Characteristics of MR arthrography findings in traumatic posterosuperior rotator cuff tears

Cho, Yung-Min

Department of Medicine

The Graduate School, Yonsei University

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Directed by Professor Chun, Yong-Min

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Cho, Yung-Min

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This certifies that the Master's Thesis of Cho, yung-min is approved.

Thesis Supervisor : Chun, Yong-Min

Thesis Committee Member#1 : Choi, Yun-Rak

Thesis Committee Member#2 : Young Han Lee

The Graduate School
Yonsei University

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ABSTRACT

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Cho, Yung-Min

Department of Medicine
The Graduate School, Yonsei University

(Directed by Professor Chun, Yong-Min)

Background: Few studies have investigated magnetic resonance (MR) characteristics of traumatic posterosuperior rotator cuff tears involving the supraspinatus and infraspinatus. We hypothesized that traumatic rotator cuff tears may have MR characteristics distinguishable from non-traumatic tears.
Methods: Preoperative MR arthrography and intraoperative tear size measurements were compared in 302 patients who received MR arthrography and underwent subsequent arthroscopic rotator cuff repairs for traumatic (61 patients, Group T) or non-traumatic (241 patients, Group NT) tears. The inclusion criteria for both groups were posterosuperior full-thickness rotator cuff tear and age between 40 and 60 years. For Group T, traumas were limited to accidental falls or slips, or sports injuries, motor vehicle accidents; injuries were associated with acute onset of pain followed by functional shoulder impairment; and time between injury and MRI was 6 weeks or less.
Results: In Group T, 72% of shoulders (44 patients) exhibited tendon tears with blunt edges while 28% shoulders (17 patients) showed tears with tapering edges. In contrast, 21% patients in Group NT (51 patients) had blunt-edge tears, while 79% (190 patients) of tears had tapering edges. These results were statistically significant ($p < 0.001$) and estimated odds ratio was 9.6. The size of tear did not vary significantly between groups.
Conclusions: We did not find an exclusive MR characteristic to define traumatic tears. However, oblique coronal MR images showed a significantly strong tendency for traumatic tears to have abrupt and rough torn tendon edges and relatively consistent tendon thicknesses (without lateral tapering) compared to non-traumatic cuff tears.

Key words : rotator cuff tear, trauma, arthroscopy, shoulder, MR arthrography

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I. Introduction

The authors have often been queried whether it is possible to determine if a particular rotator cuff injury resulted from a trauma. Often these questions infer that this type of information could be interpreted from a patient's magnetic resonance (MR) scan. Indeed, we have often been solicited for advice or opinions of courts or health insurance companies attempting to determine whether a rotator cuff injury resulted from trauma.

Most rotator cuff tears are generally considered to be associated with degenerative tendon changes.[1-3] Early reports have described that the incidence of acute traumatic rotator cuff tears was only 8% of 510 patients referred to the Mayo Clinic for cuff repairs,[4] while recent studies have reported up to 17%.[5,6] Although several studies have reported on traumatic rotator cuff injuries, these have primarily focused on the subscapular tendon or on anterosuperior rotator cuff tears.[5,7-9]

While there have been several radiological studies regarding the distinction between traumatic and non-traumatic rotator cuff tears, these have primarily investigated ultra-sonographic findings.[10,11] Although ultra sonography has shown relatively high sensitivity and specificity ranging from 80% to 100%,[10-14] the accuracy largely depends on the examiner's expertise. In contrast, magnetic resonance imaging (MRI) or MR arthrography (MRA) are now considered the most accurate diagnostic tool for rotator cuff tears. Nevertheless, there are only a few studies regarding the traumatic rotator cuff tear and there are mainly about the anterosuperior rotator cuff tear or isolated subscapularis tear.[5,7,8] Even in the previous studies about a traumatic anterosuperior rotator cuff tear, they only addressed functional or radiological outcomes after open or arthroscopic repair, and did not describe the distinguishable characteristic MR findings of the traumatic rotator cuff tear. Also, no study has been published that explore the radiological findings of traumatic posterosuperior rotator cuff tears by MRA. Thus, we attempted to determine some consistency or unique distinctions of traumatic posterosuperior rotator cuff tears, as shown by MRA.

