Can imaging determine if a rotator cuff tear is traumatic?

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ABSTRACT

AIM: We reviewed the last decade of literature to update a previous publication on this topic by the senior author. In New Zealand, traumatic causation has implications for entitlement for treatment though the Accident Compensation Corporation (ACC). Acuity and chronicity may also be relevant in determining repairability.

METHODS: Literature was reviewed regarding acromial morphology, greater tuberosity (GT) cysts, acromiohumeral interval (AHI), fatty degeneration and atrophy, acromioclavicular (AC) arthrosis, tendinopathy, bursal changes and other features.

RESULTS: Some factors can be considered normal for those middle aged and older, including AC arthrosis, type 1 and 2 acromion and tendinopathy. Some factors may indicate acuity, including haemorrhage and debris, GT oedema, mid-substance soft tissue tear, kinking of the tendon and isolated complete subscapularis tears. Other factors may be associated with chronicity, including significant fatty degeneration, positive tangent sign for atrophy, anterior GT cysts, type 3 acromion, critical shoulder angle (CSA) >35 degrees and acromial index (AI) <0.7.

CONCLUSION: A multitude of factors on imaging may infer, to a varying degree, the likelihood of acuity or chronicity. The patient history is also of importance in determining causation.

In 2010, we published a paper with the same title in the *New Zealand Medical Journal*.[1] The impetus for that review was the importance of this topic in defining entitlement for Accident Compensation Corporation (ACC) funded treatment in New Zealand. The 2010 publication has been used and cited in medicolegal reviews and guidelines including the ACC document *Rotator Cuff Tears: Consideration Factors for ACC Cover*.[2]

In this paper we review the last decade of literature on this topic and update the conclusions of our 2010 paper. We performed an online search of PubMed, Embase, Medline and the Cochrane Library between 2011 and 2021. Each of the radiographic categories were searched with “imaging” AND “chronicity of rotator cuff tear”; for example, “acromion morphology” AND “imaging” AND “chronicity of rotator cuff tear”. This search yielded 14,747 results. Duplicates were excluded and titles and abstracts were screened to determine suitability for inclusion in the paper. In total, 63 articles were included in the final review.

We anticipate this will continue to be a useful resource for clinicians, advocates and the ACC in the complex field of determining causation in rotator cuff tears. Understanding the radiological features of chronicity is also helpful for clinicians’ decision making, as it may influence repairability.

Acromion morphology

Historical

Our last review from 2010 found that many studies were not designed to assess the role of acromial morphology in the causation of rotator cuff pathology, and that acromial morphology was unreliably and inconsistently assessed by radiographs. Previous research was conflicting as to the role of acromial morphology and rotator cuff disease; however, studies reported that patients with a large subacromial spur were more likely to have rotator cuff pathology.[3]

Recent research

In 2006, Nyffeler et al. described the acromial index (AI), which was a measure of the lateral extension of the acromion relative to the glenoid.[4] It was postulated that a large AI predisposes to the development of degenerative rotator cuff tears. The supraspinatus must exert a greater force in order to counteract the more vertical pull of the middle fibres of the deltoid as a consequence of a large AI. The study demonstrated a significant correlation between an increased AI and the presence of degenerative rotator cuff tears when compared with patients with arthritis and an intact cuff and age-matched controls.[4] This has been further supported by Morelli et al., who demonstrated in a systematic review that an AI of greater than 0.695 has the greatest predictive value for a non-traumatic rotator cuff tear.[5]

However, the AI does not account for either glenoid tilt or the presence of degenerative changes, which may falsely alter the overall measurement. Moor et al. has recently reconceptualised the relationship between scapular morphology and rotator cuff pathology with the critical shoulder angle (CSA), which is the angle that combines the measurements of inclination of the glenoid and the lateral extension of the acromion. In their study of 298 patients there was a significant association between an increased CSA >35 degrees and the presence of degenerative rotator cuff tears, while a CSA <30 degrees was associated with the development of osteoarthritis.[6] The CSA demonstrated excellent inter- and intra-observer reliability; however, it is important to note this study excluded acute rotator cuff tears.

