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Magnetic Resonance Imaging of Rotator Cuff Tears in Shoulder Impingement Syndrome

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Summary

Background: Shoulder joint is a common site of musculoskeletal pain caused, among other things, by rotator cuff tears due to narrowing of subacromial space, acute trauma or chronic shoulder overload. Magnetic resonance imaging (MRI) is an excellent modality for imaging of soft tissues of the shoulder joint considering a possibility of multiplanar image acquisition and non-invasive nature of the study. The aim of this study was to evaluate the prevalence of partial and complete rotator cuff tears in magnetic resonance images of patients with shoulder impingement syndrome and to review the literature on the causes and classification of rotator cuff tears.

Material/Methods: We retrospectively analyzed the results of 137 shoulder MRI examinations performed in 57 women and 72 men in Magnetic Resonance facility of the Department of Radiology and Diagnostic Imaging at the St. Jadwiga the Queen Regional Hospital No. 2 in Rzeszow between June 2010 and February 2013.

Examinations were performed using Philips Achieva 1.5T device, including spin echo and gradient echo sequences with T1-, T2- and PD-weighted as well as fat saturation sequences in transverse, frontal and sagittal oblique planes.

Patients were referred from hospital wards as well as from outpatient clinics of the subcarpathian province.

Results: The most frequently reported injuries included partial supraspinatus tendon tear and complete tearing most commonly involved the supraspinatus muscle tendon.

The smallest group comprised patients with complete tear of subscapularis muscle tendon.

Among 137 patients in the study population, 129 patients suffered from shoulder pain, including 57 patients who reported a history of trauma. There was 44% women and 56% men in a group of patients with shoulder pain. Posttraumatic shoulder pain was predominantly reported by men, while women comprised a larger group of patients with shoulder pain not preceded by injury.

Conclusions: Rotator cuff injury is a very common pathology in patients with shoulder impingement syndrome. Isolated supraspinatus tendon injury or complete tearing is most frequent, rather than in conjunction with injuries to other rotator cuff tendons. We did not observe isolated complete tears of infraspinatus and subscapular muscle tendons.

MeSH Keywords: Magnetic Resonance Imaging • Rotator Cuff • Shoulder Pain

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Background

Shoulder joint is the third most common site of musculoskeletal pain occurring in 7–26% of general population [1]. Males over 40 years old are affected most often [2]. Pathological changes to rotator cuff are frequently the cause [3]. They develop as a result of chronic impingement syndrome, acute injury, chronic overload or supraspinatus muscle ischemia [2].

Flat tendons of four muscles: supraspinatus, infraspinatus, subscapularis and teres minor constitute the rotator cuff. They join together, covering anterior, posterior and superior surface of acromioscapular joint like a shirtsleeve. It enables shoulder rotation, hence the name "rotator cuff."

Moreover, their primary function involves maintaining shoulder stability during arm movement [4] and holding humeral head within glenoid cavity. Subacromial bursa, located between humeral head and acromion, reduces friction between muscles and acromion during arm movements, particularly in abduction [5].

Most common causes of rotator cuff injury include:
1. Repeated throwing or arm waving (volleyball, tennis, baseball, swimming, handball or strength training) in active, young people [5];
2. Impingement syndrome [2] – reduction of space between acromion and humeral head. Rotator cuff and its corresponding bursa may become constricted during arm lifting, which leads to inflammation and edema of the tendon and the bursa, resulting in pain.

Articular capsule and subacromial bursa are highly innervated and compression of those structures together with bursitis are considered the main source of pain [6].

It might result from anatomical variations of acromion (rotator cuff tear accompanies type III acromion according to Bigliani classification in 80% of cases) [2], acromioclavicular osteoarthritis with osteophyte formation [2] (osteophytes larger than 3 mm pointed downward are of significance [6]), chronic subacromial bursitis [2] (minute amount of fluid in the bursa is a frequent finding, more than 3 mm of fluid is considered exudate suggestive of bursitis [6]), posttraumatic deformation of humeral head and os acromiale [2]. It might also result from abnormal reduction of space between coracoid process and humeral head [2].

