

Surgical Neck of the Humerus in Respect to Muscle Tears

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ÖZET

Kas yırtıkları açısından humerus collum chirurgicum'un değerlendirilmesi

Bu çalışmanın amacı humerus'un cerrahi boyun uzunluğunun rotator kas yırtıkları üzerine olan olası etkisinin değerlendirilmesidir. Çalışma 37 erkek bireyin sol omuz görüntüleri üzerinden yapılmıştır. Parsiyel yırtığı olan 10 olgu, tam kat yırtığı olan 7 olgu olmak üzere toplam 17 rotator kas yırtığı olan olgunun sol omuz manyetik rezonans (MR) görüntüleri, herhangi bir patolojisi olmayan 20 adet normal omuz MR görüntüleri ile karşılaştırılmıştır. Filmlere digimizer programında lineer ölçümler yapılmıştır. Elde edilen bilgiler SPSS 13.0 yazılımı ile değerlendirilmiştir. Collum chirurgicum'dan ölçülen transvers hat lineer değerleri iki ortalama arasındaki farkın önemlilik testi ile değerlendirilmiştir. Kas yırtığı olan olguların ortalama değerleri 9.50 mm, kontrol grubu niteliğindeki patolojisi bulunmayan grubun ortalama değeri 12.04 mm olarak tespit edildi. İki grup arasındaki fark anlamlıdır ($p<0.05$). Humerus cerrahi boyun uzunluğunun rotator kas yırtıkları üzerinde etkili olduğu düşünülmektedir.

Anahtar Kelimeler: Rotator kas yırtığı, humerus, cerrahi boyun, lineer ölçüm, manyetik rezonans.

SUMMARY

The aim of this study was to evaluate the length of surgical neck of the humerus in relation to rotator cuff tears. The study was performed on left shoulder images of 37 male subjects. Left shoulder magnetic resonance images (MRI) of 17 subjects with rotator cuff tears, composed of 10 subjects with partial rupture and 7 subjects with whole rupture, were compared with the normal MRI images of 20 subjects. The length of the surgical neck of the humerus was measured using Digimizer software. The data was evaluated with SPSS 13.0 software. The data regarding the measurements of the transverse line taken from the surgical neck of the humerus were analyzed with the independent samples t-test. The mean length of the surgical neck of the subjects with muscle rupture and the healthy control group were 9.50 mm and 12.04 mm, respectively. The difference between the groups was statistically significant ($p<0.05$). The length of the surgical neck of the humerus is suggested to play a role in rotator muscle tears.

Key words: Rotator muscle rupture, humerus, surgical neck, linear measurement, magnetic resonance

Introduction

Rotator muscles are structures that contribute to the anatomical integrity of the shoulder joint by insertion tendons (1). They have been evaluated in many different aspects until today including: the course of repair of their rupture after surgery and the evaluation of clinical results (2); the relationship between full thickness rupture cases with the long tendon of the biceps brachialis muscle (3); and different anatomical shapes of acromion narrowing the area in the origin of the supraspinatus muscle and causing rotator cuff rupture (4). This study investigated the relation between the length of the surgical neck of the humerus and rotator cuff rupture. For this purpose the length of the surgical neck of the humerus of males with rotator muscle rupture and three additional measurement parameters were compared to the values of the control group involving males in the same age group.

Materials and Methods

The study was performed on the left shoulder magnetic resonance (MR) images of 37 males aged between 38-57 years. Coronal section images obtained from a Siemens 1.5 Tesla MR machine were investigated. In order to perform standard measurements in the images, the section images, in which the anatomical structuring present above the glenoidal cavity and the humerus head were seen in the same ratio, were used. The MR imaging method was selected due to reports stating the reliability of this imaging method in the evaluation of muscle ruptures (5). Left shoulder magnetic resonance (MR) imaging of a total of 17 cases with rotator muscle rupture, 10 cases with partial rupture, and 7 cases with full thickness rupture were compared to 20 cases with normal shoulder MR images of who did not have any muscle pathology. Initially, H1-H4 codes were assigned to the parameters measured from the proximal portion of the humerus. Then, the linear measurements of the neck of the humerus (H2) and three other parameters (H1, H3, and H4) that were placed on MR images were completed with the Digimizer software (Figure 1) (Table 1). The level at which the length of the surgical neck of the humerus to be measured was determined as follows: an oblique line was drawn determining the anatomic neck of the humerus (Figure 2, line A-B). The intersection point between the line drawn from the "B" point to the most prominent point of the slope between

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the head and body of the humerus and the medial edge of the bone was determined (Figure 2, point C). The transverse line passing from the “C” point through the body of the humerus (Figure 2, line C-D) was determined as the length of surgical neck of the humerus on the image. The definitions of the anatomic localizations of the other parameters are shown in Table 1. The line (L1) passing from the center of the corpus of the humerus vertically upwards was used as a reference for the (L2) line, which is used in the calculation of the (H3) parameter. Attention was given to ensure that the (L2) line was parallel to the (L1) line (Figure 1).