The purpose of this study is to compare traumatic and non-traumatic posterosuperior rotator cuff tears using preoperative MRA findings, which were re-evaluated by arthroscopic surgery. We hypothesized that traumatic posterosuperior rotator cuff tears would present characteristic MRA findings distinguishable from non-traumatic posterosuperior rotator cuff tears.

II. Materials and Methods

1. Study populations

This study is a retrospective comparative study consisting of 302 patients who had received an MRA in our institute with our routine shoulder MR protocol, and had subsequently undergone arthroscopic rotator cuff repairs for either traumatic (61 patients, Group T) or non-traumatic posterosuperior rotator cuff tears (241 patients, Group NT) between March 2008 and August 2012. Patients included in the study met the criteria described below. Even though the MRI has high accuracy for detecting the rotator cuff tear, MRA can delineate anatomic structures and demonstrate subtle abnormalities by contrast solution.[15] Thus, to outline the shape of the torn tendon of rotator cuff, we thought that the MRA is more appropriate than conventional MRI. The common inclusion criteria for both groups were (1) a posterosuperior full-thickness rotator cuff tear involving the supraspinatus or greater; (2) patients between the ages of 40 to 60 years to exclude patients with asymptomatic pre-existing degenerative rotator cuff tears, which are common in elderly patients.[16-18] Medical records including radiological images were reviewed retrospectively. Institutional review board approval was obtained by a waiver of informed consent.

For the trauma group, (1) we limited traumas to accidental falls or slips, sports injuries, or motor vehicle accidents; (2) injuries were associated with acute onset of pain and followed by functional shoulder impairment; and (3) the time from injury to MR imaging was 6 weeks or less to exclude any chronic insidious degenerative changes at the edge of the torn cuff. The inclusion criteria for the non-trauma groups, the inclusion criteria were (1) patient who did not have accidents or injuries which were followed by acute onset of pain and dysfunction. The common exclusion criteria were (1) subscapularis-involving rotator cuff tears requiring repair; (2) tears of only partial thickness; (3) greater tuberosity avulsion fractures; (4) prior shoulder surgery on the affected shoulder; (5) rotator cuff arthropathy; (6) and patients who have claimed workers' compensation. For each patient, the mechanism and degree of injury was evaluated in detail during examination. For all patients in the trauma group, pre-existing pain in the effected shoulder before trauma necessitated exclusion from the study. In the non-trauma group, patients with any history of previous trauma in the affected shoulder were excluded.

2. Radiological assessment

MRAs were taken of all shoulders. In our institution, MR examination was performed with a 3.0T MR imager (Magnetom Trio Tim, Siemens, Erlangen, Germany) or a 3.0T MR imager system (Achieva®, Philips Healthcare, Best, The Netherlands) fitted with a dedicated shoulder coil. By using anterior approach under fluoroscopic guidance, direct arthrography was performed by intra-articular injection.

To evaluate distinguishable characteristics in traumatic posterosuperior rotator cuff tear in MR images, we focused on the status of the edge of the torn tendon and the existence of the tendon stump left on the greater tuberosity in the oblique coronal image. These characteristics were assessed in the image showing the longest retraction of the torn tendon, which was either T1-weighted fat suppression oblique coronal images or T2-weighted fast spin echo oblique coronal images based on the PACS system (Centricity PACS; GE Medical System Information Technologies, Milwaukee, WI). The longest retraction on the oblique coronal image was defined as maximum medial to lateral length which was described by Davidson et al.[19]

According to the shape of the torn edge of the tendon, we classified it as either blunt or tapering. A blunt edge was defined by an abrupt and rough edge of the torn tendon and was characterized by relatively consistent tendon thickness (without tapering laterally) on the oblique coronal image with arthroscopic reference (Fig 1.). In contrast, tapering edges were defined by a laterally tapered and smooth edge of the torn tendon (Fig 2.). Two independent observers reviewed the MRA images and classified the shape of the torn edge of the tendon. In cases of an ambiguous edge or disagreement between the observers, consensus was achieved based on whether the tendon had consistent thickness. If so, it was classified as a blunt edge, and if not, it was classified as a tapering edge. At the time of arthroscopic surgery, the tendon stump remaining on the greater tuberosity was classified either as a true tendon stump or merely fibrous scar tissue (Fig 3.).

