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ARTHROSCOPY AND SPORTS MEDICINE

Attrition of rotator cuff without progression to tears during 2–5 years of conservative treatment for impingement syndrome

Tae-Hwan Yoon[1] · Chong-Hyuk Choi[1] · Sung-Jae Kim[1] · Yun-Rak Choi[1] · Soon-Phil Yoon[1] · Yong-Min Chun[1]

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Abstract

Purpose The purpose of this study was to investigate the natural history of intact rotator cuff in impingement syndrome patients with concomitant spur protruding from the undersurface of acromion.

Methods This retrospective study included 119 patients with an intact rotator cuff who underwent conservative treatment for a spur protruding from the undersurface of the acromion. The protruded spur was defined as a trapezoid- or tetragon-shaped bony protrusion with a downward peak extending more than 3 mm in length from the baseline drawn along the acromial undersurface on the coronal view of magnetic resonance imaging (MRI) or computed tomography arthrography (CTA). Functional outcomes were evaluated by the visual analogue scale for pain, subjective shoulder value, American Shoulder and Elbow Surgeons score, University of California Los Angeles shoulder score, and active range of motion (ROM). To evaluate cuff integrity, follow-up MRI, CTA, or ultrasound were performed at least 2 years after the initial presentation.

Results No new rotator cuff tears were noted in any patient during the follow-up imaging studies. However, 18 patients (15%) underwent arthroscopic acromioplasty during the study period. During the arthroscopic examinations, moderate to severe attrition of the cuff was identified, although no tears were seen. At the final follow-up, pain level and shoulder function, including ROM, showed satisfactory outcomes.

Conclusion Spurs protruding from the acromial undersurface did not lead to rotator cuff tears during 2–5 years of conservative treatment. However, attrition of the rotator cuff was found during arthroscopic acromioplasty, suggesting that the protruding spurs caused extrinsic impingement of the cuff.

Level of evidence Therapeutic case series Level IV.

Keywords Subacromial spur · Impingement · Conservative · Natural history · Rotator cuff tear

Introduction

The extrinsic theory is known as one of the causes in rotator cuff pathology that is attributable to the impingement between the acromion undersurface and humeral head. Since Bigliani et al. [3] indicated that a hook type of acromion was associated with rotator cuff tear, concomitant acromioplasty was regarded as an integral procedure during rotator cuff repair. However, recent randomized controlled studies reported that concomitant acromioplasty with rotator cuff repair does not considerably improve clinical outcomes and structural integrity when compared to repair without acromioplasty [2, 9, 12, 17, 18, 24].

Nevertheless, some studies have reported that an acromial spur protruding from the undersurface of the acromion is associated with rotator cuff tear [15, 22, 25]. Kim et al. [15] reported that bursal-sided partial thickness rotator cuff tears are associated with a significantly higher incidence of protruding subacromial spurs than articular-sided partial thickness rotator cuff tears.

Although rotator cuff tear may result from extrinsic factors in the subacromial space, it is unclear whether a spur protruding from the acromial undersurface is the result of irritation by the torn rotator cuff or a preexisting pathology that causes the tear. In particular, in circumstances with a protruding spur and an intact rotator cuff, no study has evaluated whether preventive acromioplasty is necessary to

✉ Yong-Min Chun
min1201@hanmail.net

[1] Department of Orthopaedic Surgery, Severance Hospital, Arthroscopy and Joint Research Institute, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, CPO Box 8044, Seoul 120-752, South Korea

avoid rotator cuff tear initiated by the spur. Likewise, no study has described the natural history of an intact rotator cuff in the setting of a protruding subacromial spur.

The purpose of this study was to investigate the natural history of intact rotator cuff in impingement syndrome patients with concomitant spur protruding from the undersurface of acromion. We hypothesized that for 2–5 years after diagnosis, conservative treatment for the protruding subacromial spur would provide satisfactory outcomes and not lead to the development of a rotator cuff tear.

Materials and methods

Study population

This study retrospectively reviewed data from 177 patients with an intact rotator cuff who underwent conservative treatment for the symptoms originating from impingement of a spur protruding from the undersurface of the acromion between March 2009 and May 2015. The intact rotator cuff was confirmed by magnetic resonance imaging (MRI) or computed tomography arthrography (CTA). Using the coronal view of MRI or CTA images, the spur was measured from the acromial undersurface. A baseline was drawn along the anatomical undersurface of the acromion, and any trapezoid- or tetragon-shaped bony protrusion that has downward peak of more than 3 mm from the baseline was defined as the subacromial protruding spur (Fig. 1).

