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SCIENTIFIC ARTICLE

Magnetic resonance imaging of deltoid muscle/tendon tears: a descriptive study

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Abstract

Objective To describe the MRI features of deltoid tears and to evaluate tear characteristics in patient groups based on history of trauma and rotator cuff tear (RCT).

Materials and methods The records of patients who underwent shoulder MRI at our institution between July 2007 and June 2018 were retrospectively reviewed to identify deltoid tears, and patients were divided into groups based on history of recent trauma and presence of RCT. Images were reviewed to identify the location and size of the deltoid tear; the presence or absence of RCT, muscle atrophy, tendon retraction, humeral head subluxation, soft tissue edema, and additional pathologies were also noted. Medical records were reviewed for information about history of steroid injection, previous rotator cuff surgery, and treatments used.

Results Among 69 patients with deltoid tears (45 men; mean age, 65.2 years; range, 19–89 years), patients with RCTs and no trauma had the highest frequency of deltoid tears in the middle portion ($p = 0.005$). Only patients with RCTs had undergone steroid injection or rotator cuff surgery. Two patients had deltoid tear without RCT and without recent trauma; these patients demonstrated evidence of calcific tendinopathy and chronic subacromial-subdeltoid bursitis.

Conclusion The middle (acromial) portion of the deltoid is more frequently affected in patients with RCTs than in those with trauma. Although deltoid tears are commonly associated with RCT, calcific tendinopathy and chronic bursitis may also be seen in patients with deltoid tears.

Keywords Deltoid muscle · Shoulder MRI · Rotator cuff tear

Introduction

The deltoid muscle is the most important muscle in shoulder abduction and is responsible for active stabilization of the humeral head and 50% of arm elevation in the scapular plane [1]. When shoulder function is decreased in patients with rotator cuff tears (RCTs), increased deltoid forces are required to achieve glenohumeral abduction [2], with the deltoid muscle serving as the only driving force for shoulder abduction in patients with massive RCTs [1, 3]. Proper deltoid muscle functioning is especially critical in patients who undergo reverse shoulder arthroplasty, as studies have shown that deltoid dysfunction in these patients leads to poor range of motion and poor functional outcomes after surgery [3–6].

Tears of deltoid muscle or tendon are rare; however, this type of tear is a well-known complication of shoulder surgeries, with approximately 8% of patients developing deltoid tears after rotator cuff surgery [7–9]. In patients with no history of surgery, previous studies have demonstrated an association between deltoid tear and trauma and chronic RCTs [10–24]. Despite the important effect of deltoid tear on shoulder function, data regarding the imaging characteristics of this type of tear are lacking. Our goal in this study was to describe the imaging features of deltoid tear and to evaluate tear characteristics in various patient groups based on history of trauma and RCT.

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Materials and methods

After obtaining approval from the Institutional Review Board with a waiver of informed consent, we performed a retrospective review using Encore (documentation query tool for basic searching of text documents, with results sorted by relevance based on the search criteria) to identify reports of patients with deltoid tear who underwent shoulder magnetic resonance imaging (MRI) at our large tertiary healthcare system between July 2007 and June 2018. Encore was searched using keywords such as deltoid muscle (tendon) edema/contusion/detachment/disruption/fraying/tear. The total number of shoulder MRI examinations during this period was also recorded.

The MR scans were reviewed in consensus by one radiology fellow and one musculoskeletal radiologist with 18 years of experience; when available, shoulder radiographs from the study patients were also assessed. Both readers were blinded to patient clinical history and medical records for this imaging review (Fig. 1). The medical records were then reviewed for information about patient age, sex, the presence of any other musculoskeletal disease (i.e., inflammatory arthritis) or trauma, history of shoulder surgery, and use of steroid injection or other treatment.