In 2019, a systematic review by Morelli et al. analysed the effects of acromial morphological type (as described by Bigliani et al.), the AI and the prevalence of rotator cuff tears.[5] Those individuals with a Bigliani type 3 (hooked) acromion were three times more likely to have a degenerative rotator cuff tear compared with a type 1 or 2 acromion. A further systematic review of 34 studies by Andrade et al. from 2019 has supported the previously published work on the CSA, AI and the acromial type, finding moderate evidence to suggest an association between a CSA >35 degrees, AI >0.7, a type 3 acromion and the presence of a degenerative rotator cuff tear.[7]

Liu et al. reported on a novel radiographic measure, the acromion–greater tuberosity impingement index (ATI), and its association with degenerative rotator cuff pathology.[8] This index is calculated by dividing the distance from the centre of rotation (COR) of the humeral head to the greater tuberosity (GT) by the distance from the COR to the underside of the acromion. A cut-off value of 0.965 on magnetic resonance imaging (MRI) and 0.865 on X-rays was able to discriminate between the presence and absence of subacromial impingement, with a higher ATI associated with a degenerative rather than a traumatic tear.

Similar to our previous review in 2010, a recent update on os acromiale by You et al. has not determined a correlation between the presence of an os acromiale and rotator cuff tears.[9]

Conclusion

The recent evidence suggests that those individuals with a type 3 acromion, a CSA of greater than 35 degrees and a larger AI are more likely to have a degenerative rotator cuff tear than those without these morphological features.

Reduced acromiohumeral distance (AHD)

Historical

The AHD was first described by Golding in 1962 as a radiographic measurement that could be used to assess for rotator cuff disease on radiographs.[10] This represents the distance between the undersurface of the acromion and the superior aspect of the humeral head. Recent research has validated the AHD as a reliable and reproducible radiographic parameter with the use of standardised X-rays, and it has been noted that the position of the arm can alter the AHD with a neutral rotation recommended.[11,12] An AHD of <7mm is abnormal and associated with full thickness tears of the rotator cuff or multiple tendon tears, and up to 71% of patients with an AHD <7mm will show fatty atrophy on an MRI scan.[12] Our previous study concluded that the available evidence demonstrated a reduced AHD of <7mm on standardised X-rays is reliable, reproducible and associated with rotator cuff tears with both fatty atrophy and symptoms that may be of more than several years duration.

Recent research

The AHD in the normal population is reported to be between 7 to 14mm with a decreased AHD associated with rotator cuff tears, an increased rate of irreparable rotator cuff tears, higher rates of re-tear and increased fatty degeneration of the muscles.[14,15] Chuang et al. also demonstrated an inverse relationship between the AHD and the degree of tendon retraction, with each 1mm increase in the ADH being associated with a decreasing chance of developing advanced tendon retraction.[16] Although previous studies have demonstrated a good inter- and intra-observer reliability, McCreesh et al. highlighted the importance of utilising standardised radiographs to measure AHD in order to improve the reliability of the measurement, with up to 7mm variability reported using non-standardised radiographs.[17] Sanguanjit et al. demonstrated a significant difference in the AHD between supine and upright radiographs, with the average AHD on supine radiographs being 1.3mm lower. The group found that an upright AHD of <7mm and a supine AHD of <6.5 were both 100% specific for a full thickness rotator cuff tear, with an accuracy of 64% and 66% respectively, making this a useful measure for ruling out a full thickness tear.[18]

