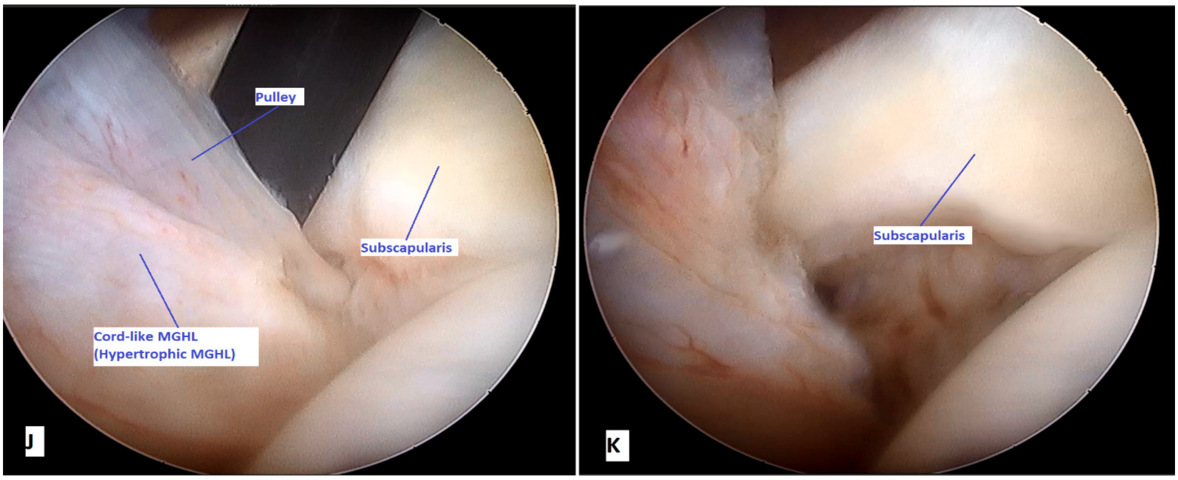


**Figure 6.** J- Arthroscopic image of pulley and cord-like MGHL formation around subscapularis tendon before debridement, K- Arthroscopic image of subscapularis tendon after debridement

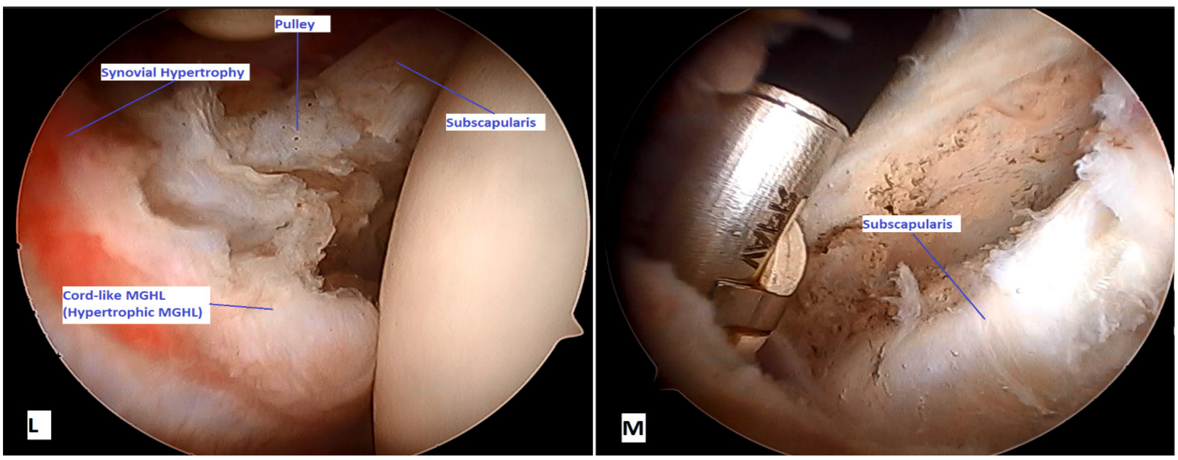


**Figure 7.** L- Arthroscopic image of all three types of adhesions around subscapularis tendon before debridement, M- Arthroscopic image of subscapularis tendon after debridement