Deltoid tear was described as increased signal intensity in both short and long TE images with loss of continuity of the fibers of tendon/muscle [25]. Muscle edema or low-grade strain can also demonstrate similar appearance. In such cases, visible fiber disruption was required to determine the tear. Using these criteria for deltoid tear, the readers identified 69 eligible cases. Previous studies have shown the association between trauma/chronic RCTs and deltoid tear. Trauma is a sudden onset extreme force that may result in any type of tear in any tendon or muscle. Opposite to trauma, repetitive forces and chronic loads may also result in deltoid tear in patients with chronic RCTs. When a full-thickness rotator cuff tear occurs, the undersurface of the deltoid tendon/muscle becomes open to any friction forces and the loads at the tendon margins are increased, leading to the failure of other fibers and decreasing regeneration of the tear. Based on these differences of underlying tear mechanism, patients were divided into groups using the presence of any full-thickness RCT and trauma. Sixty-nine eligible cases were therefore divided into four groups based on history of recent trauma, which was defined as any injuries, including sports related injury and fall, within 6 weeks before the clinical visit and presence of an RCT (defined as any full-thickness tear) [25, 26]: group 1, patients with recent trauma and RCT; group 2, patients with recent trauma and no RCT; group 3, patients with RCT and no trauma; and group 4, patients with no trauma and no RCT.

All MR examinations were performed on 3 T, 1.5 T, or 1 T systems using multiple magnets. The shoulder image acquisition protocol varied depending on the magnets, but all scans included trans axial, sagittal oblique, and coronal oblique T2 or fast T2 spin-echo imaging (TR ranges between 3210 and 4020; TE ranges between 67 and 117) as well as sagittal oblique T1 imaging (TR ranges 450–650; TE ranges 10–76),

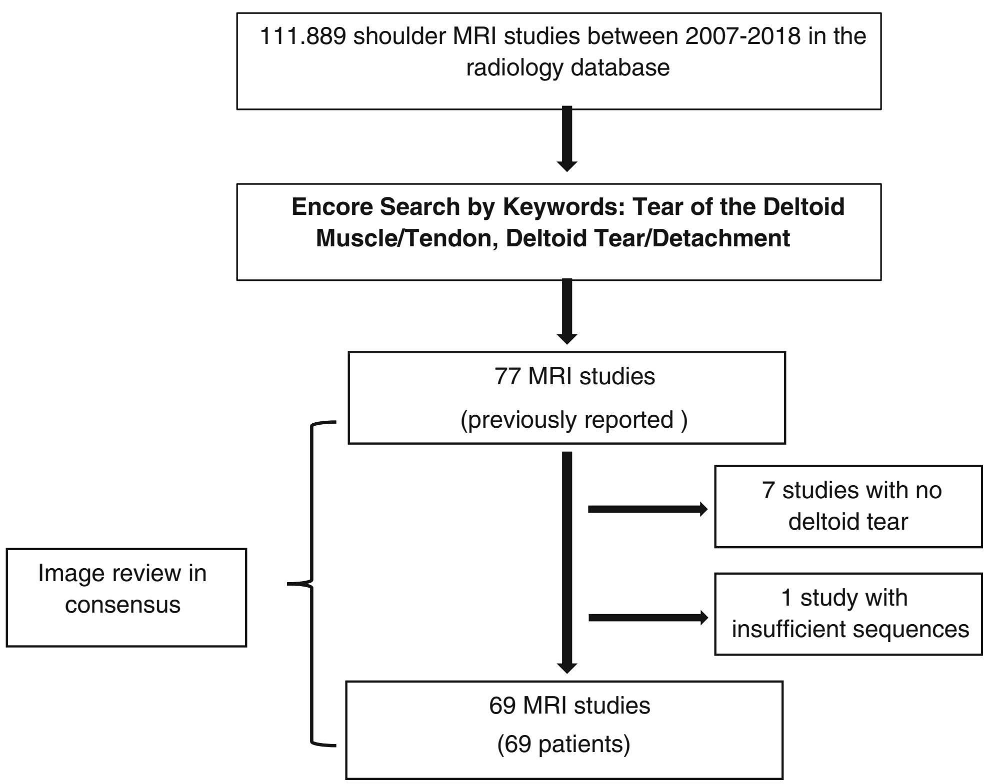

Fig. 1 Flowchart demonstrating patient selection

often with the addition of fat suppression and 3–5 mm slice thickness. All imaging studies were reviewed through a secure research database using Aquarius iNtuition (TeraRecon) image viewing software.