The measurement of AHD on MRI scans and its correlation with plain radiographs has been increasingly investigated. Mirzayan et al. demonstrated a high degree of correlation between plain radiographs and MRI for the measurement of AHD in patients with Hamada 3–5, while a large variability was seen between the imaging modalities in Hamada 1 and 2 patients, with a tendency towards a larger AHD on the plain films. The group also noted that while the AHD on plain radiographs correlated with the degree of supraspinatus fatty degeneration, MRI measures of AHD correlated with both supraspinatus and infraspinatus fatty degeneration.[19] The AHD on average has been found to decrease by 1.7mm on MRI scans when compared with upright plain radiographs, and as such the cutoff of <7mm is not applicable to MRI measurements.[18]

de Oliveira França et al. investigated the influence of gravity on the measurement of the AHD on MRI scans. The group concluded that the location of the tear rather than the presence of gravity was more significantly associated with the degree of humeral head migration, with the posterosuperior and antero-posterosuperior tears being more closely associated with a reduced AHD compared to superior or anterosuperior tendon tears.[20]

Conclusion

A reduced AHD is associated with chronic rotator cuff degeneration and has high intra- and inter-observer reliability when measured on standardised shoulder X-rays. However, caution must be exercised in the use of computed tomography (CT) and MRI, as the AHD has been shown to be significantly smaller than values on radiographs.

Acromioclavicular (AC) joint arthrosis

Historical

In 1972, Neer mentioned that excrescences on the undersurface of the AC joint may potentially impinge on the rotator cuff and contribute to rotator cuff tears. Our previous review revealed an extremely high prevalence of AC arthritis on imaging studies. Shubin et al. demonstrated AC joint arthrosis in 68% of those under 30 years and in 93% in those over 30 years, and likewise Needell et al. found AC joint arthrosis to correlate more closely with age rather than the development of rotator cuff tears.[21,22]

Recent research

Choo et al. found, in their review of 146 patients, similar rates of rotator cuff degeneration and rotator cuff tears between those with symptomatic and asymptomatic AC joint arthrosis. Furthermore, inferior AC joint osteophytes, subchondral cysts, AC joint articular surface irregularities and fluid within the AC joint were not associated with the presence of rotator cuff tears and were instead age-related changes.[23]

Previous research had suggested that inferior spurs on the distal clavicle may be a causative factor in the development of degenerative rotator cuff tears. Oh et al., in a prospective, randomised, controlled trial of rotator cuff tear repairs in the context of asymptomatic AC joint arthrosis, demonstrated no difference in the re-tear rates if a distal clavicle excision was performed at the time of surgery or not. The group concluded that the AC joint degenerative changes did not cause damage to the rotator cuff; however, it is important to note that the follow-up in this study was only 1 year, and thus these results might change with longer-term follow-up.[24]

Case reports have commented on the very rare occurrence of AC joint cysts, which are associated with massive rotator cuff tears. Type 1 cysts are isolated cysts that are limited to the AC joint with no communication with the glenohumeral joint. Type 2 cysts are dependent on complete rupture or tear of the rotator cuff musculature and are associated with cuff tear arthropathy.[26–28]

Conclusion

AC joint arthrosis is a common finding that is unlikely to be directly involved in the development of rotator cuff tears. However, a type 2 AC joint cyst is highly suggestive of a massive rotator cuff tear and advanced cuff tear arthropathy, although this is a rare occurrence with an incidence of only 1%.

GT changes

Historical

Our previous study concluded that while cysts in the GT are common, the location of the cyst is very important. Anterior cysts showed a strong correlation with rotator cuff tears, with 48% of patients demonstrating full thickness degenerative rotator cuff tears. Previous research has highlighted the importance of CT and MRI scans in being able to carefully characterise the location of these cysts, and has also suggested there is no strong correlation between GT cortical thickening or subcortical sclerosis and the development of degenerative rotator cuff tears.