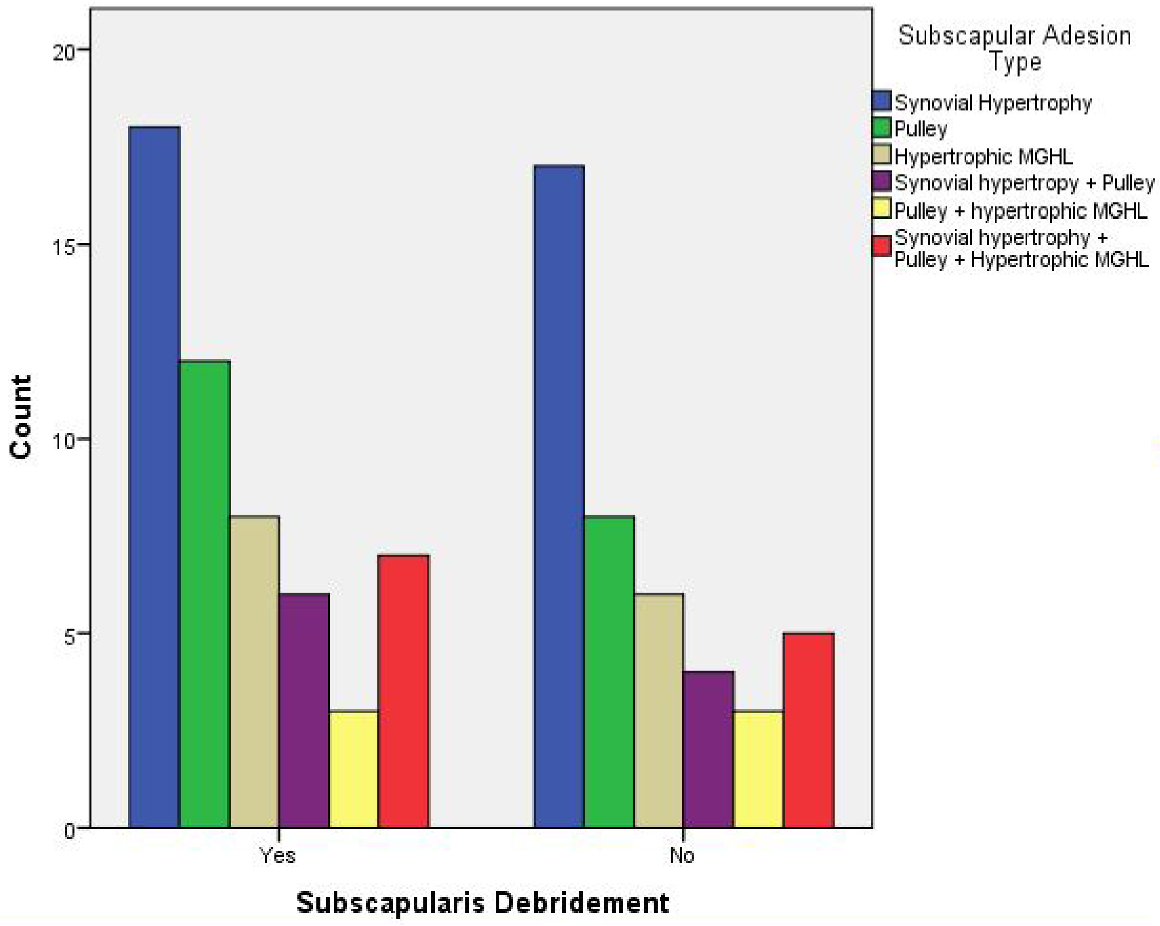


**Figure 8.** Subscapular adhesion type – debridement distribution bar chart

**Surgical technique**

All surgeries were performed by the same surgeon in the beach chair position. Standard shoulder portals (anterior, posterior, and lateral) were used for arthroscopy. The rotator interval, humeral head, long head of biceps tendon, subscapularis tendon, labrum, glenoid, supraspinatus tendon, infraspinatus tendon, and inferior joint space were evaluated, respectively. Then the subacromial space and the anatomical structures were also evaluated, such as the coracoacromial ligament, acromion, subacromial and subdeltoid bursa, supraspinatus and infraspinatus tendons, acromioclavicular and coracoacromial joint.