Image review

For each of the patients, MR images were reviewed for the presence or absence of deltoid tears and RCTs, laterality, location of deltoid tears (anterior [clavicular]/middle [acromial]/posterior [spinal]) [27, 28], presence of full-thickness or partial-thickness tear, degree of tendon retraction, degree of muscle atrophy, presence of humeral head subluxation (superior migration), and presence of soft tissue edema (defined as edema in the deltoid muscle and overlying subcutaneous tissues). The subacromial space was measured at the level of the acromial origin of the deltoid in the coronal plane on MRI. Muscle atrophy was classified as follows: no fat (normal), fat streaks (mild atrophy), fat < muscle (moderate atrophy), fat = muscle, or fat > muscle (severe atrophy) [10, 25]. The size of tear was classified as small (< 1 cm), medium (1–3 cm), large (3–5 cm), or massive (> 5 cm) [25, 29]. Deltoid muscle or tendon tears were also classified as follows: tendon tear at the attachment (no proximal tendon fragment present), musculotendinous tear, or muscle belly tear (region beyond the musculotendinous junction). The musculotendinous portion was defined as the area encompassing 1 cm from the acromion [10]. Available radiographs were also reviewed for the presence of greater tuberosity spur, which has been identified as a contributing factor to deltoid tear [10, 13, 30]. Any other shoulder abnormalities, including labral tear, biceps abnormality (including tear, tendinopathy, and dislocation), fracture, and other abnormalities such as hematoma, subscapular tendinopathy, large effusion, subacromial-subdeltoid bursitis, and calcific tendinopathy, on MR images were also assessed.

Statistical analysis

A Kruskal–Wallis test and Fisher's exact test were used to assess differences among the groups. Because of the size of the sample and exploratory nature of the study, p values were not adjusted for multiple comparisons and effect estimates were not adjusted for potential confounders. A p value <0.05 was considered statistically significant. All analyses were performed using R version 3.6.0 [31].

Results

Of the 111,889 shoulder MRI examinations performed over the study period, 77 MRI reports of deltoid muscle/tendon tear were initially identified. After imaging review, eight patients were excluded because of lack of deltoid tear (seven patients had images that demonstrated only edema/low grade strain/sprain without fiber disruption) or because of insufficient imaging sequences (one patient)). The final study sample therefore consisted of 69 patients with deltoid tears (45 men; mean age, 65.2 years; range, 19–89 years), including 11 patients in group 1 (trauma and RCT), 10 patients in group 2 (trauma, no RCT), 46 patients in group 3 (RCT, no trauma), and 2 patients in group 4 (no RCT, no trauma). There was no significant difference among the groups in age ($p = 0.092$); however, there was a significant difference in sex distribution ($p = 0.002$), with group 1 consisting of all men and group 4 consisting of all women (Table 1). All patients underwent MRI without contrast with the exception of two patients in group 3 who underwent MR arthrography. Patients in group 3 were more likely to have been previously treated with steroid injection ($p = 0.001$) (injection into subacromial space/glenohumeral joint) or rotator cuff surgery ($p = 0.003$) before the deltoid tear. No radiographs were available for 24 patients.

Patients in group 3 (RCT, no trauma) had the highest frequency of deltoid tears in the attachment ($p = 0.001$) and middle portion ($p = 0.005$; Fig. 2). Those in group 1 (RCT and trauma; Fig. 3) had no tears in the attachment, and those in group 2 (trauma, no RCT) had the lowest tear frequency in the middle portion (40%; Table 2). A total of seven patients (three patients in group 1 and four patients in group 3) had full-thickness deltoid tears; the remaining patients had partial-thickness tears. There was no significant difference among the groups in terms of deltoid tear size, number of tears, deltoid muscle atrophy, tendon retraction, presence of soft tissue edema, humeral head subluxation, or presence of greater tuberosity spur on radiographs.