This study included patients who were available for at least 2 years of follow-up of conservative treatment and available for a follow-up imaging study at least 2 years from the initial MRI or CTA study. The exclusion criteria were previous surgical history of the affected shoulder, presence of inflammatory arthritis, and inability to undergo follow-up imaging studies for the evaluation of rotator cuff integrity.

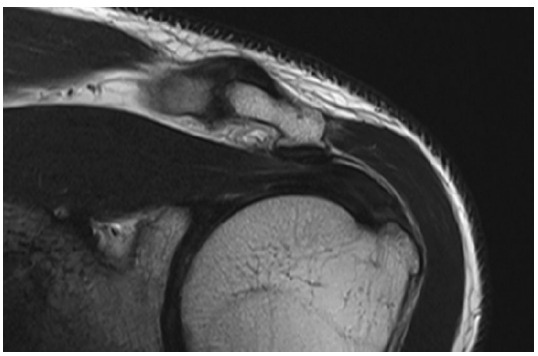

Fig. 1 The spur was defined as a trapezoid- or tetragon-shaped bony protrusion with a peak that extended more than 3 mm downward from the baseline drawn along the acromial undersurface on the coronal view of MRI (*T2* weighted image)

Conservative treatments consisted of medications, physical therapy, and intermittent ultrasound (US)-guided subacromial corticosteroid injections. Regular follow-up visits generally occurred every 3–6 months. Patients who did not respond to conservative treatment for more than 6 months were considered for arthroscopic acromioplasty. A total of 119 patients who met our inclusion and exclusion criteria were included in this study. Their medical records, including radiological findings, were reviewed retrospectively. Our institutional review board approved this study and waived the requirement for informed consent.

Functional and radiological assessments

Functional outcomes were evaluated by assessing the visual analogue scale (VAS) for pain, subjective shoulder value (SSV), American Shoulder and Elbow Surgeons (ASES) score, University of California Los Angeles (UCLA) shoulder score, and active range of motion (ROM). Active ROM was determined by measuring the amount of forward flexion, external rotation, and internal rotation of the shoulder joint. The forward flexion angle was measured in the scapular plane, whereas the external rotation angle was measured with the arm at the side. Internal rotation was estimated as the highest spinal segment of the back the patient could reach with the thumb. To simplify the statistical analysis, spinal segments were converted to consecutive numbers: segments between *T1* and *T12* were designated 1 through 12, segments from *L1* through *L5* were designated 13–17, and the sacrum was designated as 18 [13, 14, 23]. Shoulder functional scores and active ROM were assessed at baseline and during each follow-up visit by an independent examiner who was blinded to other patient information. Follow-up imaging studies were performed at least 2 years after the initial presentation. MRI, CTA, or US were used to evaluate rotator cuff integrity at follow-up. First, US was used in all patients undergoing follow-up to evaluate their cuff integrity as a screening tool; and then, for cases with suspected partial or full thickness cuff tear, MRA was further ordered [5]. However, in patients for whom MRA was not feasible due to financial strain, claustrophobia, or history of pacemaker insertion, CTA was performed instead to assess cuff integrity. The follow-up USs were performed by a shoulder-specialized orthopedic surgeon who had completed shoulder and sports medicine fellowship-training.

Results

Patient demographics

The mean follow-up time was 39.8 months and the patients' mean age was 53.5 years old. There were 56 men and 63

women in the study. The mean duration of symptoms prior to the initial visit at our institution was 11.8 months, and 79% (94/119) of patients had pathology in their dominant arm.

Radiological and functional outcomes

The follow-up imaging study was performed at the mean follow-up duration of 39.8 months (24–61 months) after initial presentation. To assess cuff integrity, US was used as the imaging tool in 69% of patients (82/119), and the remaining patients were evaluated by either US with subsequent MRI (21%; 25/119) or CTA (10%; 12/119). New cuff tears were not observed in any patient on the follow-up imaging study, but 18 patients (15%) underwent arthroscopic acromioplasty during the study period, with a mean duration from initial presentation to surgery of 22.7 months (10–35 months).

Functional outcomes were assessed in those patients who received only conservative treatment. The mean VAS pain score was 4.3 ± 1.5 initially and improved to 0.7 ± 1.0 at final follow-up. The mean SSV was 56.5 ± 15.2 at initial presentation and improved to 91.5 ± 10.5 at last follow-up. The mean UCLA and ASES scores were 21.9 ± 4.5 and 62.4 ± 13.3 at initial presentation, respectively, and improved to 32.7 ± 3.0 and 93.6 ± 8.5, respectively, at last follow-up. The mean amounts of active forward flexion, external rotation, and internal rotation were $143.5 \pm 13.1°$, $58.6 \pm 5.9°$, and 12.1 ± 2.1, respectively, at initial presentation and $149.9 \pm 5.8°$, $60.2 \pm 5.7°$, 10.5 ± 1.5, respectively, at final follow-up (Table 1).

