ORIGINAL RESEARCH

Pseudo-impingement of the Rotator Cuff with Strength Training using Magnetic Resonance Imaging

[1]Rajesh Pattanaik, [2]Santosh Kumar Padhy, [3]Ashis Kumar Satapathy

[1-3]Assistant Professor, Department of Radiodiagnosis, Institute of Medical Sciences & SUM Hospital, Bhubaneswar, Odisha, India

Correspondence:
Ashis Kumar Satapathy
Assistant Professor, Department of Radiodiagnosis, Institute of Medical Sciences & SUM Hospital, Bhubaneswar, Odisha, India

ABSTRACT

Objective: The goal of this study was to outline a novel, one-of-a-kind idea of secondary impingement of the rotator cuff muscles, myotendons, and tendons caused by hypertrophy as a result of strength training exercises.

Methods: In this retrospective observational study, 58 patients were referred to the radiology department by their orthopaedic surgeon for magnetic resonance imaging (MRI) over a period of 112 years. All patients had a history of strength training programmes and clinical signs of rotator cuff impingement.

Results: In 12 of the 58 patients, we found hypertrophy of the rotator cuff muscles, myotendons, and tendons. On the MRI, this was the sole anomaly. Rotator cuff muscle and tendon hypertrophy completely filling the subacromial space to the point of overfilling, resulting in secondary compressive features.

Conclusion: Rotator cuff impingement is a common occurrence that can develop as a result of a variety of input and outlet pathological situations. However, rotator cuff impingement can be caused by muscle and tendon hypertrophy as a result of strength training regimes. Rotator cuff hypertrophy can cause overfilling of the subacromial area, resulting in secondary impingement, which we call "pseudo-impingement."

Keywords: Rotator cuff impingement syndrome, Pseudo-impingement, Strength-training, Magnetic resonance imaging, Shoulder anatomy

INTRODUCTION

One of the most prevalent musculoskeletal concerns is shoulder pain. According to studies, the annual incidence is 14.7 per 1000 patients, with a lifetime prevalence of up to 70% [1,2]. Shoulder pain has an impact on work productivity, everyday activities, and quality of life. Shoulder pain is frequently caused by internal derangements of the shoulder, such as disorders of the muscles and tendons, joints, and labroligamentous and periarticular structures. Diagnostic imaging is becoming increasingly crucial for assessing these structures.With its multiplanar imaging, excellent resolution, and lack of ionising radiation, magnetic resonance imaging (MRI) is an important diagnostic technique. MR arthrography is a more sensitive method for assessing labroligamentous structures, joint capsule and cartilage, and other indicators of rotator cuff injuries. Already the favoured imaging modality for assessing many internal shoulder derangements, improvements in MRI have brought further potential benefits for assessing shoulder disease.

Rotator cuff impingement is a highly prevalent source of shoulder discomfort and impairment. [1] Such an occurrence is a complicated illness known as rotator cuff impingement syndrome. Trauma, extrinsic causes, rotator cuff muscle and tendon weakening, aberrant motion patterns, diminished pectoral and rotator cuff muscular flexibility can all cause rotator cuff impingement syndrome. [2] Physical therapy and sports training may help with the management of rotator cuff impingement syndrome, according to the literature. [2] However, for the first time in the literature, our retrospective study shows that strength training can cause impingement pain, which we call "pseudo-impingement."The goal of this case series is to illustrate routinely occurring aspects of hypertrophy of the rotator cuff muscles, myotendons, and tendons in strength trainees, culminating in subacromial space overfilling with clinical signs of impingement. This phenomenon is referred to as pseudo-impingement because it comes from overfilling of the subacromial space rather than a narrowed subacromial space as found in classic impingement states.

MATERIALS AND METHODS

STUDY DESIGN AND PATIENT SELECTION

During a 122-year span, we conducted a retrospective observational case series at our institution. The inclusion criteria comprised guys under the age of 40 who were conducting a strength training routine and had clinical signs of impingement. Exclusion criteria were acromion, coracoacromial arch, and acromioclavicular (AC) joint morphological abnormalities, past shoulder injury, prior surgical history, tumour, or poor picture quality. Our orthopaedic surgeons referred all of the patients.