Recent research

In 2017, Chin et al. examined the accuracy of plain radiographs in diagnosing rotator cuff pathology in 50 consecutive patients undergoing shoulder arthroscopy for presumptive rotator cuff pathology. The group examined 11 radiographic parameters: acromial pathology (acromial spur, reduced acromiohumeral space, sourcil sign, acromial acetabularisation, os acromiale); humeral head pathology (GT cortical irregularity, sclerosis, cysts, humeral head rounding); and reduced acromiohumeral interval (AHI) of <6mm. The strongest predictors of rotator cuff pathology were tuberosity irregularity, tuberosity sclerosis and cystic changes. Furthermore, 100% of patients with a >50% posterosuperior rotator cuff tear demonstrated three or more of the 11 radiographic signs, with the humeral head signs being more closely correlated with rotator cuff pathology than acromial changes.[28] Chuang et al. also demonstrated a significant correlation between GT sclerosis and irregularity (spurring) and the degree of tendon retraction, with these signs also correlating with a more advanced Patte stage.[29]

Regarding GT cysts, Suluova et al.[30] studied the correlation between MRI findings of GT cysts and the occurrence of rotator cuff pathology on shoulder arthroscopy. The study found that cyst size correlated with age; however, cyst location was unrelated to patient age. Anterior cysts were more common (56%) and strongly associated with rotator cuff pathology, while posterior and lesser tuberosity (LT) cysts were less common and unrelated to either patient age or rotator cuff pathology.[30] Furthermore, a strong correlation was noted between the MRI and arthroscopy findings with a sensitivity of 96% and specificity of 87%.[30] This is further supported by Gwark et al., who demonstrated an odds ratio of 11.43 and 7.71 for anterior GT cysts and the presence of a supraspinatus and infraspinatus tendon tear respectively.[31] Similarly, Pan et al. studied the association between GT cysts and rotator cuff pathology in 105 consecutive patients with painful shoulders undergoing arthroscopy.[32] Anterior cysts were commonly associated with rotator cuff pathology, while posterior and bare area cysts were not. The positive predictive value for GT cysts in the context of a painful shoulder for those over 50 years was 74% and for those over 60 years was 85% for the presence of a rotator cuff tear.[32]

The association between the presence of LT cysts and the presence of subscapularis degeneration has been less clear, with Wissman et al. demonstrating a very strong correlation between LT cysts and subscapularis tears, while Cho et al. were unable to support this finding, instead noting the presence of a small pit about the LT correlated with subscapularis tendon pathology.[33,34]

Conclusion

The presence of changes in the GT on standardised true glenohumeral X-rays can be a highly predictable method of predicting rotator cuff pathology. The presence of cysts in the anterior GT strongly correlates with both supraspinatus and infraspinatus tears, while cysts within the LT are yet to be definitively linked to subscapularis tears. Furthermore, GT irregularity and sclerosis are also highly predictive of rotator cuff pathology, particularly in conjunction with the presence of anterior cystic change.

Changes in rotator cuff tear size with time

If a patient has a known historical rotator cuff tear, what is the likely change with time in the condition of the rotator cuff and what is the likelihood of developing cuff tear arthropathy? Cuff tear arthropathy is graded according to the Hamada classification, which is based primarily on reduced AHI as follows:

- Grade 1—AHI >6mm
- Grade 2—AHI < or equal to 5mm
- Grade 3—Acetabularisation of the acromion
- Grade 4—Narrowing of the glenohumeral joint
- Grade 5—Humeral head collapse

Two recent key papers have reported a higher rate of progression than previously reported in literature. Ranebo et al. reported on the 22-year follow-up outcomes for 69 patients that underwent a subacromial decompression alone with evidence of rotator cuff tearing at the time of surgery.[35] At the index operation there were 45 partial thickness and 24 full thickness tears. Eighty-seven percent of the full thickness tears showed evidence of progression, with 74% showing signs of cuff tear arthropathy (Hamada 2 or more) and 30% showing Hamada 4b (severe arthropathy). For partial thickness rotator cuff tears there was a 42% rate of tear progression; however, only 7% demonstrated radiographic evidence of rotator cuff tear arthropathy. Chalmers et al., in their 8-year follow-up of 138 patients, demonstrated that within the first 5 years there was increasing superior migration of the humeral head and Hamada grade, which then plateaued from 5 to 8 years.[36] As the study had a control group, a partial thickness group and a full thickness group they were able to show that size of the tear did not correlate with the amount of progression of the Hamada grade; however, the presence/absence of a tear did correlate.[36] Despite advancing proximal humeral migration, severe arthritic changes were rarely seen.