Arthroscopic findings

On arthroscopic examination of 18 patients who underwent arthroscopic acromioplasty, no cuff tears were noted in any patient. However, moderate to severe attrition of the cuff was observed (Fig. 2), which was not identified in the preoperative radiological assessment. In addition to acromioplasty for the spur protruding from the acromial undersurface, arthroscopic debridement was performed.

Discussion

It is not uncommon to encounter a patient with a spur protruding from the undersurface of the acromion in the setting of an intact rotator cuff tear. Although conservative treatment can yield satisfactory outcomes, we have wondered whether the protruding spur would eventually cause a rotator cuff tear. Our study originates from this query. Consistent with our hypothesis, 85% of patients responded well to conservative management, and no new rotator cuff tear developed during the 2- to 5-year study period. However, conservative treatments failed in 15% (18/119) of patients, requiring arthroscopic acromioplasty.

The causes of rotator cuff tear have been studied by many investigators, and recent debate has narrowed the etiology to two major groups of factors suspected to cause rotator cuff pathology. First, intrinsic factors within the rotator cuff tendons themselves may cause a tear: degeneration of the tendons leads to poor vascularity, altered biology, and inferior mechanical properties of the aging rotator cuff, which in turn results in a rotator cuff tear [6, 21]. Others have argued that extrinsic factors, such as acromial shape and spur formation, are the main cause, placing the rotator cuff tendons at increased risk of a tear [1, 3, 20]. Most authors agree that both intrinsic and extrinsic factors influence rotator cuff pathology [7, 11, 19, 26].

Table 1 Functional scores and active ranges of motion

	Initial ($N=119$)	Final follow-up ($N=101$)
VAS pain score	4.3 ± 1.5	0.7 ± 1.0
SSV	56.5 ± 15.2	91.5 ± 10.5
UCLA score	21.9 ± 4.5	32.7 ± 3.0
ASES score	62.4 ± 13.3	93.6 ± 8.5
Forward flexion	$143.5° \pm 13.1°$	$149.9° \pm 5.8°$
External rotation	$58.6° \pm 5.9°$	$60.2° \pm 5.7°$
Internal rotation	12.1 ± 2.1	10.5 ± 1.5

Internal rotation was estimated by recording the highest spinal segment reached by patient's thumb. To facilitate statistical analysis, the spinal segments were converted into numbers: *T1–T12* were designated as 1–12, *L1–L5* as 13–17, and the sacrum as 18

Values are mean ± standard deviation

VAS visual analogue scale, *SSV* subjective shoulder value, *UCLA* University of California, Los Angeles, *ASES* American Shoulder and Elbow Surgeons

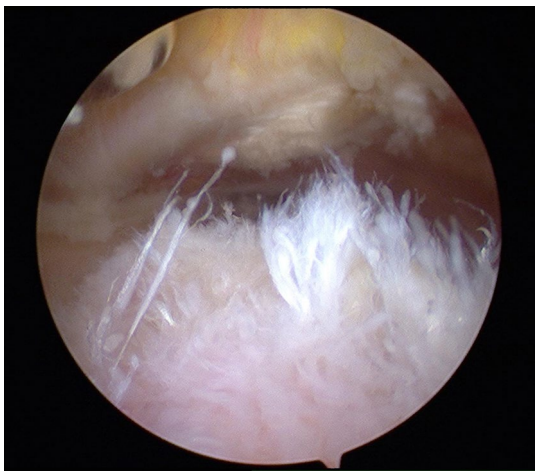

Fig. 2 Arthroscopic image of severe attrition of the supraspinatus tendon (as viewed from the lateral portal) identified in the left shoulder of a patient during follow-up

Neer et al. [20] was the first to mention acromial spur as an extrinsic factor and indicated that a proliferative spur impinges upon the rotator cuff tendons. They stated that because prolonged impingement leads to rotator cuff tear, acromioplasty is necessary to prevent potential cuff pathology. Since this publication, several studies have attempted to determine the relationship between acromial spurs and rotator cuff tears [21, 25]. Although these studies found a relationship between the two conditions, whether there is an actual causal relationship remains a matter of considerable debate. Hamid et al. [10] have been in favor of the extrinsic factor theory, since spurs are seen more frequently in shoulders with rotator cuff tears than in shoulders without a tear. By contrast, Bonsell et al. [4] have opposed these findings and emphasized that spur formation is a degenerative change that does not affect development of rotator cuff tears. In our opinion, however, the spurs Bonsell et al. described seemed to be traction spurs along the coracoacromial ligament.

