Partial-thickness tears of the rotator cuff are not rare and can be a cause of unexplained pain in the shoulder giving considerable disability. Although they occupy a significant position in the spectrum of disease of the rotator cuff, they have been inadequately defined and often elude diagnosis even by MRI and arthroscopy. In this review the management of degenerative partial tears is considered. Those occurring in young overhead athletes resulting from repetitive microtrauma or internal impingement\(^1,2\) are included to allow their different causes to be recognised, which may necessitate specific treatment.

Definition and classification

The average thickness of the normal tendon of the rotator cuff is 10 to 12 mm\(^3\). Partial-thickness tears occur within the tendon and do not communicate with the subacromial bursa or the glenohumeral joint. There are three subtypes: 1) a bursal-side tear (BT) which is confined to the bursal surface of the tendon; 2) an intratendinous tear (IT) which is found within the tendon; and 3) a joint-side tear (JT) which is present on the side of the tendon adjacent to the joint. Photomicrographs of these subtypes from surgical specimens are shown in Figure 1.

A partial-thickness tear is considered to be a definite disruption of the fibres of the tendon and is not simply fraying, roughening or softening of the surface. The degree of tearing is described more by the depth involved in the thickness of the tendon\(^3\) than by the area of the tear.\(^4\)

The Neer\(^5\) staging system (I, II and III) of subacromial impingement brought together the available knowledge of rotator-cuff disease and allowed rational consideration of options for treatment. Although this system is widely utilised, there is some disagreement as to whether partial tears belong in stage II or stage III since Neer\(^5\) did not place them separately.

Ellman\(^3\) proposed a new scheme of classification which included specific consideration of the site and extent of the partial tear, whether its location was adjacent to the articular or bursal surface or whether it was intratendinous. The grade was defined in terms of the depth as measured arthroscopically by a probe with a 3 mm bent arm. Grade-I tears had a depth of less than 3 mm, grade II of 3 to 6 mm and grade III, involvement of more than half of the thickness of the tendon.

The system of Snyder et al\(^4\) for the size and location of partial tears was primarily designed for arthroscopic examination and did not describe the intratendinous lesion. Fukuda et al,\(^6\) Fukuda, Craig and Yamanaka,\(^7\) Olsewski and Depew\(^8\) and Wright and Cofield\(^9\) have placed partial tears in a ‘modified’ stage II. They proposed that both acute oedema and haemorrhage, and chronic fibrosis and tendinitis belong in ‘modified’ stage I, with a full-thickness tear in a ‘modified’ stage III. This modification of Neer’s staging is more directly related to treatment. All stage (modified)-I lesions are best treated conservatively, but for those in stage (modified) II with partial-thickness tears, surgery is appropriate if the symptoms are severe and conservative management has failed. For the lesions placed in stage (modified) III, or with a full-thickness tear, surgical treatment is the only option.

The aetiology of partial tears is not considered in these classifications but it is important to know the cause in order to select the most appropriate treatment.\(^10,11\) For instance, some JT’s which develop in young throwers and other overhead athletes secondary to internal impingement, may be successfully treated by repair of the anteroinferior capsule and not by subacromial decompression.\(^1,2\)

Incidence

The incidence of partial tears is unclear, because most, especially intratendinous lesions, can only be identified at operation, and MRI may demonstrate partial tears in asymptomatic individuals.\(^12\)

Codman’s opinion\(^13\) about the incidence of tears of the cuff, written in 1934, appears to hold true even now: “I have made this diagnosis (complete rupture) in no less than 10% and perhaps more than 20% of all shoulder cases. If cases of partial rupture were included the percentage would be at least doubled”.