3. Trauma – fall onto an arm, particularly in the elderly;
4. Age – related degeneration of rotator cuff tendons [2], which are more susceptible to injury due to decreased blood flow [2,7].

Clinical signs of injury include pain in superior part of the arm (mostly anteriorly and laterally) becoming more intense during arm movements – so-called painful arc (i.e. pain on abduction between 70 and 120 degrees), waking up at night [5] or not allowing to sleep, especially when patient is lying on the affected side, weakening of arm strength, limited arm movement (e.g. difficulty in fastening a bra, putting the affected hand into a back pocket, combing hair), cracking noises during arm movements [5], disruption of so-called scapulohumeral rhythm.

There are many classifications that characterize rotator cuff injuries.

Neer described three stages of injury to rotator cuff tendons:

Stage I – edema/bleeding usually occurs in people under 25 years old who actively participate in sports activities, particularly in disciplines that require arm lifting (e.g. swimming). It is entirely treatable with conservative management [3,8,9].

Stage II – fibrosis-tendinitis usually occurs in patients between 25 and 40 years old. There is thickening and fibrosis of subacromial soft tissues. This condition presents clinically as recurrent shoulder pain [3,8,9]. Management is conservative as in stage I. However, persistence of symptoms over 6–12 months despite conservative treatment justifies surgical intervention [8].

Stage III – tendon tear leading to progressive failure of limb motor function. It is most common in patients over 40 years old [3,8,9]. Surgical treatment depends on patient age, loss of limb function, presence of limb weakness and pain [3].

Ellman et al. divided complete rotator cuff injuries into small (less than 1 cm), moderate (1–3 cm), large (3–5 cm), and massive (>5cm).

Snyder classified rotator cuff injuries as [10]:
0: normal;
I: minimal irritation of bursa or synovial membrane or mild damage to articular capsule involving small surface (<1 cm);
II: damage and loss of some rotator cuff fibers, as well as damage to bursa or capsule (<2 cm);
III: damage and fragmentation of tendon fibers, usually involving entire thickness of a tendon, usually of the supraspinatus muscle (<3 cm);
IV: severe damage accompanied by tendon tear and fragmentation often involving more than one tendon.

SCOI classification (Snyder) divides rotator cuff injuries into [11]:
A: partial periarticular tear;
B: partial peribursal tear;
C: complete tear.

Partial periarticular tears are more common than peribursal [10] and twice as common as complete tears [2,10].

Periarticular tears most often result from degeneration caused by chronic overload [2].

Partial peribursal tears (incomplete thickness) are most frequently related to impingement syndrome [2,10].

In 95% of cases rotator cuff pathology involves supraspinatus muscle tendon (alone or together with the remaining rotator cuff muscles) [6].

Due to its non-invasiveness, MR imaging supersedes shoulder artrography. Its superiority lies in the fact that it

Table 1. Number of patients with shoulder pain.

	Women	Men
Number of patients with a history of trauma	16 (12%)	41 (32%)
Number of patients without a history of trauma	41 (32%)	31 (24%)

allows visualization of both bone and periarticular soft tissues in frontal, axial and sagittal oblique planes [9].

The goal of this work was to assess frequency of occurrence of partial and complete rotator cuff muscle tears in magnetic resonance imaging among patients with painful shoulder syndrome as well as to review literature on the causes of rotator cuff injuries and their classifications.

Material and Methods

Retrospective analysis was performed on the results of 137 shoulder MRI examinations, including 57 women and 72 men, performed in Magnetic Resonance facility of the St. Jadwiga the Queen Provincial Hospital in Rzeszow between June 2010 and February 2013.

The largest group consisted of patients aged 40–65 years – 52% of subjects, while patients from the age group of 25–40 years constituted 18.6% of studied population, people over 65 years old – 10% of subjects. Patients between 5 and 25 years old comprised the smallest studied age group corresponding to 9.3% of studied population.

