

**Throwing Disorder with Antero-Posterior Instability of
the Shoulder in the Throwing Plane (The APIT Lesion)**

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INTRODUCTION

Throwing motion needs sufficient physical strength of the shoulder and efficient coordination of the trunk and lower extremity movement. However, compulsory motion due to poor balance caused by systemic muscular fatigue is frequently observed, and throwing disorder caused by overuse of an upper extremity is also noticed.

Concretely, there were dysfunction existed at the shoulder due to lack of centripetal force resistance of the humeral head against the glenoid during the throwing motion. But these were actually diagnosed and treated under an assumed clinical entity like subluxation, in many cases. Throwing plane is the concept advocated by Nobuhara in the study of baseball pitching biomechanics. This plane is formed by the upper extremity during the throwing motion and it is defined by the trajectory of the line connecting the shoulder, elbow and wrist joints from the acceleration phase to the deceleration phase including the Zero Position during the throwing motion. Observation of the dynamic activity of athletes who could not perform the throwing motion due to severe pain have identified both organic and functional factors associated with its pathogenesis.

Since 1987, we have encountered many patients who complained pain in the rotator interval and the insertion of the infraspinatus tendon with associated instability of the shoulder. Clinical symptoms in these patients, were very similar to those with RI lesion or incomplete avulsion of the infraspinatus tendon (ISP lesion). The specific clinical symptom was severe pain during the throwing motion in the throwing plane. It was unclear whether this disease state was due to the concomitant lesions of the RI and the insertion of the ISP tendon, or whether it should be treated as a different pathological entity. As for the instability of the glenohumeral joint, it was not clear if this was associated with abnormal translation of the humeral head in the glenoid cavity during normal range of throwing activity in the shoulder itself.

To facilitate further analysis, we hypothesized that this pathological disease state was related to a throwing disorder caused by A-P instability of the shoulder in the throwing plane. The objectives of this study were to perform a retrospective review of patients with the APIT lesion to fully characterize the clinical entities of this disease state, and to elucidate the nature of instability based on the analysis of radiographical findings.

MATERIALS AND METHODS

SUBJECTS FOR CLINICAL STUDY: 1,044 athletes who visited our institute from 1987 to 1999 were investigated. Their complaints were pain and unstable feeling in their shoulder during the throwing motion. Among these, 343 patients who had symptoms associated with the APIT lesion were evaluated in this study. Patients with an RI lesion or an ISP lesion as well as those with a past history of traumatic or recurrent dislocation, or injury of the glenoidal labrum were excluded. As controls, patients with an RI lesion and those with an ISP lesion which have similar symptoms were examined.

SUBJECTS FOR RADIOGRAPHIC STUDY: All of the patients having throwing disorders were measured

radiographically. Unclear images, or those where definite points for measurements could not be determined were excluded, and finally, data of 96 patients with the APIT lesion were adopted as the materials in radiographic study. As controls, patients with an RI lesion, patients with an ISP lesion, and healthy normal males were examined.

DIAGNOSTIC METHODS FOR THE APIT LESION: Definite diagnosis of the APIT lesion was done based on clinical symptoms, such as tenderness at the RI and at the insertion of the ISP tendon, continuous motion pain during the throwing motion, as well as on positive physical exams, and abnormal findings of radiographs and arthrographs of the shoulder.

MOTION UNDER FLUOROSCOPIC OBSERVATION: The translation of the humeral head in the glenoid cavity at each position during the throwing motion was radiographically recorded and measured. Radiographic images were taken with the subject during simulated active throwing postures from the upper extremity in maximally elevated position to the ball release position. The movement between the glenoid cavity and the humeral head in the axial view was video taped under fluoroscopic observation.

ANALYSIS OF RADIOGRAPHIC FINDINGS: The recorded images were analysed with an image processing system. The translation of the humeral head was measured every 10 degrees during simulated active throwing motion in the throwing plane from 60 degrees to 140 degrees.

RESULTS

CLINICAL EVALUATION: As for the sex ratio, that of men was higher in the APIT lesion group than in the other groups, and mean average age was lower by 2 years when compared with the ISP lesion group. In the APIT lesion group, the time elapsed from the onset of pain to medical consultation ranged from 1 week to 4 years with an average of 8 months, suggesting a delay of treatment in many players. As for predisposing factors, of the APIT lesion group, laxity of the shoulder was involved in as low as 3.5 %, while a rather high percentage of patients presented tightening of the latissimus dorsi muscle in this group.

Regarding the phase of pain development, the APIT lesion and the RI lesion groups had a higher tendency in the cocking phase comparing with the ISP lesion group. In the follow through phase, the APIT lesion group was significantly higher than the RI lesion group.

As for the treatment provided, rest and guidance of throwing form and rehabilitation were given to all the patients with the APIT lesion. 29 % of the patients with the APIT lesion were instructed to stop practicing throwing.

Arthrography was performed on all the patients with the APIT lesion, and obliteration of the subscapularis bursa was found in 90 % patients. In these patients, joint distension was carried out to reduce pain. Almost all the patients recovered within 3 months. Surgical treatment was indicated to 5.5 % patients with the APIT lesion who did not respond to conservative treatment. Their average age was 22 years. The surgical procedure consisted in repair of the RI and the ISP tendon were performed. Postoperative results were excellent and all but 2 of them returned to the former sports.