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\(^{4}\) ©2003 British Editorial Society of Bone and Joint Surgery
doi:10.1302/0301-620X.85B1.13846 $2.00
Cadaver studies have consistently shown that partial-thickness tears are more common than full-thickness tears. Yamanaka and Fukuda\textsuperscript{14} studied 249 cadaver supraspinatus tendons and found partial tears in 13\% (BT, 2.4\%, IT, 7.2\% and JT, 3.6\%) and full-thickness tears in 7\%. Loehr and Uhthoff\textsuperscript{15} examined 306 shoulders (age range 26 to 95 years) and found partial tears in 32\% and full-thickness tears in 19\% of the specimens of the supraspinatus tendon. It must be noted, however, that most cadaver specimens are from individuals who are older than those who are usually seen in clinical practice and hence the incidence of partial tears is likely to be greater.

Among the three subtypes of partial tear, JTs are two to three times more common than BTs.\textsuperscript{8,10,16-19} ITs are less frequent, comprising 7.9\%\textsuperscript{16} to 13.6\%\textsuperscript{20} in the series of Fukuda et al and 25.6\% in that of Wright and Cofield.\textsuperscript{9} Most of the earlier reports did not include intratendinous lesions. The apparent paucity of the last in published series is due to the difficulty of the diagnosis. Hence, the reported distribution of each subtype does not reflect the true rate of occurrence. Partial tears are found almost exclusively in the supraspinatus tendon and may extend to that of infraspinatus, but rarely to the tendon of subscapularis. Isolated lesions in the tendons of infraspinatus, teres minor or subscapularis are rare.

Natural history and spontaneous healing

Little is known of the natural history and spontaneous healing of partial tears. Codman’s assertion\textsuperscript{13} that spontaneous healing occurs has not been substantiated by histological examination. In a series of 35 \textit{en-bloc} histological sections from surgical specimens of partial tears, Fukuda and associates\textsuperscript{20-23} observed no active repair in any portion examined. Rather, there were many instances of impending full-thickness lesions on histological sections which showed only narrow tissue connections on the bursal- or joint-sides of the tendon.

In order to determine the potential for healing and repair of torn tendons of supraspinatus, Hamada et al\textsuperscript{24} used in situ hybridisation to localise cells containing \(\alpha_1\) type-I procollagen mRNA, a precursor of collagen type I. Biopsy specimens of torn supraspinatus tendons were obtained at operation from 13 patients with partial and 19 with full-thickness lesions. Four similar tendons which were normal on macroscopic evaluation were obtained as a control group. A 22 mer oligonucleotide probe was labelled with digoxigenin and used as an in situ marker. In 14 of 19 full-thickness tears, staining was clearly detected in the cells at the proximal stump of the tear. At a higher magnification the label was identified in the cytoplasm of the tenocytes. The labelled cells at the proximal stumps of both partial and full-thickness tears were significantly more abundant than in the...
normal tendons. In full-thickness lesions the labelled cells in specimens which were obtained less than four months after trauma were significantly more abundant than in those obtained after four months. The number of labelled cells, however, was maintained at the torn portion even in longstanding partial tears with more found in the intratendinous layer than in the bursal-side or joint-side layers. Partial tears and concomitant intratendinous extensions may continue to rupture after the initial injury. The torn supraspinatus tendon has an intrinsic healing capacity in the intermediate and late phases of healing of the tendon. There appears to be a potential for repair of torn tendons of the rotator cuff as in any other tendon of the body, but its ability to effect closure of the defect is in doubt.

From the clinical and histological aspects, despite the aforesaid observations at the molecular level, spontaneous healing of partial tears appears to be unlikely except on rare occasions. Various untoward factors involved in the repair of the torn tendon include ageing, separation of the tear caused by contraction and the weight of the arm, hypovascularity, shear stress within the tendon, and subacromial impingement.

Yamanaka and Matsumoto undertook an arthographic follow-up over two years on 40 JTs which had not been treated by operation, and found that 10% decreased in size and 10% disappeared, but that the remaining 80% enlarged or progressed to full-thickness lesions. This is the only study to date which demonstrates the deterioration of partial tears with conservative treatment.

After arthroscopic debridement of JTs there was no evidence of healing at the second arthroscopy.