Moosmayer et al. reported on the outcomes of 50 patients with asymptomatic full thickness rotator cuff tears managed non-operatively for a duration of up 3 years.[37] The group demonstrated that those patients who became symptomatic, on average, had a larger tear size than those patients who remained asymptomatic. Furthermore, a correlation between the development of symptoms and higher grades of muscular atrophy and fatty degeneration was found on MRI scans.[37] Fucentese et al. followed 24 patients with isolated full thickness rotator cuff tears who declined operative intervention. At an average of 42 months of follow-up they noted overall no significant change in tear size, but the degree of fatty infiltration did significantly progress; however, no patient had Goutallier >2 at final follow-up.[38] Both of these studies, however, are limited by shorter follow-up than the previous studies.

Conclusion

The recent literature supports that full thickness rotator cuff tears have a higher risk for progression to cuff tear arthropathy at longer-term follow-up compared with partial thickness rotator cuff tears.

Fatty muscle degeneration

Historical

Goutallier et al. introduced the concept of fatty degeneration of the rotator cuff in 1989, and developed a 5-grade staging system, which noted that rotator cuff tears were associated with fatty muscle degeneration.[39] This group were also the first to demonstrate a highly negative correlation between fatty infiltration of the infraspinatus and surgical outcome. Several natural history outcome studies have noted poorer surgical outcomes and higher re-tear rates for patients with pre-operative fatty infiltration and muscular atrophy, particularly Goutallier grade 2 or higher. Although often used interchangeably, fatty infiltration and muscular atrophy are two distinct phenomena, the pathophysiology of which is not yet fully understood. The tangent sign, as described by Zanetti et al., is an indicator of muscle atrophy.[40] The tangent sign is evaluated on the sagittal plane at the most lateral image where the scapular spine is in contact with the scapular body. The tangent sign is positive if the supraspinatus does not reach above this line.[1] Our previous review highlighted that while CT and MRI may both be used for the evaluation of rotator cuff fatty infiltration and muscle atrophy, the inter-observer reliability remains relatively poor; however, this can be improved through evaluation on the axial plane images.[41]

Recent research

Rotator cuff atrophy and fatty infiltration are two distinct phenomena and are both independent predictors of outcome for rotator cuff surgery.[42,43] Fatty infiltration represents a chronic change in the muscle and may signal a poor biological capacity to heal and poor mechanical properties that can make repair difficult or reduce the chance of a repair remaining intact.[44,45] A large retrospective review of 1,688 patients by Melis et al. demonstrated that fatty infiltration of the supraspinatus is associated with increasing age, duration of symptoms prior to presentation and the number of tendons involved.[42,44,45] On average, grade 2 fatty degeneration occurred after 4 years and severe fatty infiltration after 6 years. For traumatic tears the progression of fatty infiltration was on average 1 year faster. Melis et al. also demonstrated the correlation between the degree of fatty infiltration and muscle atrophy. Significant muscle atrophy with a positive tangent sign occurred on average 4.5 years after the onset of symptoms.[44] Hebert-Davies et al. likewise highlighted the chronic nature of fatty infiltration and atrophy, with the appearances of these phenomena being present on average 1 year and 1.4 years after the onset of symptoms for supraspinatus and infraspinatus respectively.[46]