Table 1. The anatomical localization of the measured parameters

Parameter	Anatomical localization
H1	The length of the distance between the inferior point of the line of the anatomic neck of the humerus and the farthest superolateral point of greater tubercle in the coronal section
H2	The distance of the surgical neck of the humerus.
H3	The distance between the farthest superolateral point of the greater tubercle and the vertical line (L2) passing upwards from the farthest lateral point of the surgical neck
H4	The angle between the H1 line and farthest medial point of the surgical neck of the humerus

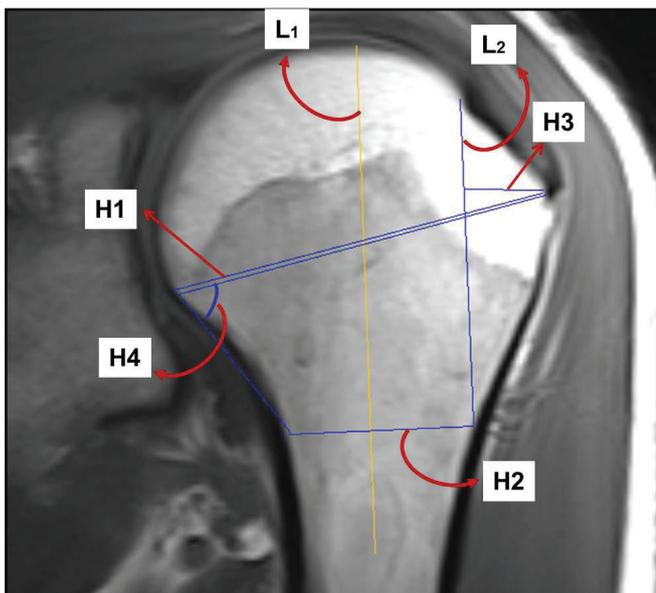


Figure 1. The parameters for which the measurements taken from the humerus and the L1 and L2 vertical lines that were accepted as reference points

L1: The upward vertical line from central part of the corpus of the humerus

L2: The vertical line moving upwards from the farthest lateral point of the surgical neck distance parallel to the (L1) line that is used in the calculation of the (H3) parameter

Results

The mean length of the surgical neck of the humerus in cases with muscle rupture (H2) was 9.50 ± 1.57 mm whereas it was 12.04 ± 0.88 mm in the control group. The length of the surgical neck of the humerus was found shorter in cases with muscle rupture. The obtained data was evaluated with the Mann-Whitney U-test and the difference between the groups was found significant ($p < 0.05$) (Table 2). On the other hand, (H1), which is the distance between the “B” point of the anatomic neck of the humerus and the farthest superolateral point of the greater tubercle demonstrated no significant difference between groups [the mean of patient groups was 23.68 ± 1.90 mm, control group 24.03 ± 1.88 mm, $p > 0.05$]. (H3), which is the distance between the farthest superolateral point of greater tubercle and the vertical line passing upwards from the “D” point was found to be 5.52 ± 1.17 mm in the patient group, and 4.87 ± 1.09 mm in the control group on average. No statistically significant difference was found between the groups ($p > 0.05$). The H1/H2 ratio was 2.54 ± 0.31 in the patient group and 2.01 ± 0.22 in the control group on average. The difference between them was statistically significant ($p < 0.05$). The mean of the H4 parameter in the patient and the control groups were 73.63 ± 4.66 and 68.09° ± 0.31, respectively, and the difference between these values was statistically significant ($p < 0.05$).

Discussion

The reference points and the intentional lines that were used in the study demonstrate similarities with those used in biomechanical investigations (6). Furthermore, a total of four parameters that were measured partially corresponded to those in the study of Kranjoti et al. (7).

