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Does adipose tissue thickness affect the duration of rotator cuff operations?

Omuz bölgesi yağ kalınlığının rotator manşet operasyonlarının süresine etkisi var mıdır?

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ABSTRACT

Objective: Accurate estimation of operation time will reduce operating room costs and increase patient satisfaction. In recent studies, authors have found that thicker adipose tissue at the operation site is associated with a higher rate of complications. However, there is no study in the literature investigating the effect on operation time of an increase in adipose tissue thickness. This present study hypothesized that thicker adipose tissue in shoulder surgeries would prolong the operation time, therefore the study was planned accordingly.
Material and Methods: Preoperative magnetic resonance images of patients applied with rotator cuff repair between 2015 and 2020 were independently evaluated by two observers. The acromial fat thickness was measured as the fat thickness of the operation area, and the scapular fat tissue thickness as the fat thickness of the region relatively far from the operation area. The data obtained were evaluated using multivariate analysis and a binary logistic regression model.
Results: Evaluation was made of a total of 106 patients. The mean total operation time was 89±33 mins. The mean acromial fat thickness was 12.2±4.89 mm and the mean scapular fat thickness was 27.9±12.5mm. The increase in acromial fat thickness was determined to have extended the operation time (OR=5.75, 29.21, p<0.05).
Conclusion: The thickness of fat tissue in the surgical area is one of the factors affecting operating time. Patients can be informed about the risk of prolonged surgery time and associated complications before surgery and costs can be reduced by optimizing operating room planning. In addition, it should be considered that tendinous pathologies may be more common in individuals with increased adipose tissue thickness and thus contribute to prolonging the operation time.

Keywords: adipose tissue thickness, rotator cuff repair, surgery time

ÖZ

Amaç: Ameliyat süresinin doğru tahmin edilmesi ameliyathane maliyetlerini azaltacak ve hasta memnuniyetini artıracaktır. Son çalışmalarda yazarlar, operasyon bölgesinde artan yağ dokusunun komplikasyonları arttırdığını bulmuşlardır. Ancak literatürde yağ dokusu kalınlığındaki artışın operasyon süresine etkisini araştıran bir çalışma bulunmamaktadır. Bu çalışmanın hipotezi, omuz bölgesinde artan yağ dokusu kalınlığının ameliyat süresini uzatacağıydı ve çalışma buna göre planlandı.
Yöntemler: 2015-2020 yılları arasında rotator manşet tamiri uygulanan hastaların ameliyat öncesi manyetik rezonans görüntüleri iki gözlemci tarafından bağımsız olarak değerlendirildi. Akromiyal yağ kalınlığı operasyon bölgesinin yağ kalınlığı olarak, skapular yağ dokusu kalınlığı ise operasyon bölgesine görece uzak bölgenin yağ kalınlığı olarak ölçüldü. Elde edilen veriler çok değişkenli analiz ve ikili lojistik regresyon modeli kullanılarak değerlendirildi.
Bulgular: Toplam 106 hasta değerlendirildi. Ortalama toplam operasyon süresi 89±33 dakika idi. Ortalama akromiyal yağ kalınlığı 12.2±4.89 mm ve ortalama skapular yağ kalınlığı 27.9±12.5 mm idi. Akromiyal yağ kalınlığındaki artışın operasyon süresini uzattığı belirlendi (OR=5.75, 29.21, p<0.05).
Sonuç: Ameliyat bölgesindeki yağ dokusunun kalınlığı ameliyat süresini etkileyen faktörlerden biridir. Ameliyathane planlaması optimize edilerek hastalar ameliyat öncesi uzamış ameliyat süresinin ve buna bağlı komplikasyonların riskleri hakkında bilgilendirilebilir ve maliyetler düşürülebilir. Ayrıca yağ dokusu kalınlığı artan bireylerde tendinöz patolojilerin daha fazla olabileceği ve bu yollada ameliyatı süresini uzamasına katıkıda bulunabileceği göz önünde bulundurulmalıdır.

Anahtar kelimeler: yağ dokusu kalınlığı, rotator manşet tamiri, ameliyat süresi

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Introduction

With the developments in imaging methods such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and X-rays, orthopedic surgeons can better evaluate muscle, bone, tendons, ligaments and similar structures and make a more accurate preoperative plan. Adipose tissue however, which shows a good deal of interpersonal variations, is often not taken into account, although it can provide some information for preoperative planning. Previous studies have stated that the thickness of fatty tissue around the surgical area increases complications, such as postoperative surgical site infections [1, 2]. It has been suggested that the increase in complications may be a result of prolongation of the operation time [3-5]. However, no study in the literature has yet investigated the effect of increased adipose tissue thickness on operation time and this information may be useful in distinguishing whether these complications are due to immunological and metabolic causes of obesity, or to prolongation of the actual operation time, as some have suggested.