In our study, many patients responded well to conservative management, including intermittent US-guided subacromial injection. However, in patients who underwent arthroscopic acromioplasty, moderate to severe attrition of the rotator cuff was found during arthroscopic examination, suggesting that impingement occurred between the cuff and protruding spur. This suggests that the spur itself may function as a causative factor in rotator cuff injury, and cumulative and repetitive injury may eventually produce a tear. Moreover, we also found that the area of cuff attrition was more medial than the greater tuberosity of the humerus where the cuff inserts.

Kim et al. [15] reported that in a bursal-sided partial thickness rotator cuff tear, the occurrence of a protruding subacromial spur was much more common than in an articular-sided partial thickness tear. In their study investigating the relationship between different types of acromial spurs and rotator cuff tears, Oh et al. [22] found that a heel type of spur was more commonly associated with rotator cuff pathology than other types of spurs and suggested that this type of spur contributes to direct abutment of the humeral head on the acromion through superiorly directed microinstability. Tucker et al. [25] reported a case series of 20 patients with a keeled type of spur on the undersurface of the acromion and found that 60% of patients had a concurrent full-thickness tear of the rotator cuff. Although Oh et al. and Tucker et al. stated that their findings suggested a considerable causative relationship between heel or keeled types of spurs and the development of a rotator cuff tear, we also thought about an opposing possibility—that spur proliferation is caused by irritation from the free edge of a torn tendon. However, the latter explanation may be less likely since a protruding spur and an intact rotator cuff were evident in all patients in the current study. Thus, we consider that spur formation may precede the tear and act as an extrinsic factor in the development of rotator cuff tears.

No definitive study has evaluated the potential benefit of acromioplasty in preventing eventual tear of the rotator cuff. However, Kolk et al. [16] compared 43 patients who underwent bursectomy alone or bursectomy with acromioplasty due to subacromial pain syndrome without a rotator cuff tear. After follow-up for a mean of 14 years, they found no significant difference between groups in clinical scores or incidence of rotator cuff tear. There was a 17% (3/18) incidence of full-thickness rotator cuff tear during this long duration of follow-up. In addition, Beard et al. [2] studied a total of 313 patients who were divided into the following three groups: decompression, diagnostic arthroscopy, and conservative care. They followed up with these patients for 1 year, and the results of this randomized and placebo controlled study presented no significant difference between decompression and diagnostic arthroscopy groups. However, both groups with surgical intervention showed statistical significance over conservative care group, although researchers explained that the difference had no important clinical correlation. They concluded that the difference had originated from either placebo effect or postoperative rehabilitation. Thus, even in the presence of extrinsic impingement, there is probably a low likelihood of the sudden development of a rotator cuff tear in the short-term, so if the rotator cuff is intact on imaging studies, there is no need to rush to perform an acromioplasty.

In their study of 94 patients with impingement syndrome followed for a mean of 2 years, Cummins et al. [8] found that with conservative management alone, functional scores and pain levels improved. Furthermore, only 21% of their patients required surgical intervention. Although the study did not focus on the role of acromial spurs in rotator cuff pathology, their good outcomes with nonsurgical treatment led us to consider providing conservative management over surgical intervention. In the current study, there was some concern about the potential for developing a rotator cuff tear from the protruding spur during conservative treatment, but our patients had satisfactory outcomes. In addition, although a small proportion of our patients underwent arthroscopic acromioplasty after conservative treatment, none of our patients exhibited a rotator cuff tear on the final imaging evaluation during the 2- to 5-year study period.

There are some limitations in this study. First, our study was a retrospective records review of patients with 2–5 years of follow-up, which does not provide as much strength of evidence as a prospective study with longer follow-up, especially when examining the natural history of a condition. Second, there was a 15% failure rate of conservative management in our patient population. Comparison between the operation and non-operation groups was not feasible because of the small number of patients who underwent

surgery. Third, the imaging modality used at follow-up in 70% of our patients was US alone, instead of subsequent MRI or CTA. Although US has some limitations in evaluating cuff integrity, patients with suspected cuff tear were examined again with MRA or CTA, and double-checking with these modalities ensured that no tear was present in these suspected patients. Therefore, the authors were unable to determine whether the protruding spur had grown in size during follow-up.

Conclusion

In conclusion, a spur protruding from the undersurface of the acromion did not lead to rotator cuff tear during 2–5 years of conservative treatment. However, considering the attrition of the rotator cuff found during arthroscopic acromioplasty, the protruded spur appears to cause extrinsic impingement of the rotator cuff.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Institutional review board approval was obtained, and the requirement for informed consent was waived.

Informed consent We obtained approval from Institutional review board of our institute and written informed consent was waived as this study is a retrospective analysis of medical and radiological data.

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