Figure 1. 53-year-old man with traumatic rotator cuff tear. Torn tendon with blunt edge (white arrow) on the T2-weighted oblique coronal image.

Figure 2. 56-year-old woman with non-traumatic rotator cuff tear. Torn tendon with tapering edge (white arrow) on the fat-saturated T1-weighted oblique coronal image.

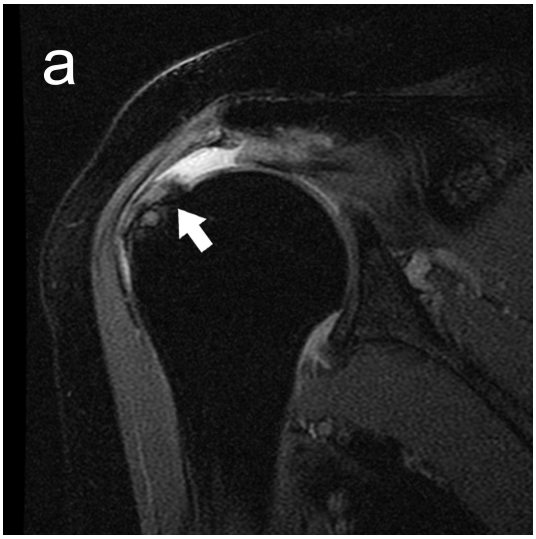

Figure 3. 51-year-old man with traumatic rotator cuff tear. Tendon stump left on the greater tuberosity (white arrow) on the fat-saturated T1-weighted oblique coronal image.

3. Statistical analysis

To compare the shapes of the torn edges and whether a tendon stump remained on the greater tuberosity between groups, Chi-square tests were implemented using the SPSS software (version 18.0, SPSS science Inc, Chicago, IL). For all analyses, a critical p value of 0.05 was regarded as significant.

III. Results

Group T consisted of 36 males and 25 females, and Group NT contained 90 males and 151 females. The mean age of patients in Group T was 55 years of age (ranging from 41 to 59 years old) and 56.2 years of age (ranging from 41 to 59 years old) in Group NT. For Group T, the mean time between the injury and MRA was 4.1 weeks (ranging from 0.5 to 6 weeks), and the mean period between the injury and surgery was 2.7 months (ranging from 1.5 to 4 months). Among the 61 patients, 30 patients were injured from falls, 25 were injured during sports activities, and six were injured in a motorcycle accident. In Group NT, the mean period between symptom onset and MRA was 8.2 months (range, 3 to 15 month), and the mean time from symptom onset to surgery was 12.2 months (range, 6 to 22 months).

Among the 61 shoulders in Group T, 44 shoulders (72%) had torn tendons with a blunt edge and 17 shoulders (28%) had tapering edges. The interclass correlation coefficient for reliability was found to be 0.837 ($p < 0.001$). In the 241 shoulders of Group NT, 51 shoulders (21%) had torn tendons with a blunt edge, and 190 shoulders (79%) had tapering edges. The interclass correlation coefficient for reliability in this group was 0.829 ($p < 0.001$). Significant differences were measured between the groups ($p <0.001$) using a Chi-square analysis. The estimated odds ratio between blunt shaped edges and Group T was 9.6 (95% confidence interval: 5.1, 18.3; Table 1.).

Table 1. Distribution of blunt and tapering edges of torn tendons

	Blunt edge	Tapering edge
Group T (61 cases)	44(72%)	17(28%)
Group NT (241 cases)	51(21%)	190(79%)

Group T: traumatic rotator cuff tears; Group NT: non-traumatic rotator cuff tears. Blunt edge: abrupt and rough edge of the torn tendon with relatively consistent tendon thickness (without lateral tapering) on the oblique coronal image. Tapering edge: the relative lateral tapering and smooth edges of the torn tendon on the oblique coronal image.

The incidence of tendon stumps remaining on the greater tuberosity was 26% in Group T and 16% in Group NT. There was no significant difference between the groups measured by a Chi-square analysis ($p = 0.055$)(Table 2). However, there was a significant difference between blunt and tapering edges measured by the Chi-square test ($p = 0.037$), and the estimated odds ratio between the existence of a stump and a tendon tear with a blunt edge was 1.9 (95% confidence interval: 1.1, 3.5; Table 2.).