When all elective surgical procedures are taken into account, rotator cuff operations present much more variability in terms of surgical time. Based on this observation, we determined that examining the operation time of these types of surgeries would provide the greatest clinical benefits. By determining the possible complications, an accurate estimation of operating time will help to reduce the operation costs by providing more effective operating room usage [6, 7]. Furthermore, with a more efficient operating room schedule, patient satisfaction rates can be improved by providing shorter waiting times [8]. Estimation of the operation time, patient age, body mass index (BMI), primary surgery, anesthesia type, secondary procedures and surgeon type data have been taken into consideration in the published literature [9,10]. In addition to these defined factors, the operation area adipose tissue thickness and non-operation area adipose tissue thickness were added to the multivariate logistic model in the current study.

This study hypothesized that an increase in the thickness of the adipose tissue in the surgical area would prolong the operation time. No study on this subject could be found in the literature, therefore this study aimed to investigate the relationship between increased thickness of fat tissue and operating time, in patients applied with rotator cuff repair.

Materials and methods

Approval for this study was granted by the Local Ethics Committee. The data used was obtained from the hospital electronic records system and the electronic Picture Archiving Communication Systems (PACS). The patients included in the study were those who underwent shoulder rotator cuff operation between January 2015 and March 2020 and had shoulder MRI taken less than 6 months pre-operatively. All the operations were performed by two surgeons, each with twelve and six years of experience, respectively.

Patients were excluded from the study if the MR images had not been captured with the appropriate technique or if the data regarding the operating time or the procedures applied during the operation was not available. A record of demographic data, including age and gender, was made for each patient. Surgeon type (surgeon 1, surgeon 2) and operating time were recorded and the preoperative MRIs were evaluated according to the DeOrio and Cofield classification [11]. The BMI values of the patients, American Society of Anesthesiologist (ASA) scores and the anesthesia method used, were also examined. The thickness of fat tissue was measured on the preoperative MR images. The acromial fat thickness was recorded as the fat thickness of the operation area, whereas the scapular fat tissue thickness was recorded as the fat thickness of the region relatively far from the operation area.

Images were obtained using a 1.5 Tesla MRI device. The acromial fat distance was measured in series obtained with coronal oblique fat suppressed PD (proton density) sequences, and scapular fat distance was measured in series created with axial fat-suppressed PD sequences. For standardization of the measurement of fat tissue thickness in each patient, the spina scapula axis was first determined on the transverse section that showed the longest view of the spina scapula, and from the midpoint of the spina scapula on this

image, fat tissue thickness was determined over the vertical line drawn from the determined axis (Figure 1). Then, the thickness of the adipose tissue on the line joining the superior and inferior corners of the glenoid was measured in the section where the glenoid was seen to be largest in coronal sections (Figure 2).

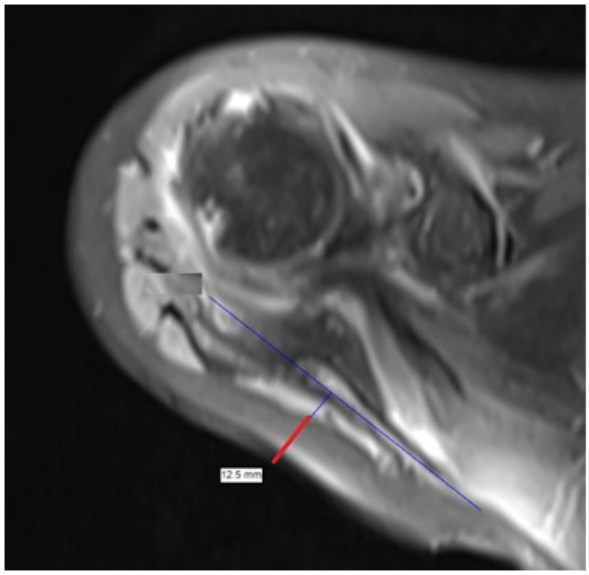


Figure 1. Measurement of the scapular fat thickness.