Patients were referred for examinations from hospital wards and specialist outpatient clinics of subcarpathian province.

Table 2. Types of damage to rotator cuff tendons.

	Number of patients	% of subjects
Partial supraspinatus muscle tendon tear	86	57
Partial infraspinatus muscle tendon tear	34	26
Partial subscapularis muscle tendon tear	40	31
Complete supraspinatus muscle tendon tear	14	11
Complete infraspinatus muscle tendon tear	3	2
Complete subscapularis muscle tendon tear	1	0.7

Images were acquired with a 1.5T Achieva Phillips device in T1- T2- and PD-weighted spin echo and gradient echo sequences and partly in fat saturation sequences in transverse, frontal and sagittal oblique planes.

Results

In our study group 129 patients reported shoulder pain, including 44% of subjects with a history of trauma.

A group of patients reporting pain comprised of women in 44% and of men in 56%. Posttraumatic shoulder pain was predominantly reported by men (32% of subjects), while a larger group of patients with shoulder pain without history of trauma consisted mainly of women (32% of subjects) (Table 1).

Types of diagnosed rotator cuff tendon injuries are presented in Table 2.

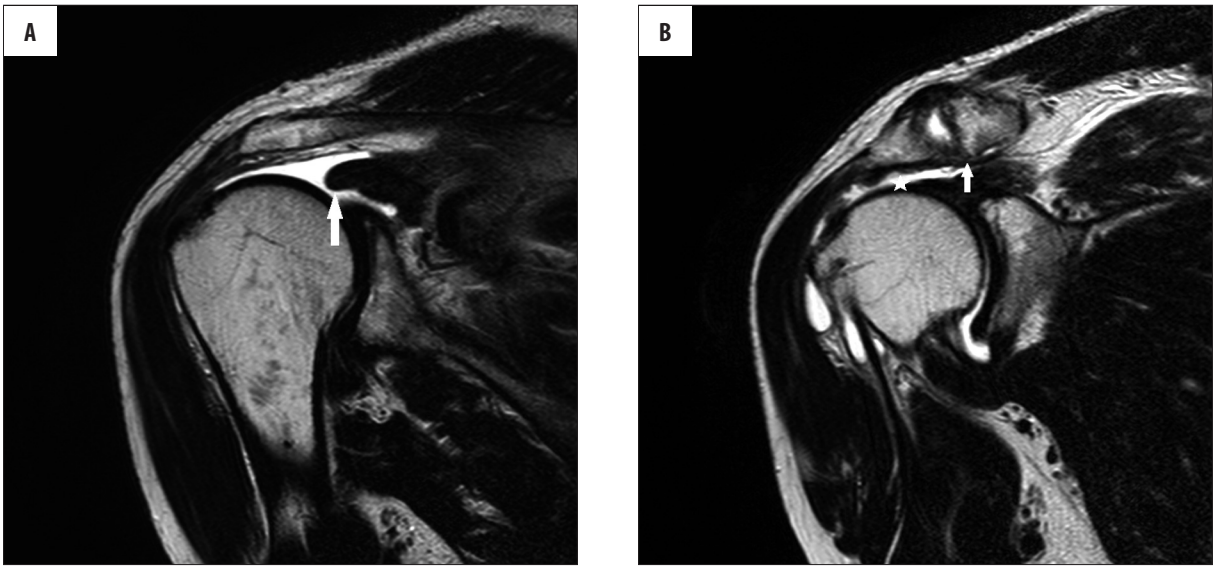

Figure 1. Shoulder MRI. (**A**) T2-weighted image, frontal plane. Complete tear of supraspinatus tendon with retraction of the torn edge and muscle atrophy (arrow). (**B**) T2-weighted image, frontal plane. Narrowing of subacromial space (star). Acromioclavicular joint arthrosis (arrow). Increased volume of intraarticular fluid. Subacromial-subdeltoid bursa fluid.