The subacromial space varied significantly among the groups ($p < 0.001$), with group 2 having the highest mean value (7.49 mm) and group 1 having the lowest mean value (3.23 mm). Groups 1 and 2 demonstrated the highest frequency (72.7% and 70%, respectively) of soft tissue edema, whereas group 3 demonstrated the lowest (37%); however, this difference among groups was not significant ($p = 0.054$).

In group 2 (patients with trauma but no full-thickness RCT), we observed evidence of tendinopathy in four patients, intact rotator cuff tendons in two patients, and partial-thickness RCTs in four patients. In group 4 (no trauma, no RCT), one patient had a partial-thickness RCT, and one patient demonstrated intact rotator cuff tendons (Table 2). Patients in groups 1 and 3 demonstrated evidence of larger RCTs and more severe rotator muscle atrophy ($p < 0.001$).

Additional shoulder abnormalities were identified in 85.5% (59/69) of patients. The frequency of additional abnormalities was 90.9% in group 1, 70% in group 2, 86.9% in group 3, and 100% in group 4. Biceps abnormality was the most common finding in group 3, whereas labral tear was the most common finding in group 2. Patients in group 4 demonstrated evidence of calcific tendinopathy ($n = 1$; Fig. 4) and chronic

Table 1 Characteristics of study patients

Patient characteristic	Group 1 (*n*=11) Trauma and RCT	Group 2 (*n*=10) Trauma, no RCT	Group 3 (*n*=46) RCT, no trauma	Group 4 (*n*=2) No trauma, no RCT
Mean age±SD (y)	67.36±12.78	52.60±19.92	67.22±10.57	70.00±26.87
Male	11 (100.0)	7 (70.0)	27 (58.7)	0 (0)
Radiographs available	10 (90.9)	5 (50.0)	30 (65.2)	0 (0)
Right side involved	9 (81.8)	3 (30.0)	27 (58.7)	0 (0)
Previously treated with steroid injection	0 (0)	0 (0)	17 (37.0)	0 (0)
Previously treated with RCT repair	0 (0)	0 (0)	15 (32.6)	0 (0)

Except where otherwise indicated, data are number of patients (%)

RCT rotator cuff tear

subacromial and subdeltoid bursitis ($n = 1$; Fig. 5). Twelve of the 69 patients (17.4%) demonstrated evidence of additional musculoskeletal diseases, including adhesive capsulitis ($n = 3$), rheumatoid arthritis ($n = 2$), gout ($n = 5$), and polymyalgia rheumatica ($n = 1$) in group 3 and gout ($n = 1$) in group 4 (patient with subacromial-subdeltoid bursitis).

Regarding management of deltoid tears, the treatment status of 11 patients was unknown because of lack of follow-up;

Table 2 Results of image review

Imaging finding	Group 1 (*n*=11)	Group 2 (*n*=10)	Group 3 (*n*=46)	Group 4 (*n*=2)	*p* value
Deltoid tear					0.222
Partial thickness	8 (72.7)	10 (100.0)	42 (91.3)	1(50.0)	
Full thickness	3 (27.3)	0 (0)	4 (8.7)	0 (0)	
No. of deltoid tears					0.850
1	10 (90.9)	10 (100.0)	41 (89.1)	1 (50.0)	
2	1 (9.1)	0 (0)	5 (10.9)	0 (0)	
Absence of deltoid muscle atrophy	10 (90.9)	10 (100.0)	40 (87.0)	1 (50.0)	0.860
Location of deltoid tear					
Attachment	0 (0)	4 (40.0)	27 (58.7)	0 (0)	0.001
Belly	10 (90.9)	6 (60.0)	32 (69.6)	1 (50.0)	0.331
Musculotendinous junction	8 (72.7)	7 (70.0)	35 (76.1)	1 (50.0)	0.771
Anterior	5 (45.5)	7 (70.0)	20 (43.5)	1 (50.0)	0.497
Middle	8 (72.7)	4 (40.0)	41 (89.1)	1 (50.0)	0.005
Posterior	4 (36.4)	1 (10.0)	17 (37.0)	0 (0)	0.352
Mean subacromial space, mm (SD)	3.23 (1.12)	7.49 (3.13)	3.67 (2.20)	6.10 (0.35)	< 0.001
Presence of soft tissue edema	8 (72.7)	7 (70.0)	17 (37.0)	1 (50.0)	0.054
RCT size (any thickness)					< 0.001
Small	0 (0)	4 (40.0)	5 (10.9)	1 (50.0)	
Medium	1 (9.1)	0 (0)	4 (8.7)	0 (0)	
Large	6 (54.5)	0 (0)	19 (41.3)	0 (0)	
Massive	4 (36.4)	0 (0)	18 (39.1)	0 (0)	
Rotator cuff muscle atrophy					< 0.001
None	2 (18.2)	10 (100.0)	6 (13.0)	1 (50.0)	
Fatty streak	3 (27.3)	0 (0)	18 (39.1)	1 (50.0)	
Fatty muscle	4 (36.4)	0 (0)	17 (37.0)	0 (0)	
Severe	2 (18.2)	0 (0)	5 (10.9)	0 (0)	