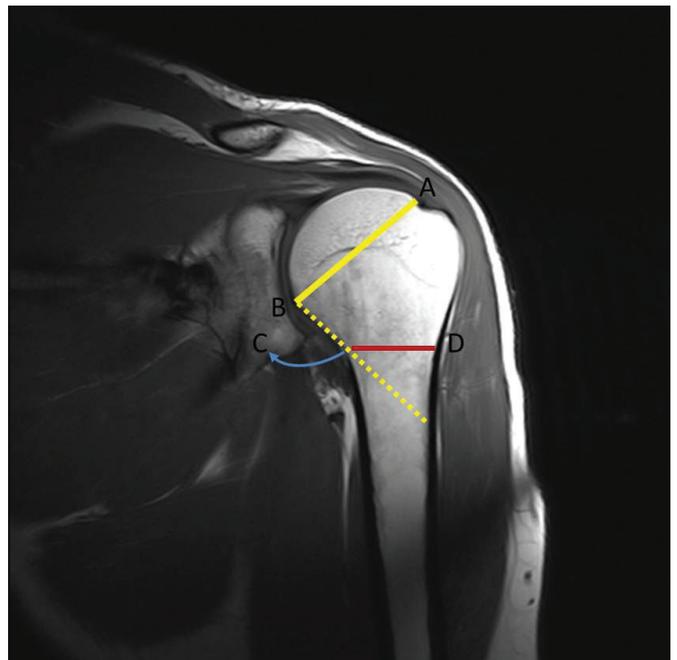


Figure 2. The reference points and lines on the humerus

Table 2. The results of the significance test of the difference of the two means in groups (Mann-Whitney U-test)

	Parameter	Patient Group		Control Group		p
		Mean	SD	Mean	SD	
H1	Longest distance (mm)	23.6806	1.90408	24.0275	1.88180	0.729
H2	The length of surgical neck (mm)	9.4953	1.57472	12.0355	0.87745	0.000
	Ratio (LD/SN)	2.5353	0.30747	2.0065	0.21926	0.000
H3	The distance of the greater tubercle (mm)	5.5229	1.16968	4.8710	1.09111	0.085
H4	Angle (Degree)	73.6306	4.65833	68.0910	4.82082	0.001

The significant difference found between the lengths of the surgical neck of the humerus in the patient group and in the control group ($p < 0.05$) necessitates this parameter to be evaluated as a possible etiological factor causing the mentioned muscle pathologies. The cases with rotator muscle rupture were investigated many times, in terms of aspects such as age, activities at the time of trauma, and evaluation of the healing after the surgery; however, the humerus in the cases were not anatomically evaluated (8-12). Only Sorensen et al. stated that there was anatomical irregularity in greater tubercle, which is the insertion point of the supraspinatus muscle in the ultrasonographic evaluation of the bone structure after trauma in their study (9). This study evaluated the surgical neck of the humerus to be shorter in the patient group, and the (H3) parameter, which is the distance to the greater tubercle, to be similar with the control group ($p > 0.05$), and the presence of a significant difference in the H1/H2 ratio ($p < 0.05$) between the two groups as follows: the humerus has had a shorter surgical neck and the greater tubercle, which is found at the upper part of this structure became more laterally prominent. This prominence is explained as the increase in the distance between the lateral and medial margins of the greater tubercle, which

was marked with a "gw" sign in the study of Robertson et al., (13) in which they investigated the morphology of proximal humerus on cadavers. This covers a longer distance from the upper part of the supraspinatus muscle towards the greater tubercle (Figure 3, m-n arch) and will end in greater tubercle forming a right angle (Figure 4, C2 angle) (Figure 4, C1 and C2 angles, $C1 > C2$). In addition, the significant difference between H4 parameters in the patient group and control group also achieves the same result due to a shorter distance of the surgical neck of the humerus and higher values of H4 angles found in individuals with rotator muscle rupture. Thus, the drawing found in the second line of the schematized drawings in Figure 5 provides these findings. According to this, as the value of the H4 angle increases, the value of the angle between the body and the head of the humerus will decrease (the head of the humerus facing downwards) (14), in turn, causing the greater tubercle to become more prominent laterally. In the light of these results, it is believed that tension occurs rapidly in the muscles of these cases and this has role in the formation of ruptures. When analyzing the muscle functions in terms of mechanic factors, the distance between the insertion point of a tendon and the joint determines the velocity of the contraction. The