Figure 2. Shoulder MRI. (**A**) T1-weighted image, frontal plane. (**B**) T2-weighted image, frontal plane. Anterior supraspinatus tendon thinning, partial tear above the attachment to greater tubercle (arrow). Posttraumatic changes of lesser and greater tubercles, bone marrow (star) and surrounding soft tissue edema. (**C**) T2-weighted image, frontal plane. Increased volume of intraarticular fluid (arrow head).

Most commonly occurring pathologies included partial tear (edema, fibrosis and tearing of some fibers) of supraspinatus muscle tendon (57%), followed by subscapularis muscle tendon (31%) and, less frequently, infraspinatus tendon tears (26%).

Complete tearing usually involved the supraspinatus muscle tendon – 11% (Figure 1), more rarely infraspinatus muscle (2%) and subscapularis muscle (0.7%) tendons. The least numerous group comprised of patients with complete subscapularis muscle tendon tear – 0.7%.

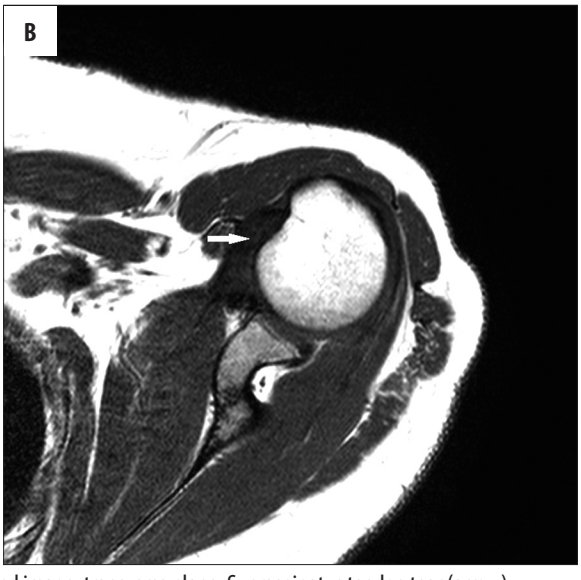

Figure 3. Shoulder MRI. (**A**) T1-weighted image, frontal plane. (**B**) T1-weighted image, transverse plane. Supraspinatus tendon tear (arrow) T1-weighted image, transverse plane. Subscapularis tendon tear (arrow).