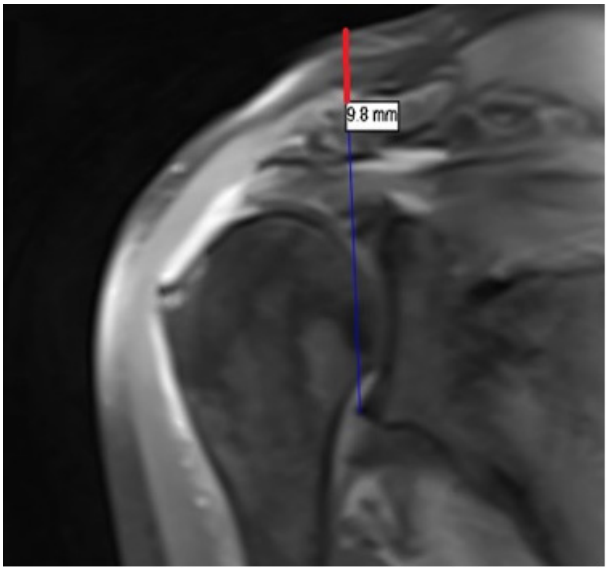


Figure 2. Measurement of the acromial fat thickness.

An orthopedic surgeon and a radiology specialist took the measurements, both with over 10 years of experience. The measurements were taken twice at an interval of 4 weeks between the two measurements of the orthopedic surgeon and the radiology specialist. The interclass and intraclass coefficient (ICC) values were calculated for the results obtained. In addition to the cuff repair, additional procedures such as biceps tenotomy, tenodesis, acromioplasty, superior labrum anterior and posterior (SLAP) repair and Bankart repair, were all recorded.

Data obtained in the study was analyzed statistically using the SPSS vn. 23.0 software (IBM, Armonk, NY, USA). Continuous variables were compared between the groups using the Mann Whitney U-test or the Kruskal Wallis test and categorical variables were analyzed using the Chi-square test. Multivariate analysis and a binary logistic regression model were applied in the evaluation of the data. A value of $p<0.05$ was accepted as statistically significant.

Results

Initially, 113 patients were included in the study and seven were then excluded from the analysis: four patients with preoperative MRIs not available and three with unavailable operation information. Thus, the evaluation of 106 patients was performed, with a mean age of 57±10.6 years and a mean operating time of 89±33 min. The demographic characteristics of the patients are shown in Table 1. The sex and age of the patients had no significant effect on operation time ($p>0.05$) (Table 1). The mean acromial fat thickness was determined to be 12.2±4.89 mm and the mean scapular fat thickness was 27.9±12.5 mm.

Table 1. Operation Time according to Demographic Characteristics.

	n (%)	Operation Time	P value	Operation Time Class		P value
Overall	106	89.00 ± 33.52		<90	90>	
Sex			0.603[a]			0.378[c]
Male	40 (37.7)	93.68 ± 41.23		22 (55.0)	18 (45.0)	
Female	66 (63.3)	86.69 ± 28.45		42 (63.6)	24 (36.4)	
Age (years)			0.251[b]			0.427[c]
<50	28 (26.4)	99.29 ± 39.90		14 (50.0)	14 (50.0)	
51- 60	34 (32.1)	82.66 ± 33.62		24 (70.6)	10 (29.4)	
61- 70	34 (32.1)	88.64 ± 29.93		20 (58.8)	14 (41.2)	
71>	10 (9.4)	84.50 ± 22.91		6 (60.0)	4 (40.0)	

a Mann Whitney U-test, b Kruskall Wallis test, c Chi-Square test

In this study, the operation time was categorized as a binary variable (>90/<90 minutes). To investigate the risk factors affecting the operation time, the binary logistic regression analysis was first performed, which included independent risk factors that could affect the operation time. Using this model, surgeon type, acromial fat thickness, SLAP repair and Bankart repair, were all determined to be significant risk factors affecting the operation time. It was an expected result that SLAP and Bankart repairs would increase the operation time; we included these in the study to demonstrate that the binary logistic regression model works properly (p<0.05, p:0.001) (Table 2). The increase in the acromial fat thickness of the patients was determined to have extended the operation time (OR= 5.75, 29.21, p<0.05). The BMI value, scapular fat thickness and ASA class were not determined to have any significant effect on operation time (p> 0.05) (Table 3). When the predictive value of the results of the regression model was evaluated, operation time longer or shorter than 90 mins was determined to be predictive at 87.4%.

Table 2. Surgical procedures.