When the glenohumeral joint was inspected during arthroscopy, synovial tissue and pulley-like soft tissue formations around the subscapularis ligament were carefully examined. All arthroscopic surgery videos were recorded with a video recording device.

**Postoperative management**

Early passive ROM exercises were performed on the patients for the first 3 weeks after postoperative day 1 by a physiotherapist. Active ROM exercises were allowed 3 weeks after surgery as our standard postoperative protocol. At the third-month follow-up, active shoulder internal and external rotational ROM degrees and loss of ROM angles were measured by the operating surgeon compared to the contralateral shoulder. Since the main function of the subscapularis tendon is related to internal rotation, the limitation of internal and external rotation was assessed mainly. The pain scores of the patients were also noted according to the Visual Analogue Score Scale (VAS).

### Functional assessment

Clinical evaluation was routinely performed by the operating surgeon using a handheld goniometer to measure the active range of motion of the operated shoulder and contralateral shoulder in internal and external rotation at postoperative follow-up examinations. The loss of active internal and external rotation degrees was noted routinely for each patient. The pain was also assessed and noted according to the VAS scale during the rotational active motion. Then these data were analyzed to perform this retrospective study.

### Statistical analysis

Statistical analysis was carried out with SPSS v.22.0 software (SPSS Inc., IBM Corporation, Armonk, New York, USA). For this study, descriptive statistics, parametric, and non-parametric tests were used according to the distribution of the data. Group comparisons were conducted using an independent samples t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables, as determined by the Shapiro-Wilk test. The study was conducted at a 95% confidence level, and $p<0.05$ was considered statistically significant.

### Results

A total of 97 patients were included in the study, and 47 (48.4%) of the patients were male and 50 (51.6%) were female. The mean age was 54.2 (range 18-78, std. dev.:12.4, $p=0.056$, t=-0.96). Our study consists of 55 right (56.7%) and 42 left (43.3%) arthroscopically operated shoulders ($p=1.000$, t=0.02). There was no difference between the groups in terms of demographic data (Tables 2 and 3).

**Table 2.** Distribution of the operated shoulder sides

| | | Ssc.Debridement | | Total |
|---|---|---|---|---|
| | | Yes | No | |
| Side | Right | 31 (56.3%) | 24 (43.7%) | 55 |
| | Left | 23 (54.7%) | 19 (45.3) | 42 |
| Total | | 54 (55.6%) | 43 (44.4%) | 97 |

Ssc.: Subscapularis

**Table 3.** Crosstabulation of age, internal rotation, external rotation and VAS between groups

| | Subscapularis Debridement | | | | | | | | *p* value | z value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | | | | No | | | | | |
| | Min. | Max. | Median | Mean±SD | Min. | Max. | Median | Mean±SD | | |
| Age | 35 | 78 | 56.5 | 56.6±11.3 | 18 | 78 | 53 | 51.3±13.1 | 0.056 | -0.96 |
| Int.Rot.Loss | 0 | 30 | 15 | 14.1±7.3 | 5 | 35 | 20 | 19.8±6.3 | 0.001* | -4.03 |
| Ext.Rot.Loss | 10 | 40 | 20 | 19.0±6.5 | 10 | 40 | 25 | 25.4±7.3 | 0.001* | -4.49 |
| VAS | 2 | 6 | 4 | 3.83±1.1 | 1 | 8 | 5 | 4.9±1.7 | 0.039* | -2.09 |

Int. Rot. Loss: Internal rotation loss in degrees, Ext. Rot. Loss: External rotation loss in degrees, VAS: Visual Analog Scale
*=$p<0.05$; z: Mann Whitney U test

Of the 54 patients whose subscapularis adhesions and accompanying pathologies were released with RF (Group 1), the median active internal rotation loss was 15° (0-30) in Group 1, while the non-debridement group (Group 2) had a limitation of 20° (5-35), respectively. This difference is statistically significant for internal rotation degrees in terms of debridement effectiveness ($p$=0.001, t=-4.03). As for the external rotation comparison, the results did also show a statistically significant difference between the debridement and non-debridement groups ($p$=0.001, t=-4.49). The median active external rotation limitation degree for Group 1 and Group 2 was 20° (10-30) and 25° (10-40), respectively.