It has been shown that conservative treatment may result in the healing of a stage (modified)-I tear. There may be a watershed in the spectrum of healing of partial tears in which those destined to heal and those which will progress are apparent, but the timing of this has not been recognised. Continued study of the partial tear will enhance understanding of the natural history of disease of the rotator cuff as a whole.

Pathogenesis

Factors related to the development of partial-thickness tears are classified as intrinsic, extrinsic or traumatic. Intrinsic tendinopathy and/or enthesopathy due to changes in vascularity of the cuff or other metabolic alterations associated with ageing, may lead to degenerative tears. Extrinsic subacromial impingement as a result of narrowing of the supraspinatus outlet by abnormalities of the coracoacromial arch may cause partial tears by way of irritation of the cuff. This impingement probably plays a major role in aggravating many partial-thickness tears. An excessive tensile load of the cuff, because of either a single traumatic injury or repetitive microtrauma, may also result in such lesions. Often more than one aetiological factor is involved.

Fukuda and associates postulated that the main aetiological factor may be different in each subtype. In tears of the bursal surface, subacromial impingement may be responsible. Intratendinous lesions may occur in the presence of differential shear stress between the superficial and deep surface layers of the tendon and in JTs because of trauma to a degenerated tendon. Histological changes have been observed on the undersurface of the acromions of cadavers with bursal tears but not in those with lesions on the joint-side, suggesting that the former have suffered more abrasion by the acromion. However, a recent finite-element model of the stress environment in the supraspinatus tendon showed that extrinsic compression by subacromial impingement generated high concentrations of stress, sufficient to cause a tear on the bursal side, on the articular side or within the tendon. These observations suggest that any subtypes of partial-thickness tear could be produced by subacromial impingement.

Nakajima et al studied 60 supraspinatus tendons from cadavers and found that the histological and biomechanical properties of the bursal- and joint-side tendon layers were different. The bursal layers are composed primarily of tendon bundles which may elongate with a tensile load and are resistant to rupture, whereas the joint-side layers, a complex of tendons, ligaments, and joint capsule, do not stretch and tear easily. They suggest that intratendinous lamination is caused by differential shear stress within the supraspinatus tendon. In Fukuda’s series of 66 partial-thickness tears, of which 35 were on the bursal side, nine were intratendinous and 22 on the joint side, episodic trauma was recorded in 8.6% of the bursal lesions, 92.3% of the intratendinous and in 63.6% of the joint-side lesions. Itoi and Tabata also found that the incidence of traumatic onset was 50% in bursal lesions and 87% in joint-side tears.

Recently, JTs have been described secondary to internal impingement in young throwers and other overhead athletes. Repetitive interaction between the undersurface of the supraspinatus tendon and the posterosuperior glenoid appears to be responsible as a result of subtle instability during the late cocking phase of the throwing action.

Thus, the pathogenesis of tears of the rotator cuff is now considered to be multifactorial, and there is an interplay of age-related tissue degeneration, trauma, repetitive microtrauma, internal impingement, hypovascularity, the inherent properties of the supraspinatus tendon, and subacromial impingement.

Clinical presentation of disease of the rotator cuff

Pain, especially at night, is the most irritating symptom. While believing that nocturnal pain was the principal problem in both partial and full-thickness tears, Codman’s view that “partial ruptures account for most minor shoulder disabilities” gives an impression that the former condition is less painful. However, Gschwend, Ivosevic-Radovanovic and Patte and Fukuda have stressed that partial tears can be more painful than full-thickness tears.
Assuming that the degree of subacromial bursitis is directly related to the pain of tears of the rotator cuff, Gotoh et al.37 investigated the amount of substance P in the bursa of patients with disease of the rotator cuff. The preoperative level of pain was measured using a visual analogue scale (VAS). Thirty-seven patients who underwent surgery were divided into two groups, 19 with subacromial bursitis and/or tendinitis and partial-thickness tears (the non-perforating group), and 18 with full-thickness lesions (the perforating group). Subacromial bursae obtained from seven fresh cadavers with no shoulder pain before death were used as a control group. The VAS showed significantly greater pain in the non-perforating group. Substance P in the subacromial bursa was significantly greater in this group than in the perforating group, thus confirming the findings of the VAS. Nerve fibres immunoreactive to substance P were localised around the blood vessels with more in the non-perforating group. The authors concluded that increased substance P in the subacromial bursa correlated positively with the pain in disease of the rotator cuff, and that the pain is proportional to the degree of subacromial bursitis, not to the depth or extent of the tear.