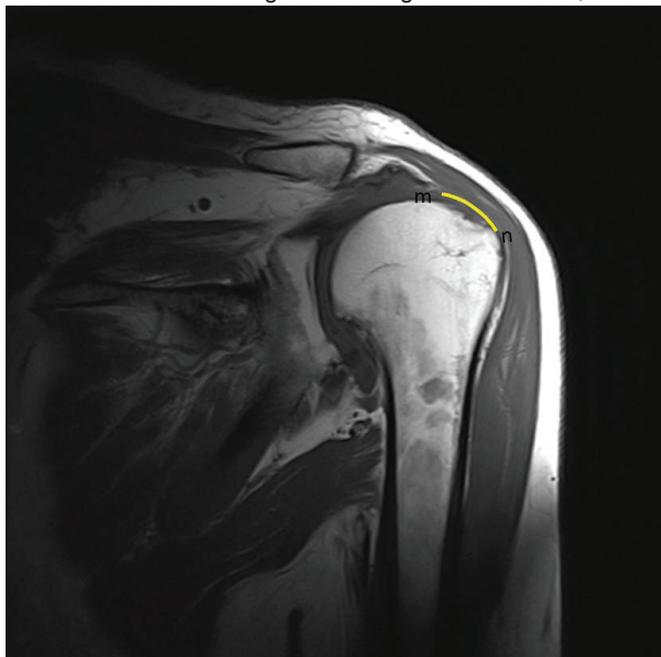


Figure 3. The supraspinatus muscle and 'm-n' arch over the humerus

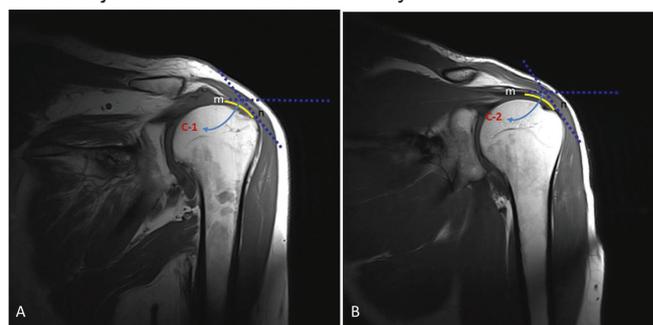


Figure 4. A: The length of the surgical neck of the humerus 9.66 mm
B: The length of the surgical neck of the humerus 9.24 mm
'm-n' arch and the insertion angles of the muscle (C-1 angle > C-2 angle)

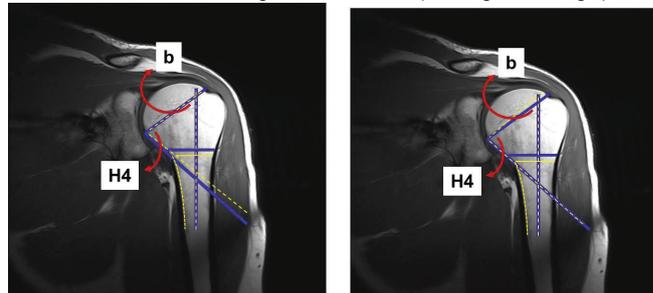


Figure 5. The schematic demonstration of H4 and head-body angle on the humerus Control group: straight blue lines, Patient group: dashed yellow lines

muscles that insert at a more distant point from the joint have a tendency to contract at a more rapid rate; the muscles inserted at a point closer to the joint have tendency to produce more force. Furthermore, the insertion angle of the tendon known as the leverage effect provides a mechanical advantage to that muscle. The closer the insertion angle of the tendon at 90 degrees, the higher the velocity of the contraction would be (15,16). Mighell et al. (17) mentioned that the height of the greater tubercle, according to the vertical axis (localization at a higher or lower distance), is important in terms of postoperative complications. The result of the position of performing the supraspinatus test defined by Jobe in 1983, is also parallel to this idea. The test is performed by applying 90 degrees of abduction, 30 degrees of anterior flexion, and internal rotation to the shoulder (18). The common result of these movements is the movement of the greater tubercle from normal anatomical localization and stretching the supraspinatus muscle. The anatomical structure of the proximal part of the humerus is an area that is studied today as a biomechanical model in intramedullary nailing, and the application of prostheses and joint capsules (6,13,19,20). It seems that it will preserve this importance as a study area thereafter. This study aroused the idea that it is beneficial to remember that the length of the surgical neck of the humerus is a factor that has an effect on the formation of rotator muscle rupture.

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