When the postoperative pain scores were examined in Group 1 and Group 2, the median VAS value was found to be 4 (2-6) in patients without subscapularis debridement, while the median VAS value was 5 (1-8) in the debridement group. Likewise, this difference was statistically significant ($p$=0.039, t=-2.09).

The minimum, maximum, and median loss of active internal and external rotation degrees for subgroups can be seen in Table 4. Synovial hypertrophy (subgroup-1) revealed a severe loss of ROM in both internal and external rotations. The median internal rotation loss was 15° (0-25) and 20° (20-30) in the debridement group and non-debridement group, respectively, while the median external rotation loss was 20° (10-30) and 30° (15-40), respectively. In subgroup-1, external rotation loss was found to be statistically significant according to the comparison between patients who underwent debridement and did not ($p$=0.002, z=-3.87). For all debridement and non-debridement groups combined, the median internal and external rotation ROM loss of subgroup-1 was found to be 20° (0-30) and 25° (10-40), respectively.

Pulley formation (subgroup-2) showed a mild loss of both internal and external rotation degrees. When this subgroup was compared in terms of debridement, no significant difference was found between debridement and non-debridement groups in terms of internal and external rotation ROM loss. In subgroup-2, external rotation loss showed no statistically significant difference according to the comparison of patients who underwent debridement and did not ($p$=0.065, z=1.84), and internal rotation loss showed no statistically significant difference ($p$=0.36, z=0.65).

The smallest median loss of ROM was observed in subgroup-3, which contains “hypertrophic MGHL” alone. In this group, 10° (5-10) for internal rotation and 15° (10-20) for external rotation losses were noted. Also, when patients in subgroup-3 were compared in terms of debridement, no significant difference was found in loss of both internal and external rotation ($p$=0.573, $p$=0.755, z=-1.74, z=-1.46, respectively).

Patients in subgroup-4 (synovial hypertrophy + pulley) were evaluated in terms of debridement; a significant difference was found in loss of external rotation ($p$=0.012, z=2.88). In this subgroup, the median external rotation loss was 15 (10-25) in the debridement group, and 30 (25-30) in the non-debridement group.

In subgroup-5 (pulley + hypertrophic MGHL), there was no significant difference in external rotation ($p$=0.072, z=-1.58) and internal rotation ($p$=0.45, z=-0.56) degrees in terms of debridement of adhesion around the subscapularis tendon.

The most limited shoulders were observed in patients who had all of the subgroup adhesion types (subgroup-6), but a statistically significant difference was not found in both internal and external rotation loss in terms of debridement ($p$=0.46, $p$=0.067, z=-0.52, z=-1.59, respectively). In this subgroup, the median internal rotation loss was 20° (15-30) and 20° (20-35) in the debridement group and non-debridement group, respectively, while the median external rotation loss was 20° (15-40) and 30° (25-40), respectively.

When the differences in VAS scores between patients with and without debridement were examined for each subgroup separately, it was observed that the highest improvement in VAS scores was in the synovial hypertrophy subgroup. In this subgroup, the median VAS was 4 (2-5) in the debridement group, while it was 5 (2-8) in the non-debridement group ($p$=0.124, z=-1.79). No significant difference was found in other subgroups in terms of VAS scores ($p$>0.05).