BTs were found to be the most painful of the three subtypes and therefore surgery should be carried out earlier rather than later in order to minimise the bursal sensitivity to inflammation and impingement.20

The physical signs and symptoms of disease of the rotator cuff are often non-specific. Fukuda et al.20 and Fukuda38 categorised them into two groups, those caused mainly by the inflammation of subacromial bursitis and tendinitis (A) and those resulting from a torn tendon (B). Category A symptoms may be characterised by various types of pain, signs of fluid, a painful arc, an impingment sign, a positive procaine test, and contracture; these may be reversible after conservative treatment. Category B symptoms may demonstrate the drop-arm sign, crepitus, muscle weakness and atrophy of the spinati, which are irreversible after conservative treatment alone. Both categories of symptoms may be experienced variously at a given stage of the subacromial impingement syndrome, and their relative balance may influence the choice of treatment (Fig. 2).

Diagnostic imaging

Codman13 relied entirely on the history and a physical examination for diagnosing full-thickness tears. However, he stated: “I believe in the near future we shall be able to make the x-ray of more use in this diagnosis, either by using injections into the joint of non-radiable fluid, or by developing soft tissue technique which will show the rupture”. As anticipated by Codman,13 arthrography, subacromial bursography, ultrasonography, CT and MRI have been developed, and the diagnosis of a full-thickness tear is now much easier. These investigations have also been used in diagnosing partial tears, but their preoperative identification remains elusive.

Shoulder arthrography. Arthrography of the shoulder allows evaluation of the integrity of the undersurface of the rotator cuff. However, its value in diagnosing JTs remains uncertain with an accuracy ranging from 15%10 to 83%.16 Neviaser, Neviaser and Neviaser39 reported that the size and location of ITs and JTs were diagnosable by a technique termed positional arthrography. They found a correlation of 56% of pre- and intraoperative diagnosis in 200 patients.

Bursography. Bursography has been used to demonstrate BTs and its accuracy in surgically-verified lesions was 67%;40 Itoi and Tabata16 reported a success rate of 25%. Subacromial inflammation and adhesions probably limited this rate of detection. Since negative arthrograms or bursograms do not reliably rule out partial tears, some40 consider the value of positive studies to be diagnostically significant.

Ultrasonography. Since the introduction of ultrasonography by Matsen and Kilcoine41 in 1984, it has proved to be accurate for the diagnosis of full-thickness42 but not of partial-thickness tears. The appearances in the latter may be subtle and present difficulty in diagnosis. Fluid within the tendon of the rotator cuff produces a focal hypoechoic area. Thus, such an area at one of the surfaces of the cuff or within its substance indicates a partial tear. A hyperechoic band within the cuff may also represent such a lesion. In a series of 69 partial tears diagnosed by ultrasonography, Wiener and Seitz42 reported a sensitivity of 94% and a specificity of 93%. They recommended ultrasonography as a reliable and cost-effective method of evaluating the rotator cuff. It is difficult, however, to distinguish partial-thickness tears from scarring within the tendon or a small full-thickness lesion. Small defects in the cuff can be missed, as reported by Brenneke and Morgan,43 who had a detection rate for partial tears of 41%. The investigation is dependent on the skill and experience of the operator in both performance and interpretation.
MRI. The diagnosis of partial tears by MRI is based on the alteration of the morphology of the rotator cuff, without evidence of discontinuity on T1-weighted images corresponding to areas of increased signal on T2-weighted images which suggests an inflammatory process. Increased joint or subacromial bursal fluid may be demonstrated in JTs and BTs, respectively. Detection of partial tears by standard MRI techniques is not reliable. Traugber and Goodwin gave a sensitivity of 56% to 72% and a specificity of 83% to 85% for arthroscopically-proven partial-thickness lesions. Gartsman and Milne reported a false-negative rate of 83% in MRI studies of 12 arthroscopically verified JTs. Wright and Cofield made the correct diagnosis in 33% of 18 partial tears on preoperative studies.