Except where otherwise indicated, data are number of patients (%)

RCT rotator cuff tear

Fig. 2 Images from a 67-year-old man with a history of chronic rotator cuff tear and rotator cuff surgery but without a history of trauma. **a** Anteriorposterior internal rotation radiograph of the right shoulder demonstrates greater tuberosity spur (arrow) and surgical screws (asterisk) from the rotator cuff surgery. **b** Partial-thickness deltoid tear (on the anterior-middle portion and belly of the muscle; medium tear with retracted fibrils) demonstrated on axial proton density BLADE fat-suppressed MR image (arrowhead). **c** Deltoid tear demonstrated on sagittal T2 BLADE fat-suppressed MR image (arrowhead), with screws and their artifact also visible (asterisk). The rotator cuff tear can also be seen (arrow). **d** Deltoid tear demonstrated on coronal T2 BLADE fat-suppressed MR image (arrowhead)

among the remaining patients, 41 were treated nonsurgically (Table 3).

Discussion

In this study, we found that the middle (acromial) portion of the deltoid muscle was more commonly affected in patients with RCTs than in those with recent trauma. Although chronic RCT was most commonly associated with deltoid tears, we found that calcific tendinopathy and chronic bursitis could also lead to deltoid tears in the middle portion of the muscle. In addition, we found that deltoid tears are most commonly treated nonsurgically.

Multiple studies have demonstrated that deltoid tears are more likely to occur among patients with chronic RCTs and among those with a history of traumatic injuries [10–24]. In patients with chronic RCTs, the humeral head migrates superiorly and laterally, resulting in friction between the humeral head, the deltoid muscle/tendon, and the acromion. These repeated friction forces progressively weaken the deltoid, leading to tears especially in the middle portion of the deltoid [3, 12, 13, 15–17]. Our results support this theory, as we found that deltoid tears in the middle portion were more common among patients with RCTs.

In a previous study, the muscle belly and musculotendinous junction were found to be common locations of deltoid tears in the lateral to medial direction in patients with rotator cuff deficiency [10]. In the current study, patients with RCTs and trauma and those with only RCTs generally had tears in the muscle belly and musculotendinous junction, again demonstrating the effect of chronic friction forces in the formation of deltoid tears secondary to RCTs. However, we also found that deltoid tears were common in the attachment among patients with only RCTs, perhaps because of the smaller size of the attachment versus muscle belly and musculotendinous junction or because these patients had a history of previous rotator cuff surgery resulting in a tear at the site of the acromial origin.

Another cause of deltoid tear, particularly in the middle portion among patients with RCTs, is the presence of degenerative changes such as osteophytes (spur) or sclerosis on the greater tuberosity; these changes create friction forces on the undersurface of the deltoid tendon [10, 13, 17]. In our study, no significant difference was seen among the groups in terms of the presence of a greater tuberosity spur on radiographs; however, the data were limited because some patients lacked

Fig. 3 Images from a 47-year-old man with a history of recent trauma and with a rotator cuff tear. **a** Grashey view of radigraph of the left shoulder demonstrates greater tuberosity avulsion fracture (asterisk) and fractured bone segment (star). **b** Coronal T2 BLADE fat-suppressed image shows a medium partial deltoid tear on the muscle belly (arrowhead) and bone marrow edema on the humeral head with greater tuberosity fracture (asterisk). **c** Axial T2 BLADE fat-suppressed image shows a deltoid tear (arrowhead) in the middle portion of the deltoid and bone marrow edema on the humeral head with greater tuberosity fracture (asterisk)

radiographs. A larger cohort of patients would be needed to assess this potential relationship.