**Table 4.** Minimum, maximum and median ROM degree loss of each subgroup in terms of debridement

| | | Ssc. Debridement + (Group-1) | | | | | | Ssc. Debridement - (Group-2) | | | | | | *p* value | z value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SH | P | HM | SH+P | P+HM | S+P+HM | SH | P | HM | SH+P | P+HM | S+P+HM | | |
| IR Loss | Median (min-max) | 15 (0-25) | 10 (10-30) | 10 (5-10) | 20 (20-20) | 15 (15-20) | 20 (15-30) | 20 (20-30) | 22.5 (15-30) | 10 (5-10) | 20 (20-20) | 20 (15-20) | 20 (20-35) | 0.001* | -2.539** |
| | Mean±SD | 10.8±8.6 | 14.5±6.5 | 9.3±1.7 | 20±0 | 16.6±2.8 | 21.4±4.7 | 22±3 | 21.8±6.5 | 8.3±2.5 | 20±0 | 18.3±2.8 | 24±6.5 | | |
| ER Loss | Median (min-max) | 20 (10-30) | 20 (15-30) | 15 (10-20) | 15 (10-25) | 15 (10-25) | 20 (15-40) | 30 (15-40) | 25 (20-30) | 12.5 (10-20) | 30 (25-30) | 30 (25-30) | 30 (25-40) | 0.001* | -4.276** |
| | Mean±SD | 18.6±7 | 21.2±4.8 | 15±3.7 | 16.6±5.1 | 16.6±7.6 | 24.2±8.3 | 26.1±6.7 | 25±3.7 | 14.1±4.9 | 28.7±2.5 | 28.3±2.8 | 33±6.7 | | |
| VAS | Median (min-max) | 4 (2-5) | 3 (2-6) | 3 (2-6) | 3 (3-5) | 4 (4-5) | 5 (3-6) | 5 (2-8) | 4 (3-8) | 4 (3-6) | 5 (4-6) | 5 (5-6) | 3 (1-8) | 0.039* | -0.812** |
| | Mean±SD | 3.5±0.7 | 3.9±1.4 | 3.7±1.6 | 3.6±0.8 | 4.3±0.5 | 4.5±0.9 | 5.3±1.6 | 4.8±1.9 | 4.3±1.3 | 5±1.1 | 5.3±0.5 | 4±2.6 | | |

Ssc: Subscapularis, IR: internal rotation, ER: external rotation, VAS: visual analogue scale, SH: synovial hypertrophy, P: pulley, HM: hypertrophic middle glenohumeral ligament, SD: standard deviation
*=$p$<0.05, ** Mann Whitney-U Test showing the differences between Group-1 and Group-2 in terms of rotational range of motion losses and VAS scores

## Discussion

Shoulder arthroscopy has become more popular as the modalities for surgical procedures expand. Because of the development of arthroscopic techniques and equipment, easy detection and intervention of intra-articular pathologies have made shoulder arthroscopy increasingly popular.

The widespread shoulder arthroscopy has brought some complications. One of the most important of these complications is postoperative joint stiffness and limitation of movement. As the studies investigating the causes of postoperative joint stiffness are examined, it is observed that there are not plenty of studies investigating this issue and there is still no clear consensus.

When the literature studies are searched, there are a few studies examining the causes of joint motion limitation except frozen shoulder, but to our knowledge, there is no study about the joint ROM limitation about rotational movements after shoulder arthroscopy in terms of intra-articular lesions and the relationship between ROM limitation.

In this study, we investigated the possible reasons that may cause the restriction of joint movements in the shoulder joint, observed potential anatomical causes during arthroscopy, and detected various adhesions around the subscapularis muscle and tendon, especially during rotational movements. It was observed that the patients who had debridement of soft tissues around the subscapularis tendon had less motion limitation and pain in postoperative clinical controls. The results of this study indicate that debridement improves the postoperative ROM because the mean active internal rotation loss was 14.06° in the debridement group and 19.88° in the non-debridement group. As for the external rotation comparison, the results did also show a statistically significant difference between the debridement and non-debridement groups, as the mean active external rotation limitation degree for Group 1 and Group 2 were 19.07° and 25.46°, respectively. When we evaluated the subgroups, we found that the largest loss of rotational ROM was observed in patients with all the adhesion types together, which include synovial hypertrophy, pulley formations, and hypertrophic MGHL (subgroup-6). As an anatomical variant, hypertrophic MGHL alone caused the smallest loss of ROM (subgroup-3). Surprisingly, even synovial hypertrophy alone caused an undeniable loss of ROM (subgroup-1). Since the small number of patients in the subgroups is not sufficient to show statistical significance, it was not possible to statistically prove that hypertrophic MGHL and pulley alone, or combinations of these, caused limitations. However, statistically significant differences were found in terms of rotational ROM loss in the general group comparisons (debridement and non-debridement groups) because of the adequate number of patients.