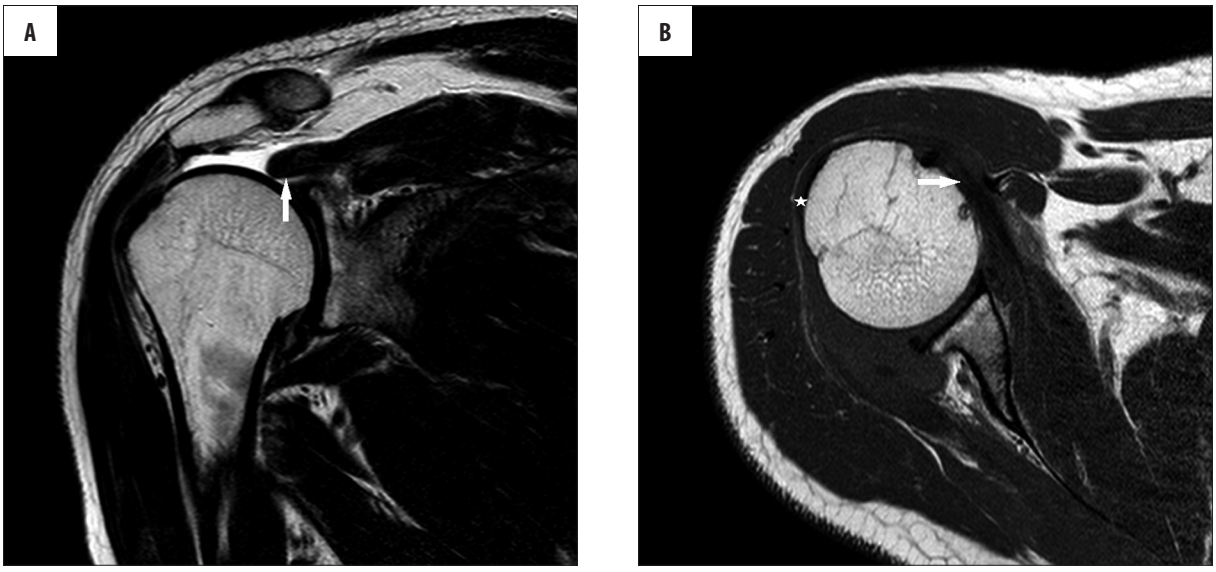

Figure 4. Shoulder MRI. (**A**) T2-weighted image, frontal plane. Complete supraspinatus tear (arrow) with muscle partial retraction. Increased volume of subacromial-subdeltoid bursa fluid. (**B**) T1-weighted image, transverse plane. Partial tear (star) of subscapularis (arrow) and infraspinatus tendons (star).