Various traumatic deltoid injuries have been reported previously, including seat belt injuries and injuries caused by fast bowling and golfing movements [18–23]. In cases of traumatic deltoid tears, sudden weakness of the affected shoulder has been reported as the main clinical finding. The underlying pathomechanism of this type of tear remains unclear; however, it has been suggested that sudden movements involving various muscle groups can place a substantial amount of force on the deltoid, potentially leading to a tear [2, 18]. In patients without a history of trauma or rotator cuff deficiency, deltoid tears can still occur. In our study, two patients with no history of trauma or RCT had this type of tear, one with calcific tendinopathy and the other with chronic subacromial-subdeltoid bursitis. We postulate that the etiopathogeneses of these deltoid tears are similar to those that occur secondary to chronic rotator cuff deficiency. Both cases were subject to repeated friction forces, one arising from calcification on the undersurface of the deltoid muscle and the other arising from chronic bursitis. The patients had been stretching the deltoid muscle/tendon fibers, progressively weakening the muscle and ultimately causing the tear. In the patient with bursitis, concomitant gout arthritis may have also contributed to a chronic inflammatory condition.

Deltoid tears with chronic RCTs are more commonly seen in women [3], although this was not reflected in our study population. In this study, we found that most patients with deltoid tear and trauma were men, perhaps because men are more likely to play contact sports or work in fields that require vigorous physical activity. This may also explain the higher frequency of labral tears we observed in patients with a history of trauma. The most common additional finding among patients with RCTs was biceps abnormality; these abnormalities are more likely to be associated with chronic degenerative process such as rotator cuff arthropathy.

It has been reported that the subacromial space is narrowed in degenerative RCTs but remains intact in traumatic tears [32]. Our results also reflect these findings. Narrowed subacromial space may also contribute to the repetitive forces and chronic friction.

Previous research has demonstrated that repeated steroid injections may lead to deltoid tears [14]. Yamaguchi et al. reported that intratendinous steroid injections have adverse effects on tendons. However, debate over this potential association is ongoing. Because steroids have long-acting variable