Glenohumeral synovitis is frequently confronted during shoulder arthroscopy, yet the etiology and effects on postoperative clinical outcomes are poorly understood. Some studies in the literature have revealed that synovitis is usually associated with severe inflammation, angiogenesis, and inflammatory mediators [12-16]. Tan et al. [9] investigated the association of synovial hypertrophy and post-arthroscopic shoulder stiffness and concluded that patients with higher degrees of glenohumeral synovitis at the time of arthroscopy were more likely to generate postoperative shoulder stiffness than patients with lower grades of synovitis. They also included that this pathological risk factor for postoperative shoulder stiffness may allow surgeons to adjust intraoperative and/or postoperative management to prevent and treat postoperative joint stiffness [9]. It would not be wrong to assume that the diffuse synovitis around the subscapularis muscle and its tendon will also interfere with the movement of the subscapularis tendon due to this limitation of increased synovitis in postoperative shoulder joint movements. After debridement of the tissues with severe synovitis around the subscapularis muscle, we believe that more successful patient outcomes will likely be encountered in the postoperative period.

The MGHL is one of the three ligaments that augment and strengthen the anterior shoulder capsule with the superior glenohumeral ligament (SGHL) and the inferior glenohumeral ligament (IGHL), which forms a bridge between the labrum and humeral head [17, 18]. In a study by Collette et al. [19]; 63% of MGHL was observed as leaf-like, 27% cord-like, 5.5% vestigial, and 2% several stranded. They also found that this ligament was absent in 2% of their 107 arthroscopic cases. The morphological varieties of MGHL are thought to form pulley-like adhesions near the subscapularis tendon, which may lead to postoperative active external rotation loss [19]. Although hypertrophic or cord-like MGHL is not a cause of adhesion, it was also evaluated in our study in order to find out its effects on the ROM due to its close neighborhood to the subscapularis tendon.

In our study, the largest loss of rotational ROM was observed in patients with all the adhesion types together, which include synovial hypertrophy, pulley formations, and hypertrophic MGHL (subgroup-6). While hypertrophic or cord-shaped MGHL caused negligible ROM differences because of being an anatomical structure, synovitis alone and its combinations caused more and significant ROM degree loss, as our clinical outcomes are consistent with the studies mentioned in the literature. Due to the insufficient number of studies in the literature investigating the effect of adhesions around the subscapularis tendon mobility, new studies are required to compare our observations.

The major limitations of the current study include the small sample size in subgroups, as the reliability of statistical analysis decreases due to the small number; however, the total number of patients included in the main groups was considerably high. The other limitation was our study's retrospective nature because the study is prone to various forms of bias, such as selection bias and recall bias. Another limitation is that it is difficult to compare the results to other studies and provide abundant references, as there are not plenty of studies on this subject in the literature.

In conclusion, after arthroscopic shoulder procedures, joint stiffness, limited motion of the shoulder, and patient dissatisfaction with pain are common conditions. In our study, we observed that debriding the soft tissue adhesions or pathologies around the subscapularis tendon significantly improved rotational ROM, clinical results, and patient satisfaction. Therefore, the subscapularis muscle and its tendon must be inspected, and rotational movement must be performed during arthroscopy. If any adhesions or soft tissue pathologies restricting the movements of the subscapularis muscle and tendon were detected, then these should be released, as we observe that releasing these adhesions improves clinical outcomes greatly. We believe that further studies of intra-articular anatomical disorders that cause ROM limitation are required to improve the clinical outcomes.

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E.G., F.I.C. and S.B.S. have evaluated the data in the Results section and Discussion section of the article. The manuscript was written by E.G. and F.I.C.

C.Y.K. and N.H.A. reviewed, corrected, and approved.

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