The use of adjunctive contrast or of fat-suppression techniques may improve accuracy in detection, but consistency has not been demonstrated.

Abnormal MRI findings suggestive of partial and full-thickness tears are often observed in asymptomatic older individuals. Sher et al reported that 24% of asymptomatic shoulders of those between 40 and 60 years of age had MRI findings consistent with those of partial tears. Thus, MRI evidence of a partial tear could be an incidental finding in a symptomatic as well as in an asymptomatic patient. Until clear distinction can be made in MRI between partial tears and tendinitis or scarring or focal degeneration of the tendon, MR images compatible with a partial tear should be considered as adjunct information to clinical evaluation.

Diagnosis at surgery

The use of arthroscopy has allowed visualisation of partial-thickness tears on the joint and bursal side, if adhesions are adequately controlled. Diagnosis of the intratendinous tear still remains elusive. Consequently, there are only a few studies of this subgroup. For confirmation of the anatomical diagnosis, careful inspection and palpation of the critical portion of the supraspinatus tendon are necessary during the operation. In addition to the characteristic appearance of bursal inflammation, local softening or thinning of the cuff and puckering or bulging on milking the tendon digitally or on elevation or rotation of the arm, raises suspicion of the presence of pathology under the bursal surface of the tendon. Incising the tendon along its fibres for direct visualisation of the substance or undersurface of the tendon is also a helpful diagnostic manoeuvre. Wright and Cofield made a definitive diagnosis of partial tears in 17 of 39 shoulders (44%) at operation. ‘Negative’ explorations sometimes occur but appear to do no harm after resurfacing of the tendon.

Treatment

Spontaneous healing of a partial-thickness tear is unlikely in most cases. What is the explanation then for the ‘cure’ with conservative treatment? In order to obtain healing of the torn tendon, a good blood supply, contact between the torn ends, and the ability to produce extracellular components are mandatory. Fukuda et al stated that if the signs and symptoms of inflammation are alleviated, and if those due to the mechanical deficiency of the torn cuff are compensated for by the residual cuff muscles and prime movers, then a clinical ‘cure’ is achieved. McConville and Iannotti maintained that treatment of most symptomatic partial tears should be directed towards a primary diagnosis such as an impingement syndrome or instability, with treatment of the partial tear itself being considered secondarily. Thus, it is important to recognise that the choice of treatment depends on the exact cause of the lesion.

Conservative. Most surgeons agree with the principle that treatment of disease of the rotator cuff varies according to the pathology and that initially conservative treatment should be used. The latter is primarily indicated for tendon and bursal inflammation. Time, local rest, application of cold or heat, massage, non-steroidal anti-inflammatory medication, modification of activities, gentle exercises for maintaining and increasing the range of movement, and, later, muscle-strengthening are the preferred methods. The judicious use of no more than three to four injections of steroid into the subacromial space or around the biceps tendon can also be helpful in the early phase. Physiotherapy is increased as inflammation diminishes and pain subsides.

Codman wrote that “complete ruptures do not form adhesion, while many incomplete cases do”. Posterior capsular contracture is addressed by progressive stretching in adduction and internal rotation. Horizontal adduction or cross-body adduction exercises are recommended to release the posterior capsule. As pain decreases and the range of movement increases, strengthening exercises for the rotator cuff and periscapular musculature are prescribed to restore the normal mechanics of the shoulder girdle. Progressive resistive exercises are employed within the limits of the pain utilising rubber tubing or free weights.

Most BTs respond poorly to conservative treatment. Once the vicious cycle of subacromial impingement has been established and/or the tear is deep, conservative treatment is rarely helpful. Fukuda et al recommended early surgical intervention when the severe clinical manifestations and positive imaging suggest such a diagnosis.