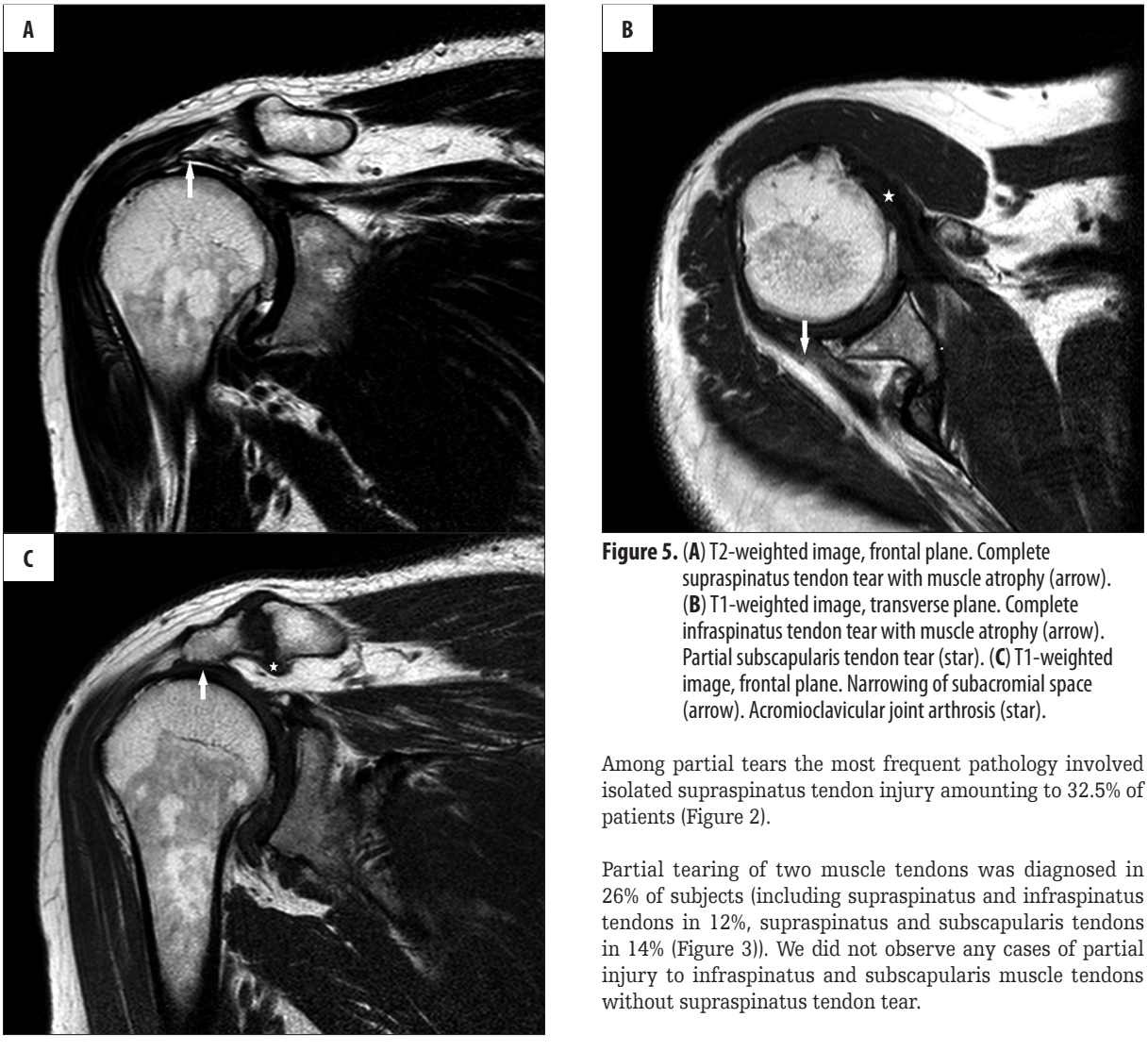

Figure 5. (**A**) T2-weighted image, frontal plane. Complete supraspinatus tendon tear with muscle atrophy (arrow). (**B**) T1-weighted image, transverse plane. Complete infraspinatus tendon tear with muscle atrophy (arrow). Partial subscapularis tendon tear (star). (**C**) T1-weighted image, frontal plane. Narrowing of subacromial space (arrow). Acromioclavicular joint arthrosis (star).

Among partial tears the most frequent pathology involved isolated supraspinatus tendon injury amounting to 32.5% of patients (Figure 2).

Partial tearing of two muscle tendons was diagnosed in 26% of subjects (including supraspinatus and infraspinatus tendons in 12%, supraspinatus and subscapularis tendons in 14% (Figure 3)). We did not observe any cases of partial injury to infraspinatus and subscapularis muscle tendons without supraspinatus tendon tear.

Table 3. Types of damage to rotator cuff tendons in the study population.

Type of rotator cuff pathology identified in MR examination	Total number of patients	Number of patients with history of trauma	Number of patients without history of trauma
Isolated partial tear of supraspinatus muscle tendon	42 (32.5)	15 (12.0%)	27 (21.0%)
Isolated partial tear of infraspinatus muscle tendon	1 (0.7%)	0	1 (0.7%)
Isolated partial tear of subscapularis muscle tendon	4 (3.0%)	2 (1.5%)	2 (1.5%)
Partial tear of supraspinatus, infraspinatus and subscapularis muscle tendons	10 (7.5%)	7 (5.0%)	3 (2%)
Partial tear of supraspinatus and subscapularis muscle tendons	18 (14.0%)	8 (6.0%)	10 (7.5%)
Partial tear of supraspinatus and infraspinatus muscle tendons	15 (11.5)	2 (1.5%)	13 (10.0%)
Partial tear of infraspinatus and subscapularis muscle tendons	0	0	0
Isolated complete tear of supraspinatus muscle tendon	3 (2.0%)	2 (1.5%)	1 (0.7%)
Isolated complete tear of infraspinatus muscle tendon	0	0	0
Isolated complete tear of subscapularis muscle tendon	0	0	0
Complete tear of supraspinatus and infraspinatus muscle tendons	1 (0.7%)	1 (0.7%)	0
Complete tear of supraspinatus and subscapularis muscle tendons	1 (0.7%)	1 (0.7%)	0
Complete tear of infraspinatus and subscapularis muscle tendons	0	0	0
Complete tear of supraspinatus, infraspinatus and subscapularis muscle tendons	0	0	0
Complete tear of supraspinatus muscle tendon + partial tear of infraspinatus and subscapularis muscle tendons	7 (5.0%)	3 (2.0%)	4 (3.0%)
Complete tear of infraspinatus muscle tendon + partial tear of supraspinatus muscle tendon	1 (0.7%)	1 (0.7%)	0
Complete tear of supraspinatus and infraspinatus muscle tendons + partial tear of subscapularis muscle tendon	1 (0.7%)	0	1 (0.7%)
Complete tear of supraspinatus muscle tendon + partial tear of infraspinatus muscle tendon	1 (0.7%)	0	1 (0.7%)

Partial supraspinatus, infraspinatus and subscapularis muscle tendon tears were identified in 8% of subjects.