Chitkara et al. reviewed the reliability of coronal imaging vs sagittal imaging for the accurate assessment of the fatty infiltration.[47] The original Goutallier method utilises the most lateral point where the scapular spine is in contact with the scapular body. However, with tendon tears there is retraction of the muscle belly with increased chronicity, and as such the sagittal image may not be examining the greatest diameter of the muscle but rather the musculotendinous junction and is thus over-calling the degree of muscle atrophy and fatty infiltration. Their study of 50 patients (30 with tears and 20 without tears) found that with sagittal imaging compared to coronal plane imaging, there was a discrepancy in the Goutallier grade 62% of the time, with the sagittal plane tending to over-call the degree of fatty infiltration.[47]

Lee et al. reported on the use of the IDEAL MRI sequence, which is accurately able to assess the intra-muscular fat fraction.[48] Although it has been mainly used for research purposes, this study shows that this sequence is highly reproducible and clinically feasible. The group found that the supraspinatus fat fraction was highly associated with the size of the tear and the degree of tendon retraction, with a fat fraction of 3.7% with no tear, 6.8% with a partial tear, 15.7% with large tears and 16.1% with massive tears.[48] Furthermore, an increasing fat fraction was seen with increasing tendon retraction, and it was noted that in general the fat fraction in muscle increased 0.15% per year independent of a tear of any size.[48]

Conclusion

Fatty infiltration and muscle atrophy are two distinct processes that occur in tandem in the setting of a chronic rotator cuff. These findings tend to be associated with a tear that has been present for >6 months duration, and they increase with increasing age, duration of symptoms and number of tendons involved in the tear. Fatty infiltration and muscle atrophy do not improve after surgical treatment; however, surgery may halt further progression. The inter-observer reliability of the Goutallier classification is low to moderate and the use of sagittal images may overstate the degree of fatty infiltration. As such, use of the coronal image or the axial image may better reflect the true degree of fatty infiltration. Furthermore, advances in scanning with the IDEAL MRI sequence may become more routine in assessing the intramuscular fat fraction.

Tendon retraction

Historical

At the time of our previous publication, little had been reported on the association between the degree of tendon retraction and the acuity of a rotator cuff tear. Previous studies suggested that retraction of a torn tendon to the glenoid does not occur within 12 weeks of injury.

Recent research

Loew et al. investigated features on MRI and radiographs that might distinguish between the acute traumatic tear and the chronic tear.[49] They found that between the two groups there was no significant difference in the degree of tendon retraction; however, the "traumatic group" were twice as likely to display a "*crinkling, undulating appearance of the peripheral end of the torn muscle, described as kinking*", with a specificity of 68% and sensitivity of 64%.[49] Furthermore, the traumatic group of tears were most frequently found to have signal enhancement on T2 sequences at the tendomuscular transition (indicating haemorrhage or oedema), which was only observed in one of the 25 non-traumatic tears. Such an oedema was found to have a positive predictive value of 93.7% and negative predictive value of 72.7% for an acute rotator cuff tear.[49]

Walcott et al. reported a case series of transtendinous rotator cuff tears in a cohort of athletic patients.[50] All patients had a clear history of trauma and a short duration of symptoms. The group concluded that such tendon tears occur in the context of trauma, specifically an axial load; for example, a fall onto an abducted arm.[50]

A sonographic study by Artul et al. looking to distinguish between acute vs chronic tears found a significant association between the thickness of the torn tendon and the acuity of symptoms.[51] A thick torn tendon is more frequently found in the acute tears, with a proposed mechanism being the tendon oedema in the acute setting. No threshold for tendon thickness was given, however.[51]

Park et al. created a scoring system to determine if a rotator cuff tear was likely to be repairable. A supraspinatus tendon length of <15mm was associated with a non-repairable rotator cuff tear and reflects chronicity of injury.[52]

Conclusion

Current literature suggests that the degree of tendon retraction is not a reliable indicator of the acuity of the tear. Rather, the presence of kinking of the tendon, musculotendinous oedema and the location of the tear (transtendinous) may be more useful guides to helping distinguish an acute rotator cuff tear.