Operative. The indications for the surgical treatment of partial-thickness tears have not been clearly delineated. Surgical treatment, however, is generally considered for those patients with symptoms of sufficient intensity and long duration, and in whom imaging suggests the presence of partial or small full-thickness lesions. The timing of surgical intervention after failed conservative treatment ranges from a few months to 1.5 years.

Operation may involve debridement of the partial tear, acromioplasty alone, acromioplasty and debridement or repair of the cuff in addition to acromioplasty. It may be performed either as open, arthroscopically-assisted mini-
open, or entirely arthroscopically. The advantages and disadvantages of open and arthroscopic procedures lie in the balance between precision and morbidity. Several factors influence surgical decision-making such as the age of the patient, occupation, preference, other medical conditions, response to conservative treatment, the type and extent of the tear, the underlying pathology, and the surgeon’s skill and experience.

Partial tears may be found almost exclusively in the tendon of supraspinatus and may extend to the tendon of infraspinatus, but rarely, to that of subscapularis. Most clinicians agree that tears involving more than 50% of the thickness of the tendon should influence the surgeon to perform an open repair. There is no consensus of opinions for treatment based on the surface area of the lesion.

**Arthroscopic technique.** Arthroscopy may confirm the diagnosis of a partial tear by allowing inspection of the articular and bursal surfaces of the rotator cuff and other intra-articular structures. It should be employed before open surgery to assess pathological changes. Intra-articular findings often associated with partial tears include Hill-Sachs defects, labral lesions and other features suggestive of anterior glenohumeral instability.

Arthroscopy is performed with the patient in the beach-chair or lateral decubitus position. If an open procedure is to follow, the beach-chair position is convenient and time-saving because repositioning is not required. Arthroscopy through the standard posterior portal allows an excellent view of the sites of insertion of the biceps, supraspinatus, infraspinatus and teres minor. When anterior acromioplasty is planned, the technique originally described by Ellman3 is recommended. Gentle debridement of the torn surfaces is often necessary to evaluate the true extent of the tear, especially for BTs. Probing the cuff through an anterior or lateral portal into the glenohumeral joint or into the subacromial bursa is helpful to assess its integrity.

In an attempt to localise the joint side from the bursal side, Snyder et al4 developed a technique for marking the JT during diagnostic arthroscopy with a suture passed through a spinal needle to be identified later on the bursal surface.

The presence of a proliferating bursitis makes diagnosis of an intratendinous lesion impossible. Arthroscopy allows visualisation of the concomitant bursitis, but it cannot identify a pure intratendinous lesion. Entirely arthroscopic techniques have been described and may be applicable in some easy-to-repair bursal and joint-side lesions using side-to-side sutures. However, if there is a deep intratendinous extension, arthroscopy has technical limitations.

**Open technique.** Open surgery provides a wider exposure and better precision of technique than arthroscopy, but at the cost of some morbidity to the anterior deltoid. With the patient in the beach-chair position, a standard anterosuperior approach gives an excellent exposure of the subacromial bursa and the tendon of supraspinatus and its environs, with a minimum detachment of the deltoid of 2.0 cm from the anterior acromion. For those over the age of 40 years we recommend anterior acromioplasty followed by repair of the tendon. For those younger than 40 years of age, section of the coracoacromial ligament is preferable unless there is an obvious abnormality of the acromion.5,32,33,48

BTs are easily identifiable but synovial proliferation may mask small defects in the cuff. Debridement or excision of the diseased tendon is then carried out before closure of the cuff. In order to detect both intratendinous and joint-side lesions, the critical portion of the tendon of supraspinatus and the adjacent area should be carefully palpated for thinning or softening. Puckering may be seen when elevating the arm or milking the tendon digitally or with a probe.