Description	Cases (n) (% of total)	Operation Time (Mean±SD)	Operation Time Class n (%)		P value
Procedures			<90	90>	
Biceps tenotomy	76 (71.7)	86.91 ± 30.93	48 (63.2)	28 (36.8)	0.352
Tenodesis	28 (26.4)	96. 61 ± 38.39	15 (53.6)	13 (46.4)	0.391
Acromioplasty	69 (65.1)	84.71 ± 31.07	48 (69.6)	21 (30.4)	0.008
SLAP Repair	19 (17.9)	117.63 ± 35.29	5 (26.3)	14 (73.7)	0.001
Bankart Repair	14 (13.2)	120.71 ± 27.59	2 (14.3)	12 (85.7)	0.001
Surgeon Type					0.001
Surgeon 1	65 (61.3)	74.69 ± 20.29	53 (81.5)	12 (18.5)	
Surgeon 2	41 (38.7)	111.71 ± 37.81	11 (26.8)	30 (73.2)	

Considering the reliability of the measurements taken on the preoperative MRIs, the interclass coefficient and intraclass coefficient values were found to have excellent reliability (ICC>90) in the scapular and acromial fat thickness values, as well as in the DeOrio and Cofield classification.

Table 3. Binary Logistic Regression Analysis of Factors Affecting Operation Time.

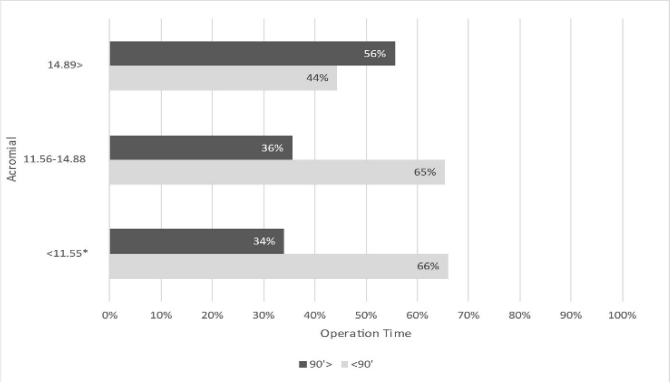
	Operation Time		P value	OR
	<90 min	90> min		
Acromial fat thickness			**0.022**	
<11.55	35 (66.0)	18 (34.0)		**5.75**
11.56-14.88	17 (65.4)	9 (35.6)		**29.21**
14.89>	12 (44.4)	15 (55.6)		
Scapular fat thickness			0.482	
<24.58	36 (67.9)	17 (32.1)		
24.59-32.83	11 (42.3)	15 (52.7)		
32.84>	17 (63.0)	10 (37.0)		
BMI Index			0.127	
<25	15 (71.4)	6 (28.6)		
26-30	30 (53.6)	26 (46.4)		5.51
31>	17 (65.4)	9 (34.6)		1.51
ASA Class			0.581	
1	13 (48.1)	14 (51.9)		
2	50 (64.1)	28 (35.9)		0.42
3	1 (100.0)	0 (0.0)		0.00

Reference class in Binary Logistic Regression. Bold values are statistically significant (p <0.05).

Discussion

The most important finding of this study was that an increase in acromial fat thickness significantly prolonged the operating time (OR=5.7, p<0.05) (Figure 3). Several studies have reported that increased fat thickness in the surgical area increased infection locally [1,4,5]. It has been reported that for every 1 mm increase in lumbar region adipose tissue thickness, the risk of infection in the operated area increases by 6% [5]. In similar studies, an increase in fat tissue thickness in the operation region has also been reported to increase the rate of postoperative infection [2]. Another significant factor increasing postoperative infection in the operation region is the operation time [12]. There are other studies in the literature which have also shown that an increase in fat tissue thickness leads to more infection and the reason for this could be prolonged operating time [3-5]. However, no study could be found that aimed to research the effect of fat tissue thickness on operating time in rotator cuff surgery.

Figure 3. As the acromial fat thickness increases, so the rate of operations lasting longer than 90 minutes increases.



In addition to infection, an increase in operating time in shoulder operations may also cause other complications. Rotator cuff operations lasting longer than 90 mins have been shown to prolong the postoperative length of stay in the hospital [13]. In the current study, it was found that the operation time exceeded 90 minutes in more than half of the patients with an acromial fat thickness greater than 14.89 mm (Figure 3). Agarwalla A. et al. reported that every increase of 15 mins in operating time led to postoperative transfusion, pulmonary embolism, surgical site infection and prolonged postoperative stay in hospital [14]. As in the current study, it was reported that each of the concomitant procedures (biceps tenotomy, tenodesis, acromioplasty, SLAP repair and Bankart repair) increased operating time, however it was concluded that none of these concomitant procedures increased complications in the short term [14]. When publications related to the duration of shoulder operations were examined, the mean operating time in the current study of 89±33 mins was found to be consistent with the findings of those studies [13,14].