Bursal changes and glenohumeral effusion

Historical

To date, little has been published regarding the association between bursal thickening and signs of non-traumatic rotator cuff tears. In our previous report, Teefey et al. investigated the sonographic difference between acute and chronic tears, with the key element being the history of a traumatic injury. Bursal thickening was defined as over 2mm, and this study found that a mid-substance tear or the presence of bursal fluid in the context of a rotator cuff tear were more commonly present in the acute setting.[53]

Recent research

Little has been reported regarding the macroscopic qualities of synovitis and their correlation with rotator cuff disease. In 2015, Jo et al. proposed a macroscopic and microscopic classification for synovitis in both the glenohumeral joint and the subacromial space. Interestingly, they found that glenohumeral joint synovitis was more clearly linked with rotator cuff disease than synovitis and inflammatory change within the subacromial space.[54] This study was further supported by Kim et al., who found that the degree of glenohumeral synovitis correlated with the duration of symptoms more closely than subacromial synovitis.[55] They suggested considering the chronic rotator cuff tear as a "pan joint pathology", like that of knee osteoarthritis.

Loew et al. compared MRI findings in those with a clear history of trauma and those without. They found that extensive effusion in the subacromial bursa occurred with similar incidences between the traumatic and non-traumatic groups (84% vs 79%).[49] They also noted that glenohumeral joint effusion tended to be more frequent in the traumatic group compared with the non-traumatic group, and while this is seemingly in contrast with the above findings, these were MRI findings rather than arthroscopic findings.[49]

Artul et al. performed a sonographic study aiming to distinguish between the acute and the chronic tear. This group found that acute tears were more likely to have significant biceps peri-tendon oedema when compared with the atraumatic tears, although no threshold for what constitutes "significant oedema" has currently been published. The group did find that a subdeltoid effusion correlated more closely with the acute tears; however, if this was the only positive feature on sonographic examination it was only just on the edge of significance.[51]

Conclusion

Assessment of the degree of glenohumeral synovitis may be more indicative of the chronicity of a tear when compared with subacromial changes. It would appear that subacromial bursal changes are unable to reliably distinguish between the acute and the chronic rotator cuff tear, unless there is extensive bursal fluid and debris. Furthermore, although there is an association between significant biceps peri-tendon oedema in the setting of an acute tear, there currently exists no clear threshold for what degree of oedema would most closely correlate with an acute rotator cuff tear.

Partial thickness tears

Historical

Our last report highlighted the complex nature of the aetiology of partial thickness rotator cuff tears. While trauma has been shown to be associated with both articular and bursal sided tears, such tears have also been demonstrated in young athletes.

Recent research

Much work has been done in recent years to determine the natural history of the partial thickness rotator cuff, and to determine the outcomes of surgical intervention; however, there remains little research with regards to determining the underlying cause for a partial thickness tear.

Tsuchiya et al., in their systematic review of partial thickness tears, demonstrated that partial thickness tears do progress over time but at a relatively slow rate in the short- to intermediate-term follow-up, on average 0.26% per month.[55] This review found no significant difference in the rate of progression to full-thickness tears over time, between the symptomatic and asymptomatic groups. Yamamoto et al. prospectively followed non-operatively treated partial thickness rotator cuffs. There were only 17 traumatic tears in the cohort of 174 shoulders, and on average 47% of partial thickness tears progressed, with the highest rate of progression in the medium-sized tears.[57] Trauma was a risk factor for the progression of medium-sized tears.

McMonagle et al., in a review on the utility of MRI in the shoulder, showed that the sensitivity and specificity for partial thickness tears was lower than that for full thickness tears (63.6% and 91.7% vs 92.1% and 92.9%), with articular sided tears being significantly more common compared with bursal sided tears.[58]

Shibata et al. compared the arthroscopic findings of acute and degenerative partial thickness and full thickness rotator cuff tears in patients over 65 years with a Goutallier grade <2. While the MRI appearances of the tears were similar, on arthroscopic repair the traumatic tears were significantly less stiff when attempting to mobilise the tear, and the tension of the repair was less when compared with the degenerative tears.[59]