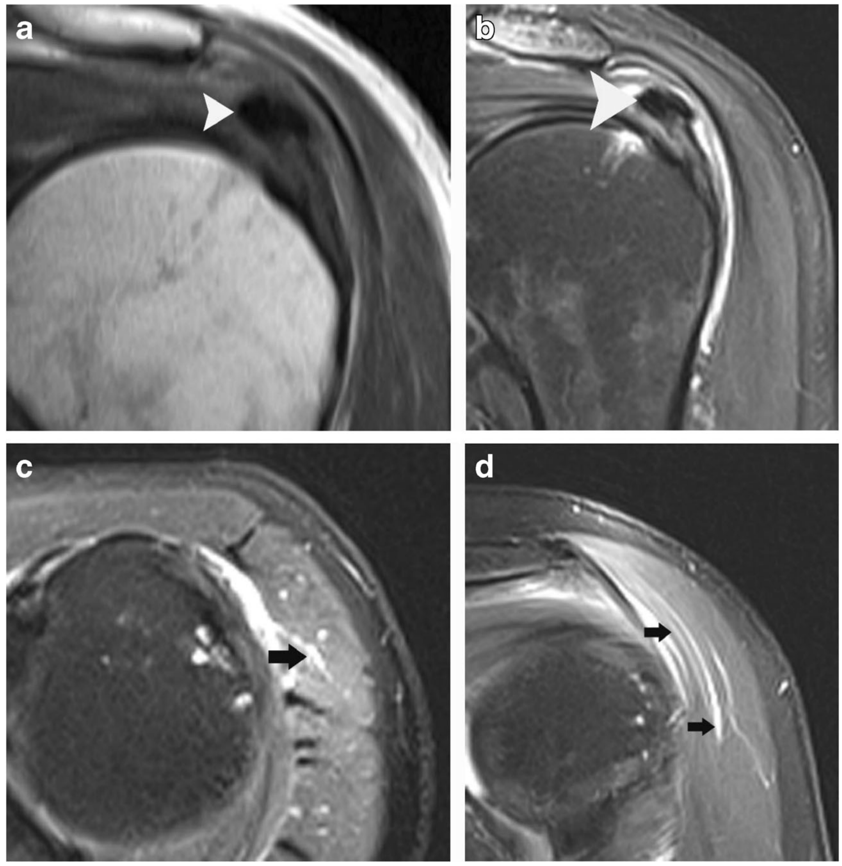

Fig. 4 Images from a 51-year-old woman with no history of recent trauma and no full-thickness rotator cuff tear and no history of intraarticular injection. Calcific tendinopathy on the rotator cuff tendons is seen on a coronal T1-weighted image (**a,** arrowhead) and on a coronal T2-weighted fat-suppressed image (**b**, arrowhead). **c** Axial T2 fat-suppressed image shows a partial deltoid tear (arrow) in the middle portion. **d** Coronal T2-weighted fat-suppressed image demonstrates high signal areas (arrows) of the tear in the muscle belly

effects on tendon metabolism, it is possible that repeated steroid injections could lead to progressive weakening of the deltoid tendon [29]. In our study, patients with RCT and no trauma were more likely than other patients to have been previously treated with steroid injections or rotator cuff surgery, although the details of the injection, whether it was intratendinous or peritendinous and the amount of injection, were not obtained due to the retrospective nature of the study. These results suggest that steroid injections may contribute to the etiopathogenesis of deltoid tears in patients with RCTs. Patients with RCT and no trauma were also more likely to have additional musculoskeletal diseases, especially inflammatory process such as gout and rheumatoid arthritis, which may contribute to the tear process.

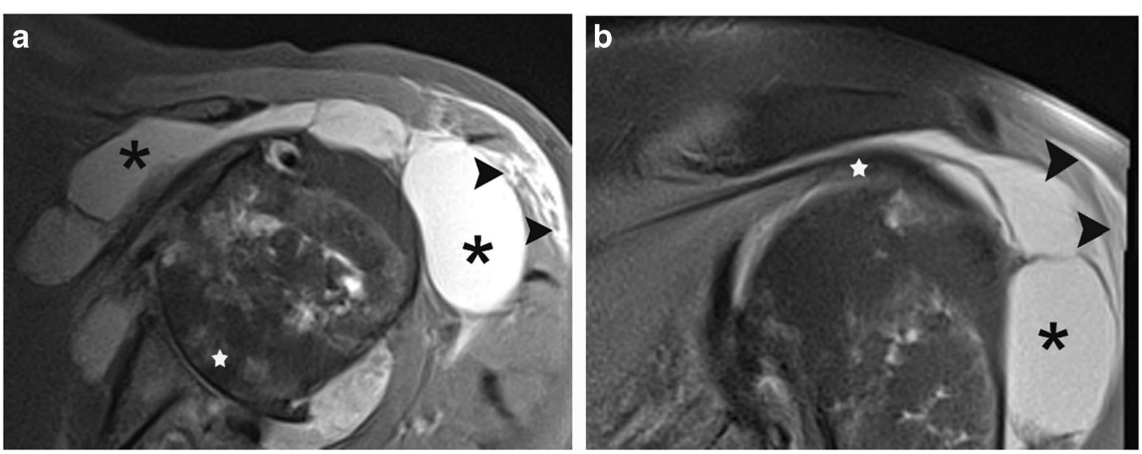

Fig. 5 Images from an 89-year-old woman with no history of recent trauma and no rotator cuff tear. **a** Axial T2 BLADE fat-suppressed MR image demonstrates large subacromial-subdeltoid bursitis (asterisks), a full-thickness deltoid tear with retracted fibrils (arrowheads), and advanced glenohmeral osteoarthritis with cystic changes in the humeral head (star). **b** Coronal T2 BLADE fat-suppressed MR image demonstrates the intact rotator cuff muscles (star), large subacromial-subdeltoid bursitis (asterisk), and a deltoid tear (arrowheads). This patient underwent surgical intervention during follow-up