Another important finding of the current study was that while an increase in the acromial fat thickness in the operation area was observed to increase operating time, scapular fat thickness and BMI had no significant effect. Similarly, Wagner R.A. et al. found that prepatellar fat thickness had a greater effect than BMI in the determination of the risk of postoperative infection [2]. In several studies that have examined the relationship between fat tissue thickness and complications, fat tissue thickness has been reported to be a better predictor of complications than BMI [1,3]. The reason for the lower predictive power of BMI than fat tissue thickness is that BMI is not always related to body fat mass and the distribution of body fat varies according to age, gender, race and genetic factors [15]. Therefore, the surgical area fat tissue thickness may not be the same in different individuals with the same height, weight and body fat ratio.

It can be estimated that the increase in the thickness of the adipose tissue prolongs the operation time, such as difficulty in orientation to the surgical field, difficulty in exposure, difficulty in using the cannula and difficulty in applying anchors, however the increase in the severity of existing tendon pathologies due to metabolic and genetic reasons in individuals with increased fat tissue thickness, is one of the factors affecting the operation time. Whole body MRI studies have shown that the thickness of the fat tissue in the shoulder and neck region of individuals with insulin-resistant diabetes is increased compared to individuals without insulin resistance [16]. A systematic review on this subject concluded that an increase in adiposity increased the frequency of tendon injuries, and further studies were recommended [17]. However, in the current study, when the acromial and scapular fat thickness values of the patients were compared with the DeOrio and Cofield classification of rotator cuff tears, no significant correlation was determined ($p>0.05$). In another study of 298 cases, the relationship between asymptomatic Achilles tendon pathologies and fat tissue distribution was investigated. Achilles tendon pathology was seen more frequently in males of advanced age with central fat tissue distribution, and in postmenopausal females with peripheral fat distribution. The condition seen in males was explained with mechanical reasons, but in the paradoxical condition formed in females, it was stated that the hormonal infrastructure and the change in postmenopausal estrogen level could both account for changes in fat tissue distribution and lead to tendon pathologies [18]. The results obtained in the current study are consistent with these findings. The acromial and scapular fat thickness values of the females with rotator cuff tear were found to be statistically significantly higher than those of the male patients ($p<0.05$) and this finding is consistent with the study

investigating the fat signal distribution in the muscle. In that study, the fat fraction within the muscles in some muscles around the shoulder was found to be higher in women than in men [19].

In addition to increased postoperative complications, another disadvantage of prolonged operating time is the longer use of the operating theater and personnel, which both increase the costs of the operation [7]. According to the Healthcare Cost and Utilization Project (HCUP), operating rooms are the costliest units in a hospital [6]. The knowledge that the adipose tissue thickness affects the operation time, provides a better estimation of the operative time, thus a more accurate schedule can be prepared and the operating rooms can be used more efficiently. In addition, the appropriate operating room program will shorten patient waiting times. A study published in 2010 showed that 15% of the reasons for patient dissatisfaction were due to prolonged wait times [8]. In the literature related to the estimation of the operation time, patient age, BMI, primary surgery, secondary procedures and surgeon type data were taken into consideration [9,10,20]. In a comprehensive study in which these factors were used in a multi-regression model in different types of surgery, it was stated that 80% of the surgical time was correctly estimated in the applied model [21]. In the multivariate regression model of the current study, in which fat tissue thickness was added to these factors, the results were able to predict the probability of the operation being over or under 90 minutes at 87.4%.

The main limitation of this study was the retrospective design. The relatively small size of the sample and the fact that it was not a multicenter study were also limiting factors. In addition, operation time in the literature has been separated into operation room duration and surgery time. However, in our hospital records, surgical time was not recorded separately, so the operating room time was used as the operation time in this study.

Conclusion

In conclusion, adipose tissue thickness in the surgical area is one of the factors affecting operation time. For shoulder surgery patients, these values can be easily measured on preoperative MRIs. Thus, the risk of a prolonged operation and associated complications can be predicted, and a more accurate schedule can be prepared with more efficient use of the operating rooms. In addition, it should be considered that tendinous pathologies may be more common in individuals with increased adipose tissue thickness, and thus contribute to prolonging the operation time.

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