ANALYSIS OF RADIOGRAPHIC FINDINGS: Continuous radiographs taken in the axial projection showed that the humeral head had a marked tendency to translate anteriorly at the cocking phase and it rotated externally, then translated posteriorly during the acceleration phase, and translated anteriorly again in the follow through phase. Arthrographs also showed specific findings, such as protrusion of contrast medium to the RI and leakage into the insertion of the ISP tendon.

In the normal group, the center of the humeral head was located in the posterior position during the throwing motion while in the APIT lesion and ISP lesion groups, it was located in the anterior position. In the APIT lesion group, the center of the humeral head was located anteriorly at 60 degrees. At 120 degrees, the humeral head location was in the posterior position in most of the subjects, then it returned to the anterior position at 140 degrees. An abnormally large translation was observed in the APIT lesion and the ISP lesion groups compared with those of the RI lesion and normal groups.

DISCUSSION

In 1993, Silliman and Hawkins pointed out that many findings would enrich our understanding on joint instability, but there are redundant concepts making clinical diagnosis of the pathologic lesion difficult. In fact, the concepts of subluxation, instability and loosening, or the terminology such as instability, translation, laxity, and abnormal mobility are confusing with adding new information to this complicated. Under such situation, where would the proposed APIT lesion stand ?

As for the physical tests used to examine instability of the shoulder, these assessments do not allow us to precisely understand the instability of the shoulder that takes place during the throwing motion. Consequently, even these examination does not allow us to identify the site of pain. Where exactly is the site responsible for the shoulder pain that develops during the throwing motion? With relation to the phase of throwing during which pain developed, patients in all three groups developed pain mainly in the acceleration phase. However, in the APIT lesion group, but no in the other groups, pain also developed from the cocking phase to the follow through phase. In the APIT lesion, the symptom improved in 90 % of the patients immediately after joint distension suggested a relationship between this lesion and pain due to an increase of intracapsular pressure.

Currently, many authors mention the glenoid labrum injury as the site where instability occurs. However, This occurrence of injury of glenoidal labrum was 21 % in our study, and this was considerably low compared with the 33 % of patients with the APIT lesion. This fact tells us that some throwing disorders may occurred without injury of the glenoidal labrum.

Malone pointed out that the final position of the shoulder facilitated the occurrence of errors due to the mechanics of the body and lower extremity as well as continuity of motion, which may lead to shoulder disorder. What are the predisposing factor involved in the pathogenesis of the APIT lesion? Court-Brown reported that 78 % of athletes who practice high-level sports show laxity of the shoulder. In this study, laxity of the shoulder was recognized only in 3.5 % of the patients in the APIT lesion group. This was significantly lower compared with those in the other groups. Thus, in the case of an APIT lesion, laxity

of the shoulder may not be related to instability of the shoulder during the throwing motion. The latissimus dorsi muscle plays a key role transmitting the rotational energy from the lower extremity during the throwing motion. If this muscle is tensed up due to fatigue, it impedes the throwing motion. Tightening of the latissimus dorsi muscle was noted in 31 % of the patients in the APIT lesion group, suggesting a strong participation of tensed latissimus dorsi muscle with the pathogenesis of APIT lesions.

Although treatment varies depending on the degree of clinical symptoms, rest, guidance of the throwing form and rehabilitation were given in principle. Throwing motion was restricted in some of the patients with the APIT lesion, however, this may decline the sports ability of the whole body, and it may be better to provide treatment for tensed latissimus dorsi muscle. Almost all the patients recovered within 3 months.

As for the range of translation of the center of the humeral head, the value of the normal group seems to suggest stability of the shoulder joint during the throwing motion. In the APIT lesion and the ISP lesion groups, the range of translation of the humeral head was larger than that of the normal group, and in the ISP lesion group, it was the largest of all groups. Concerning the translation of the center of the humeral head, the pattern of movement in the APIT lesion group in the throwing plane was similar to that observed in the ISP lesion group. This finding suggests that these lesions are different from the RI lesion, where the throwing motion is difficult due to pain at the maximum external rotation position. The differences between the APIT lesion and the ISP lesion groups were the phase at which pain developed, and the total amount of translation of the center of the humeral head. These results revealed that the APIT lesion closely resembles the RI lesion with regard to the development of pain and the ISP lesion with regard to the abnormal instability of the humeral head during the throwing motion. Although the APIT lesion frequently develops in males, age of onset, affected side, and period engaged in sports were almost the same as those in the other groups, which is another reason this lesion has not been recognized to date.

Fatigue may cause an abnormal latissimus dorsi function which can lead to the RI and the ISP lesions. Repeated injury to the rotator interval by excessive throwing motion may lead to the antero-inferior instability, which inhibits healing of the rotator interval. This instability may cause an ISP lesion, which has larger instability in the A-P direction. The A-P instability also would lead to an RI lesion. Finally, these pathological states may produce the APIT lesion.

CONCLUSION

Clinical analysis and measurement of instability revealed that the APIT lesion does not occur concomitantly with the RI lesion and the ISP lesion, but that it is a different pathological entity. The APIT lesion has been diagnosed and treated as a subluxation so far, but we expect that as this lesion is better understood, new concept of treating throwing disorders will evolve.