Table 3 Treatments used in study patients

Treatment[a]	Group 1 (n=11)	Group 2 (n=10)	Group 3 (n=46)	Group 4 (n=2)
Closed reduction	0 (0)	2 (20.0)	0 (0)	0 (0)
Injection	0 (0)	0 (0)	6 (13.0)	0 (0)
Medication/physical therapy	5 (45.5)	4 (40.0)	24 (52.2)	0 (0)
Surgery	6 (54.5)	2 (20.0)	8 (17.4)	1 (50.0)
No follow-up	0 (0)	2 (20.0)	8 (17.4)	1 (50.0)

Data are number of patients (%)

[a] Treatment type unknown for 11 patients

Consensus is lacking regarding how deltoid tears should be treated, and this lack of consensus is reflected in our study results. In patients with RCTs, the few surgical options available include arthrodesis, resection arthroplasty, and muscle transfer with hemiarthroplasty, and these procedures lead to limited functional outcomes [3, 28]. In recent years, reverse shoulder arthroplasty has become a popular treatment option for cuff tear arthropathy, and its indications are expanding to include patients with intact cuffs. Regardless of the design of the implant used, reverse total shoulder arthroplasty increases the deltoid tension and muscle work load; therefore, deltoid dysfunction is generally considered a contraindication for this surgery. Although good outcomes have been reported for concurrent repair of the deltoid tear with reverse total shoulder arthroplasty [3], it is generally recommended that these procedures be completed in separate stages to avoid catastrophic complications. Another popular surgical alternative is superior capsular reconstruction, which is a patch graft surgery for irreparable RCTs and preserving the joint. This procedure also requires a fully functioning deltoid [33, 34]. With any of these procedures, a thorough preoperative description of the deltoid tear is essential for surgical planning.

The main limitations of this study were its small sample size and retrospective nature, which limited our ability to assess the potential confounders and recall bias. The disparity of the groups in this small sample was another limitation. Previous deltoid tear studies have used a variety of metrics to classify RCTs (e.g., single muscle tear/chronic RCT or massive RCT and rotator cuff arthropathy with or without RCT symptoms) [10–24]. Research has demonstrated that when a full-thickness tear occurs, the undersurface of the deltoid tendon/muscle becomes open to any friction forces and the loads at the tendon margins are increased, leading to the failure of other fibers and decreasing regeneration of the tear [10, 25, 26]. Therefore, we chose to use the presence of any full-thickness RCT to define the patient groups; using this definition also lowered the risk of overlap among the groups. We lacked surgical confirmation of deltoid tears, but we believe that the clinical history and MR images provided enough evidence of the presence of these tears. Radiographic images were not available for some patients, which limited our ability to obtain X-ray measurements and study the effect of bony deformities on the incidence of deltoid tears. The details of previous surgical procedures were not assessed, as we could not obtain records from hospitals outside our system. A consensus read did not allow us to calculate reader agreement or reliability. Additionally, diagnostic confidence was not similar for all cases because of the use of multiple MR systems (e.g., 1 T MR systems may provide lower image quality, leading to lower diagnostic confidence for these images).

In conclusion, this study demonstrated that trauma and RCTs are the main structural findings associated with deltoid tear. The acromial (middle) portion of the deltoid muscle is less frequently affected in patients with trauma than in those with RCTs. A history of steroid injection and RCT surgery may contribute to the etiopathogenesis of deltoid tears secondary to RCTs. Calcific tendinosis and chronic bursitis can also lead to deltoid tears. Although tear of the deltoid muscle and tendon is a rare entity, it is important for radiologists to be familiar with the imaging features and associated structural findings of these types of tears.

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Declarations

Ethical approval Approval for this study was obtained from the Institutional Review Board, with a waiver of informed consent.

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

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