Table 2. Distribution of the tendon stump left on the greater tuberosity according to the Group and the edge type

	With stump	Without stump	p-value
Group T (61 cases)	16 (26%)	45 (74%)	0.055
Group NT (241 cases)	39 (16%)	202 (84%)	
Blunt edge (95 cases)	24 (25%)	71 (75%)	0.037
Tapering edge (207 cases)	31 (15%)	176 (85%)	

Group T: traumatic rotator cuff tears; Group NT: non-traumatic rotator cuff tears. With stump: tendon stump left on the greater tuberosity. Without stump: tendon stump was not left on the greater tuberosity. Blunt edge: abrupt and rough edge of the torn tendon with relatively consistent tendon thickness (without lateral tapering) on the oblique coronal image. Tapering edge: the relative lateral tapering and smooth edge of the torn tendon on the oblique coronal image.

The mean tear size on oblique sagittal image was 19.7 ± 7.1 mm for patients in Group T, and 19.5 ± 10.2 mm for patients in Group NT. No significant differences were observed between the groups for tear size. However, in both groups, tapering-edged torn tendons were associated with a larger tear size than those with the blunt edges, and these results were found to be significant ($p < 0.001$; Table 3.). In comparing the tear size between patients with blunt-edged tears, Group T patients showed a significantly larger tear size ($p = 0.035$). However, there was no significant difference between the tear sizes of patients with tapering edges, regardless of the study group.

Table 3. Mean tear sizes in Groups T and NT

		Tear size	p-value
Group T (19.7 ± 7.1 mm)	Blunt edge	16.9 ± 6.2 mm	< 0.001
	Tapering edge	23.2 ± 6.7 mm	
Group NT (19.5 ± 10.2 mm)	Blunt edge	14.0 ± 3.4 mm	< 0.001
	Tapering edge	21.4 ± 11.0 mm	

The values are presented as the mean and standard deviation. Group T: traumatic rotator cuff tears; Group NT: non-traumatic rotator cuff tears. Blunt edge: abrupt and rough edge of the torn tendon with relatively consistent tendon thickness (without lateral tapering) on the oblique coronal image. Tapering edge: the relative lateral tapering and smooth edge of the torn tendon on the oblique coronal image.

IV. Discussion

Our study found that the traumatic cuff tears had an abrupt and rough cuff-off edge with relatively consistent tendon thickness (without tapering laterally), compared to non-traumatic cuff tears with statistical significance. However, contrary to our hope, this difference did not provide a clear distinction between traumatic and non-traumatic rotator cuff tears. In assessing the shape of the tendon tear, we employed the MRA rather than MRI because we thought that the MRA would be superior to delineate the shape of the torn edge of the tendon, etc. However, the hematoma around the cuff tear might become unclear by injecting a contrast into the joint.

To evaluate this hypothesis, we excluded asymptomatic degenerative rotator cuff tears from the traumatic cuff tear group. These types of rotator cuff tears have been reported in more than 20% of individuals older than 60 years of age.[9,18] Thus, only patients between the ages of 40 and 60 were included in this study. However, we acknowledge that we could not completely exclude asymptomatic tears from the traumatic cuff tear group because we did not have images showing an intact cuff before the trauma, and Kim et al. reported that asymptomatic degenerative rotator cuff tears exist in as many as 10% of individuals younger than 60 years of age.[18] In addition, we excluded patients who had an MRA more than 6 weeks after trauma to control for time sensitive changes in the shape of the torn rotator cuff.[4]

Although we were unable to determine a method for the unquestionable definition of traumatic rotator cuff tears, we found significant differences in the distribution of tear shapes between traumatic and non-traumatic tears. In Group T, 72% of tendons had a blunt edge and 28% had a tapering edge. In contrast, only 21% of tendons had a blunt edge and 79% had a tapering edge in Group NT. Although Group T did not contain as high a blunt edge proportion as expected and Group NT did not have as low a blunt edge proportion as expected, the estimated odds ratio of blunt shaped edges and Group T was 9.6, indicating a strong tendency for traumatic posterosuperior rotator cuff tears to have blunt shaped edges on oblique coronal images. There might be a degenerative change preceding the traumatic event. However, it will be beyond the scope of this study to identify this issue.