MAGNETIC RESONANCE IMAGING PROTOCOL

The shoulder was imaged using magnetic resonance imaging (MRI) using the usual methodology on a 1.5-T scanner with a body coil. Coronal T2 fat-saturated (TR 3200, TE 84), sagittal T2 fat-saturated (TR 3000, TE 68), coronal T1-weighted spin-echo (TR 430, TE 13), sagittal T1-weighted (TR 644, TE 13), axial T2-weighted fat-saturated (TR 2500, TE 56), and axial PD (TR 2500, TE 56 The images were captured with a slice thickness of 3 mm.

RESULTS

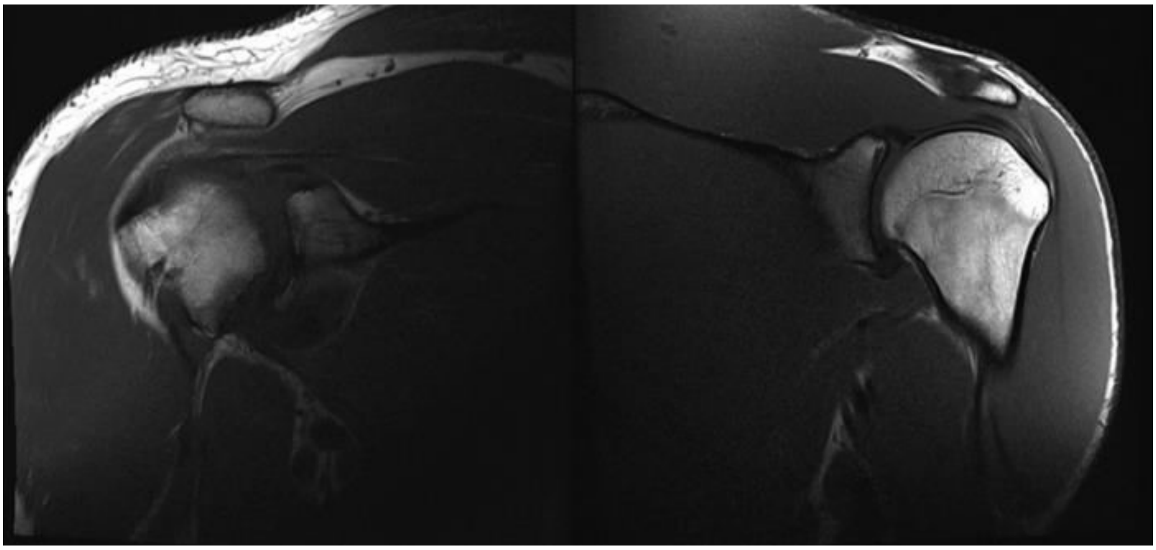

Figure 1: Coronal T1-weighted image - The rotator cuff muscles are markedly hypertrophied, bulky, with complete loss of intramuscular fat. Resultant indentation of the myotendinous junction by the acromion and effacement of the infra-acromial fat

plane is seen. The overfilling of the subacromial space (more than 6mm) is termed pseudoimpingement, causing clinical impingement pain.

MRI revealed pseudo-impingement in 12 of 58 patients (all strength trainees) during a 111-year period. As illustrated in Figure 1, MR consistently revealed uniform hypertrophy of the rotator cuff muscles with a lack of typical intramuscular T1 fat hyperintensity.