Conclusion

The aetiology of partial thickness tears is complex in nature. Despite the recent interest in the study of partial thickness tears, most research focusses on natural history or surgical outcome. The natural history of a partial thickness tear is that of slow progression. Imaging is unable to clearly distinguish between a traumatic or degenerative underlying cause

Tendinopathy

Historical

Our previous report on rotator cuff imaging noted that tendinopathy is a complex topic, with literature suggesting a multifactorial pathogenesis resulting from intrinsic, extrinsic and environmental factors. Intrinsic degeneration may result from chronic overload of the tendon, while extrinsic compression from subacromial impingement was also linked to the development of tendinopathy. Along with the multifactorial aetiology, patient age was shown to be a factor related to tendinopathy, with the peak incidence occurring in the fifth to seventh decades.

Recent research

Recent research on tendinopathy has focussed on trying to determine the underlying pathological processes that occur to cause tendinopathy. Proposed mechanisms include a combination of both intrinsic and extrinsic mechanisms.

Excessive tissue load has been reported as a significant causative factor in the development of rotator cuff tendinopathy, as reflected by the fact that tendinopathy occurs more frequently in the dominant limb and in occupations/sports with high rates of upper-limb loading.[60]

Rotator cuff tendinopathy remains a common clinical diagnosis. Frost et al. reported a high rate of rotator cuff tendinopathy in both patients with subacromial impingement (55%) and those without any symptoms of shoulder dysfunction (52%), with an increasing incidence observed in both groups with increasing age.[61] A more recent study found that 96% of asymptomatic men were reported to have some form of structural abnormality identifiable on ultrasound, including subacromial bursal thickening, supraspinatus tendinosis and supraspinatus tears.[62]

Thickening of the rotator cuff tendons is noted on MRI and ultrasound, and this can cause a relative decrease in the subacromial space and thus worsen any external impingement.[61] Histopathologic examination of tissue from rotator cuff tears demonstrated abnormal tendons features in 97% of cases, with animal models demonstrating that tendinopathic changes induce specific gene upregulation that causes tissue metaplasia and reduces the load to failure of the tendon.[63] Furthermore, serum levels of reactive oxygen species have been noted to be higher in patients with tendinopathy compared to those without, suggesting oxidative stress plays a role in tendon damage.[64]

Conclusion

The current evidence has shown a link between increasing age and the occurrence of tendinopathy. Imaging may show evidence of tendon thickening and areas of relative hyper- or hypo-vascularity. Biochemical studies have demonstrated abnormal tendon features with tissue metaplasia and evidence of inflammatory and oxidative stress. We are unable to determine if a rotator cuff tear in the setting of tendinopathy is purely due to degeneration or if acute trauma may play a role.

Conclusions

The following can be considered normal findings with increasing age and are not related to acuity or chronicity of rotator cuff tears:

- Type 1 and type 2 acromion[6,8]
- AC joint arthrosis[23,24]
- Tendinopathy[60–62]

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The following have no definite association with causation of rotator cuff tears:

- Os acromiale[9]
- Posterior and bare area GT cysts[30,31]
- Calcific tendinosis[1]

The following are associated with the risk of evolution of rotator cuff tears:

- AI >0.7[5,6,8]
- CSA >0.35[7,8]

The following are associated with chronic rotator cuff tears:

- Type 3 acromion[6,8]
- AHI <7mm[14,15,16,19]
- Goutallier fatty degeneration grade 2+[42,44,45,46,48]
- Positive tangent sign[44,46]
- Length of torn supraspinatus tendon <15mm[52]
- Anterior GT cysts[28,30,31,32]

The following are associated with acuity and trauma of rotator cuff tears:

- Bone oedema of GT[1,65]
- Mid-substance rotator cuff tears[50]
- Kinked appearance of the tendon tear[49]
- Large effusion[49]
- Bursal haematoma and/or debris[51]

COMPETING INTERESTS
None.

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