In addition to the tendon edge, we focused on the presence of a tendon stump remaining on the greater tuberosity. Although we did not find any significant differences between Groups T and NT for this parameter, there were significant differences between blunt and tapering edges, and the estimated odds ratio between the existence of a stump and having a tendon with a blunt edge was about two. Thus, a stump remaining on the greater tuberosity appears to be associated with shape of the torn tendon edge, but not with trauma.

Zanetti et al. suggested that occult greater tuberosity fractures were relatively common (38%) in patients younger than 40 years old with clinically suspected traumatic rotator cuff and indicated that the greater tuberosity should be examined for fractures.[20] Importantly, this group did not assess tendon tear shapes on MR images. However, although the patients in the current study had an MR image within 6 weeks of trauma, we did not find any occult fractures and excluded only two cases of greater tuberosity fractures.

The present study contains several limitations. As previously mentioned, we were unable to assess whether the patients in Group T had pristine tendons and relevant tissues before the trauma due to the lack of pre-trauma imaging. A subset of patients in Group T may have had asymptomatic insidious degenerative tears, which could influence our current analysis of the results. Indeed, such asymptomatic degenerative tears may predispose individuals to traumatic rotator cuff tears. Although we only included patients younger than 60 years of age, other investigators have reported 10-13% asymptomatic cuff tears in people aged 50-59 years.[9,18] Thus, this study would be weightier if we included only patients younger than 50 years of age. However, we required larger numbers of patients than those exclusion criteria would have afforded us. In addition, we tried to exclude the patients who had tendency for compensation, it would be impossible to rule out them completely. They might affect the results of this study.

V. Conclusion

In conclusion, we did not discover absolute differences in the shape of the edge of the torn tendon between traumatic and non-traumatic posterosuperior rotator cuff tears. However, we found a significantly strong tendency for traumatic rotator cuff tears to have tendons tears with abrupt and rough edges and relatively consistent tendon thickness (without tapering laterally) on the oblique coronal MR image.

VI. References

1. Brewer BJ. Aging of the rotator cuff. The American journal of sports medicine. 1979 Mar-Apr;7(2):102-10.
2. Neer CS, 2nd. Impingement lesions. Clinical orthopaedics and related research. 1983 Mar(173):70-7.
3. Mc LH, Asherman EG. Lesions of the musculotendinous cuff of the shoulder. IV. Some observations based upon the results of surgical repair. The Journal of bone and joint surgery American volume. 1951 Jan;33 A(1):76-86.
4. Bassett RW, Cofield RH. Acute tears of the rotator cuff. The timing of surgical repair. Clinical orthopaedics and related research. 1983 May(175):18-24.
5. Ide J, Tokiyoshi A, Hirose J, Mizuta H. Arthroscopic repair of traumatic combined rotator cuff tears involving the subscapularis tendon. The Journal of bone and joint surgery American volume. 2007 Nov;89(11):2378-88.
6. Hantes ME, Karidakis GK, Vlychou M, Varitimidis S, Dailiana Z, Malizos KN. A comparison of early versus delayed repair of traumatic rotator cuff tears. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 2011 Oct;19(10):1766-70.
7. Namdari S, Henn RF, 3rd, Green A. Traumatic anterosuperior rotator cuff tears: the outcome of open surgical repair. The Journal of bone and joint surgery American volume. 2008 Sep;90(9):1906-13.
8. Maier D, Jaeger M, Suedkamp NP, Koestler W. Stabilization of the long head of the biceps tendon in the context of early repair of traumatic subscapularis tendon tears. The Journal of bone and joint surgery American volume. 2007 Aug;89(8):1763-9.
9. Deutsch A, Altchek DW, Veltri DM, Potter HG, Warren RF. Traumatic tears of the subscapularis tendon. Clinical diagnosis, magnetic resonance imaging