The colour test,49 an intraoperative cuff-staining test, is useful for more accurate diagnosis and localisation of joint-side and intratendinous extensions. Indigo Carmine or Methylene Blue (3 ml mixed with 17 ml of normal saline) is injected into the glenohumeral joint and the shoulder is put through a range of movement. Torn cuff tissue is easily stained by the dye. The sheath of the long head of biceps brachii and the rotator interval are usually stained which is useful for surgical orientation. The staining test has proved to be positive when more than half of the thickness of the tendon is involved, and its accuracy for detection of the JT is 65%.49 Incising the tendon along its fibres for direct visualisation of the substance or undersurface of the tendon is also a helpful diagnostic manoeuvre. The torn portion is then excised in an elliptical or isosceles fashion until the healthier tissue is exposed and then oversewn side-to-side or to a trough in the anatomical neck or the greater tuberosity. Tear depth of more than 50% may be used as an indicator of the need for repair of the cuff, but the area of the tear is not normally used as a criterion.

Intratendinous laminations are associated with approximately 50% of BTs and JT.e.20 Ellman found “a surprising degree of lamination” with the most inferior fibres demonstrating the greatest degree of retraction. Such laminations are also often found in full-thickness tears and if these are excised totally, subsequent closure of the cuff may prove to be difficult.

Sonnenbend et al50 demonstrated by histological and immunohistochemical methods that the lining cells of these laminated tears were synovial. They suggested that the defects should be curetted in order to remove at least some of this synovial lining before repair of the suture. In this situation, Hamada et al51 recommended suturing of the superficial and deep layers of the cuff using an in-and-out suture after thorough debridement of the inner surfaces. The colour test49 or topical use of a dye helps to distinguish degenerated tissue, which stains more than normal tissue, and thus facilitates debridement. This suture technique is based on an in situ hybridisation study, which demonstrated abundant signal-positive-cells containing procollagen α1 type-I messenger RNA in intratendinous laminations of torn supraspinatus tendons obtained at surgery.24,52 Although the short-term results with this technique are promising, a definitive surgical treatment of intratendinous lesions and any
types of cuff tear associated with sizeable intratendinous extensions has not yet been established.

The postoperative rehabilitation is the same as that after the repair of a full-thickness tear and should be carefully supervised by the surgeon who will know the quality of both the tendon and the repair. The principle is to achieve a full movement of the shoulder by early passive movement and to gain strength later. Approximately five to six weeks are necessary to allow for the strong reattachment of the deltoid before active elevation of the arm is begun. Six to 12 months are needed for the return of the full use of the arm after successful repair of the tear.

Fukuda and associates\(^20,23\) believe that these combined open procedures with acromioplasty and tenorrhaphy after excision of the diseased portion give the following advantages: 1) good tendon repair and anchoring are accomplished; 2) decompression is reinforced by tenorrhaphy; 3) hidden lesions are uncovered by inspection, palpation, mobilisation, the colour test, and exploration of the tendon; 4) tissue repair is enhanced by excision of diseased tissue; 5) progression of the tear is prevented by a good repair; 6) concomitant intratendinous lamination is treated; and 7) surgery on the tendon is done with the same exposure and minimal risk.

**Mini-open technique.** A combined arthroscopic and open surgical approach has been developed to lessen the morbidity to the anterior deltoid. After arthroscopic decompression, mini-open surgery is performed using the short deltoid-splitting approach. Care must be taken to avoid avulsion of the deltoid from the anterior acromion by overzealous retraction. If needed, more exposure can be obtained by detaching the anterior deltoid for 2.0 cm.

**Results of treatment**

Only small clinical series with short follow-up have been published. Different methods of treatment make comparison difficult. Because of the uncertainty in diagnosis, there is no reliable report on the conservative treatment of partial tears. However, with surgical treatment, including arthroscopic acromioplasty and debridement, Wright and Cofield\(^9\) reported overall satisfactory (excellent and good) results in 50% to 94% of patients. The information on treatment currently available is given in Table I. Even when overhead athletes were included,\(^26,53\) mixing degenerative and traumatic causes of this disease, overall satisfactory results remained about the same (50% to 95%).