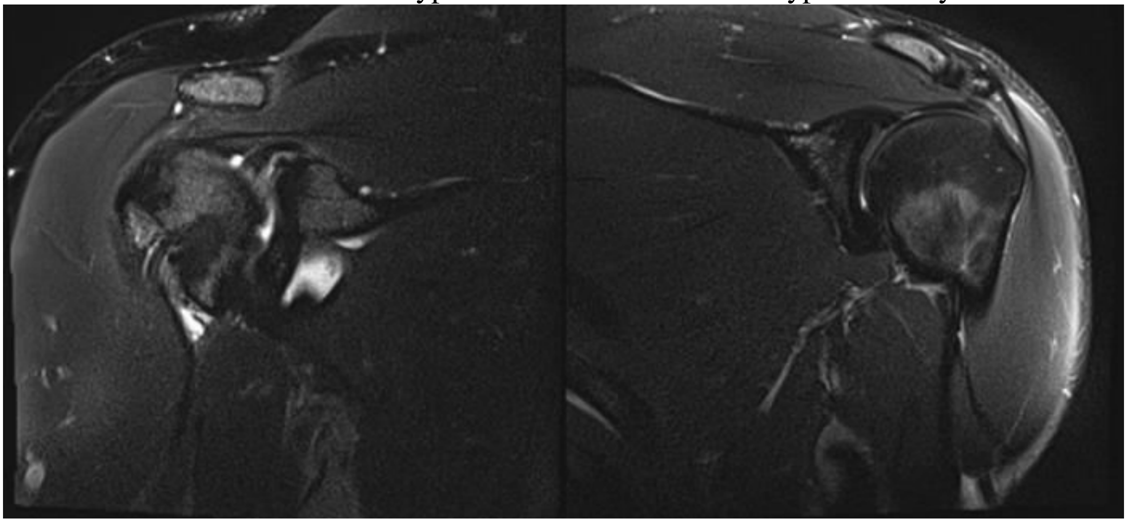

Figure 2: Coronal T2-weighted fat-suppressed image – Note the normal magnetic resonance signal appearance of the supraspinatus tendon and the lack of subacromial bursitis. The only abnormality is increased bulk of the rotator cuff muscles and myotendons from hypertrophy. Note the resultant indentation of the myotendinous junction of the supraspinatus by the acromion.

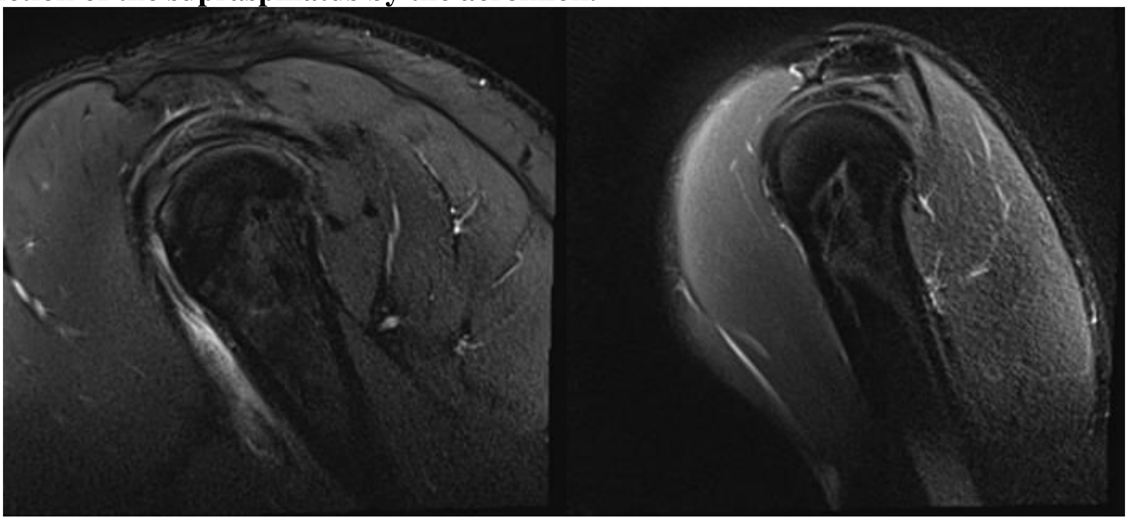

Figure 3: T2-weighted fat-suppressed image at the level of the distal insertion of the rotator cuff. Note the normal appearance of the rotator cuff at the distal most aspect of the tendons. The subacromial space is normal. There is no subacromial bursitis. No tear or tendinopathy is detected on this study.

Figures 2 and 3 illustrate an excessive superior convexity of the supraspinatus muscle in the supraspinous fossa. The rotator cuff myotendons and tendons were thick and showed uniform dark T1 and T2 signal. This was ascribed to increased tendon bulk, which was also a result of strength training. The increased bulk of the tendon and myotendon led in overfilling of the subacromial region, as seen in Figure 4.