findings, and operative treatment. The American journal of sports medicine. 1997 Jan-Feb;25(1):13-22.
10. Farin PU, Jaroma H. Acute traumatic tears of the rotator cuff: value of sonography. Radiology. 1995 Oct;197(1):269-73.
11. Teefey SA, Middleton WD, Bauer GS, Hildebolt CF, Yamaguchi K. Sonographic differences in the appearance of acute and chronic full-thickness rotator cuff tears. Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine. 2000 Jun;19(6):377-8; quiz 83.
12. Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. Health technology assessment. 2003;7(29):iii, 1-166.
13. Rutten MJ, Jager GJ, Kiemeney LA. Ultrasound detection of rotator cuff tears: observer agreement related to increasing experience. AJR American journal of roentgenology. 2010 Dec;195(6):W440-6.
14. Sipola P, Niemitukia L, Kroger H, Hofling I, Vaatainen U. Detection and quantification of rotator cuff tears with ultrasonography and magnetic resonance imaging - a prospective study in 77 consecutive patients with a surgical reference. Ultrasound in medicine & biology. 2010 Dec;36(12):1981-9.
15. Steinbach LS, Palmer WE, Schweitzer ME. Special focus session. MR arthrography. Radiographics : a review publication of the Radiological Society of North America, Inc. 2002 Sep-Oct;22(5):1223-46.
16. Sher JS, Uribe JW, Posada A, Murphy BJ, Zlatkin MB. Abnormal findings on magnetic resonance images of asymptomatic shoulders. The Journal of bone and joint surgery American volume. 1995 Jan;77(1):10-5.
17. Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. Journal of shoulder and elbow surgery / American

Shoulder and Elbow Surgeons [et al]. 1999 Jul-Aug;8(4):296-9.
18. Kim HM, Teefey SA, Zelig A, Galatz LM, Keener JD, Yamaguchi K. Shoulder strength in asymptomatic individuals with intact compared with torn rotator cuffs. The Journal of bone and joint surgery American volume. 2009 Feb;91(2):289-96.
19. Davidson JF, Burkhart SS, Richards DP, Campbell SE. Use of preoperative magnetic resonance imaging to predict rotator cuff tear pattern and method of repair. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2005 Dec;21(12):1428.
20. Zanetti M, Weishaupt D, Jost B, Gerber C, Hodler J. MR imaging for traumatic tears of the rotator cuff: high prevalence of greater tuberosity fractures and subscapularis tendon tears. AJR American journal of roentgenology. 1999 Feb;172(2):463-7.

ABSTRACT(IN KOREAN)

외상성 후상방 회전근 개 파열의 자기공명 관절 조영술상 특징

<지도교수 천 용민>

연세대학교 대학원 의학과

조 영민

배경 : 현재까지 극상근과 극하근을 포함하는 외상성 후상방 회전근 개 파열의 MRI상 특징에 대한 연구는 많지 않다. 이에 회전근 개 파열의 외상성, 비외상성 구분이 가능한 MRI 특징을 찾아보았다.
대상 및 방법 : 총 302명의 환자 중 외상성 파열 61명, 비외상성 파열 241명에 대해 MR 관절 조영술(MRA)과 관절경적 회전근 개 봉합술을 시행하였으며 MRA와 수술 중 측정된 파열 크기를 비교하였다. 대상 기준은 40~60세 사이의 후상방 회전근 개 전층 파열환자였다. 외상성 그룹은 낙상사고, 미끄러짐사고, 스포츠손상, 자동차사고로 인한 급성 통증 및 기능적 장애를 가지며 MRI검사까지 기간이 6주 이하인 경우로 제한 하였다.
결과 : 외상성 그룹 중 72%(44명)에서 blunt edge, 28%(17명)에서 tapering edge가 발생하였고 비외상성 그룹에서는 각각 21%(51명)와 79%(190명)가 발생하였다. 이는 통계학적으로 유의하며($p<0.001$) 교차비는 9.6이었다. 하지만 파열의 크기는 그룹들 사이에 유의한 차이는 없었다.
결론 : MRI에서 외상성 파열을 의미하는 특징을 찾지 못했으나 oblique coronal MRI에서 비외상성 파열들에 비해 외상성 파열들이 blunt edge와 힘줄의 두께가 상대적으로 유지되는 경향을 보였다.

핵심되는 말 : 회전근 개 파열, 외상, 관절경검사, 어깨, 자기공명 관절조영술