Complete tearing usually involved the supraspinatus muscle tendon in conjunction with partial tearing of infraspinatus and subscapularis tendons – 5.4% of subjects (Figure 4), followed by complete supraspinatus muscle tendon tear without concomitant injury to other muscle tendons in 2.3% of cases. Isolated complete subscapularis or infraspinatus tendon tears were not observed.

In our study group complete tearing of supraspinatus and infraspinatus muscle tendons, complete tearing of supraspinatus and subscapularis tendons, complete tearing of infraspinatus muscle tendon + partial supraspinatus tendon tear, complete supraspinatus and infraspinatus tendon tears + partial subscapular tendon tear (Figure 5) and complete supraspinatus tendon tear + partial infraspinatus muscle tendon tear occurred in 0.8% of patients (one patient each).

None of our patients presented with complete tearing of all three muscle tendons (Table 3).

Discussion

Shoulder MRI examination is a valuable method of assessment of rotator cuff pathologies. Morrison and Offstein analyzed artrography and MRI examinations of 100 patients with chronic impingement syndrome. It was shown that MRI was 100% sensitive but only 88% specific for rotator cuff injuries confirmed by artrography [3]. Other authors report 75–92% sensitivity and 84-94% specificity of this examination in cases of complete rotator cuff tears. Moreover, there was a full concordance regarding the size of tear reported in MRI and measurements obtained during surgery [9].

Despite the special character of MRI examination it should be always preceded by plain radiograms directed at identification of soft tissue calcifications, appearance of which varies in MRI. Ultrasonography may constitute an alternative to MRI in rotator cuff assessment, although its sensitivity depends largely on the experience of the examiner [2].

Among analyzed shoulder MRI examinations rotator cuff injury was diagnosed in 106 (82%) patients, including 100

(94%) patients with isolated supraspinatus tendon injury or together with the remaining rotator cuff muscles, which is concordant with literature data indicating that supraspinatus muscle tendon is damaged in 95% of rotator cuff pathologies [6].

Literature data indicate that partial tendon tear is more common than complete tear [10], as confirmed by our study, which showed partial supraspinatus tendon tear in 86 (81%) subjects with diagnosed rotator cuff pathology, while complete tear was diagnosed in 11 (10%) patients. The same applies to infraspinatus muscle tendon (where complete tear occurred in 34 patients, while three patients suffered complete tear) and subscapularis muscle tendon (where 40 patients were diagnosed with partial tear and only one with complete tear).

Among all patients with rotator cuff tendon pathology included in our study 58 (55%) patients were diagnosed with acromioclavicular osteoarthritis (from minute to advanced lesions), which is concordant with literature data indicating it as one of the causes of rotator cuff injury [2].

One should remember that painful shoulder syndrome might result from joint, muscle, tendon or articular capsule pathology, while not always being related to rotator cuff tendon injuries.

Conclusions

1. Rotator cuff tendon pathology was very often diagnosed in the study group of patients with shoulder pain. In men it was most often caused by trauma, while in women it was more frequently non-traumatic.
2. Injury usually involved supraspinatus muscle tendon alone, rarely together with other rotator cuff muscle.
3. Supraspinatus muscle tendon tear was the most commonly identified pathology, more rarely subscapularis muscle and infraspinatus muscle tendon injuries.
4. Complete tear most often involved supraspinatus muscle tendon (also as an isolated lesion) followed by infraspinatus and, least often, subscapularis muscle tendons.
5. None of the patients presented with complete tear of all three rotator cuff muscle tendons or isolated infraspinatus or subscapularis tendon tears.

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