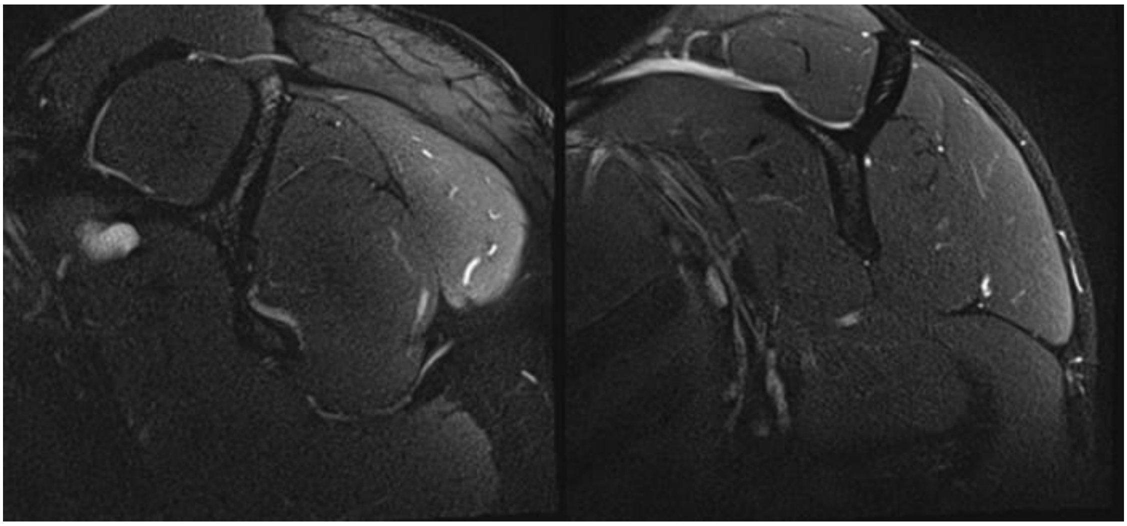

Figure 4: T2-weighted fat-suppressed image at the level of the supraspinatus fossa. Note the bulky rotator cuff muscles bellies from muscle hypertrophy. The supraspinatus muscle belly bulges beyond the confines of the supraspinous fossa.

This resulted in clinical impingement characteristics. This unusual entity has been labelled "pseudo-impingement," as it results from overfilling of a fixed bony region rather than from a restricted subacromial gap, as seen in classic impingement. There were no aberrant characteristics of inlet or outlet impingement, such as tear or tendinosis, subacromial bursitis, reduced subacromial space, or thickened coracoacromial ligament, in any of the patients.

DISCUSSION

The shoulder girdle is made up of three major bones: the scapula, clavicle, and humerus. The glenohumeral (GH) joint is the most movable of the three shoulder joints: sternoclavicular, acromioclavicular, and glenohumeral. The fibrocartilaginous glenoid labrum deepens the articulation between the humeral head and the shallow glenoid hollow. The rotator cuff muscles and tendons, which comprise the supraspinatus, infraspinatus, teres minor, and subscapularis, support this articulation.The acromion, coracoid process of the scapula, and the coracoacromial ligament form the coracoacromial arch, which roofs the humeral head and attaches to the greater tuberosisty. The supraspinatus tendon passes through this triangular area on its way to attach to the larger tuberosity of the humerus.

The supraspinatus tendon is the most usually affected tendon in impingement syndrome because it travels through the subacromial region. This can happen as a result of the chronic repetitive mechanical process of the rotator cuff's conjoined tendon enduring repetitive compression and microtrauma as it is confined to a small space under the arch. [3]The anterior circumflex and suprascapular arteries give the majority of the blood to the supraspinatus muscle. The crucial zone is an avascular zone within the supraspinatus tendon, just proximal to its insertion into the humerus. [4] This avascular spot expands with age, and impingement frequently occurs here, resulting in chronic tendinopathy and tears.

Impingement occurs when the subacromial space, defined as the distance between the acromion and the humeral head, is less than <6 mm. Clinically, the individual has pain from impingement of the rotator cuff by the coracoacromial arch while elevating the arm, which is exacerbated when sleeping on the affected side, a condition known as painful arc syndrome. The symptoms can be replicated by abducting and internally rotating the arm, which reduces the subacromial space and causes the tendon to be further squeezed. [5] The supraspinatus tendon is closest to the anterior inferior edge of the acromion when the arm is abducted to 90° with 45° internal rotation. [5] Manually extending the subacromial space by externally rotating the arm relieves the discomfort. [5]

Improved imaging modalities aid in understanding the pathogenic process and specific reasons of impingement. There are numerous imaging methods for impingement. X-rays are used in impingement syndromes; however, they are usually normal. [6] At the moment, they are used to distinguish any aberrant bone that may exist, which may aid in determining the reason of the impingement. Plain radiographs reveal different bone anomalies such as the subacromial space, acromion type, osacromiale, and the existence of a subacromial enthesophyte.

For the examination of the rotator cuff in relation to impingement, ultrasound is the method of choice. Ultrasonography aids in the diagnosis of rotator tendinopathy, and dynamic ultrasound can aid in the diagnosis of impingement by demonstrating bunching of the supraspinatus tendon and the subacromial bursa during arm abduction. During the abduction, the patient experiences agony.Tendinopathy, tendon tears, and subacromial bursitis can all be detected with an MRI. The bony boundaries of the coracoacromial arch are also depicted, including the kind of acromion, downsloping of the lateral end of the acromion, the subacromial region, the AC joint, and the state of the coracoacromial ligament. [7]

Patients who follow a strict strength training plan acquire hypertrophied rotator cuff muscles and tendons as a result of graded rotator cuff workouts. This hypertrophy is visible on MRI as increased muscle and musculotendon mass, with the intramuscular fat replaced by hypertrophied muscle fibres. Muscle atrophy is the inverse of this. Muscle hypertrophy generated by strength training programmes is well documented in the literature, resulting in greater cross-sectional area of the muscle and thus increasing strength. [8]

Tendons are traditionally regarded as tissues having a very slow metabolism and a very slow ability to adjust to mechanical stimulus. However, recent research has shown that these tissues are extremely responsive to mechanical pressure. Langberg et al., 2000, demonstrated that following a bout of vigorous activity, the Achilles and patellar tendon mass increases immediately and can remain increased for up to 72 hours. [9] Although there have been few long-term investigations on the effects of exercise training on the cross-sectional area of human tendons,[10] biochemically, it has been demonstrated that a coupling mechanism exists between muscle and tendon after exercise due to an increase in protein synthesis in both. [11]

Through biochemical experiments, Langberg et al., 2000 demonstrated that eccentric exercise can boost peritendinous type I collagen synthesis. [9] In addition, animal models have demonstrated tendon growth in response to strength training. [12] Kongsgaard et al., 2007 described tendon hypertrophy in humans as a result of resistance exercise, as well as the variance in the cross-sectional area of the patellar tendon. [8]Strength training causes excessive filling of the subacromial region due to the increased weight of the rotator cuff muscles and tendons, as shown in Figure 1. Even minor movement may result in impingement of the rotator cuff myotendon and tendons by the overlaying bony/ligamentous arch.

During a 112-year span, we were able to identify this anomaly in 12 of 58 of our patients. All patients were under the age of 40 and reported doing strength training exercises. There was no rotator cuff injury or tendinosis visible on the usual multiplanar MRI of the shoulder using T1 and PD-T2 fat-suppressed sequences. Figures 2 and 3 show that there was no subacromial bursitis. There was a type 1 or type 2 acromion present, and the acromiohumeral distance was greater than 6 mm. The coracoacromial ligament had not thickened.

The only anomaly observed in all patients was substantial hypertrophy of the rotator cuff muscles, myotendons, and tendons, resulting in increased mass of these structures, which completely filled the subacromial region. On the coronal and sagittal sequences, the superior surface of the supraspinatus tendon and myotendon was shown tightly abutting the undersurface of the acromion. The acromion clearly indented the superior myotendinous

junction of the supraspinatus. There was a decrease in T1 hyperintensity of fat within the rotator cuff muscles. This is due to the fat being replaced by hypertrophied muscle fibres as a result of strength training.Furthermore, the massive supraspinatus muscle showed excessive superior convexity in the supraspinatus fossa, which was most visible on sagittal sequences. The myotendons and tendons were thick and showed a consistent dark T1 and T2 signal. This was ascribed to increased tendon bulk, which was also a result of strength training.
As seen in Figure 4, this arrangement leads in overfilling of the subacromial space by the rotator cuff myotendons and tendons, with additional compression by the bony and ligamentous walls of the subacromial space. The pressure and irritation caused by movement induce pain and impairment symptoms that are clinically similar to impingement.

CONCLUSION

Impingement of the rotator cuff is a common complication of numerous inlet and outflow disorders. With 12 of our patients, we observed a unique phenomenon in which a strength training regimen led in hypertrophy of the rotator cuff muscles, myotendon, and tendon. As a result, the hypertrophied tendons/myotendons overfilled the usual subacromial region, as indicated by MRI. Overfilling the subacromial area causes secondary impingement of the rotator cuff muscles and tendons, which we call "pseudo-impingement." Early diagnosis of this issue in strength trainees helps avoid rotator cuff tendinopathy and rips. By reframing and redesigning strength training regimes, early clinical detection with the use of MRI can reduce pseudo impingement-related pain and disability.

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