The results of debridement alone are variable and range from as low as 50%\(^54\) to 87%.\(^26\) Snyder et al\(^4\) proposed debridement specifically as treatment for JTs. Budoff et al\(^26\) reported that arthroscopic debridement of the rotator cuff without subacromial decompression yielded satisfactory results in 87% of 79 partial-thickness lesions with a mean follow-up of 4.4 years. Their series consisted of 51 JTs, 1 BT and 27 combined JTs and BTs. No single case of an intratendinous lesion was included. They did not believe that debridement of the abnormal cuff tissue stimulated a repair response, but maintained that the procedure allowed functional recovery when there was appropriate rest and rehabilitation.

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**Table I.** The operative treatment of partial-thickness tears of the rotator cuff

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of shoulders</th>
<th>Treatment</th>
<th>Follow-up (yrs)</th>
<th>Satisfactory* results (%)</th>
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<tbody>
<tr>
<td>Neer(^32)</td>
<td>16</td>
<td>Acromioplasty</td>
<td>94</td>
<td></td>
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<tr>
<td>Fukuda et al(^6)</td>
<td>21</td>
<td>Acromioplasty, debridement, repair</td>
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<td>90</td>
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<td>34</td>
<td>AS† debridement</td>
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<td>85</td>
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<tr>
<td>Ogilvie-Harris and Wiley(^54)</td>
<td>57</td>
<td>AS debridement</td>
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<tr>
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<td>92</td>
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<td>Acromioplasty, debridement, repair</td>
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<td>Gartsman(^61)</td>
<td>40</td>
<td>AS acromioplasty, debridement</td>
<td>1.4</td>
<td>67</td>
</tr>
<tr>
<td>Altchek et al(^53)</td>
<td>6</td>
<td>AS acromioplasty in 18, debridement</td>
<td>1.9</td>
<td>84</td>
</tr>
<tr>
<td>Snyder et al(^5)</td>
<td>31</td>
<td>AS acromioplasty in 18, debridement</td>
<td>1.9</td>
<td>86</td>
</tr>
<tr>
<td>Ryu(^17)</td>
<td>35</td>
<td>AS acromioplasty</td>
<td>1.9</td>
<td>86</td>
</tr>
<tr>
<td>Itoi and Tabata(^16)</td>
<td>38</td>
<td>Acromioplasty in 25, repair</td>
<td>4.9</td>
<td>82</td>
</tr>
<tr>
<td>Olsewski and Depew(^8)</td>
<td>21</td>
<td>AS acromioplasty, debridement</td>
<td>2.3</td>
<td>81</td>
</tr>
<tr>
<td>Tabata et al(^28)</td>
<td>101</td>
<td>Acromioplasty, debridement, repair</td>
<td>5.9</td>
<td>95</td>
</tr>
<tr>
<td>Gartsman and Milne(^10)</td>
<td>111</td>
<td>AS acromioplasty, debridement, in 85</td>
<td>2.7</td>
<td>88</td>
</tr>
<tr>
<td>Wright and Cofield(^9)</td>
<td>39</td>
<td>Acromioplasty, debridement, repair</td>
<td>4.6</td>
<td>85</td>
</tr>
<tr>
<td>Fukuda et al(^20)</td>
<td>66</td>
<td>Acromioplasty, debridement, repair</td>
<td>2.7</td>
<td>94</td>
</tr>
<tr>
<td>Weber(^18)</td>
<td>32</td>
<td>AS acromioplasty</td>
<td>4.0</td>
<td>45</td>
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<tr>
<td>Olsewski and Depew(^8)</td>
<td>33</td>
<td>AS acromioplasty, repair (mini-open)</td>
<td>3.2</td>
<td>94</td>
</tr>
<tr>
<td>Budoff et al(^26)</td>
<td>79</td>
<td>AS debridement</td>
<td>4.4</td>
<td>87</td>
</tr>
</tbody>
</table>

* satisfactory includes excellent and good
† arthroscopic
Of the 21 authors quoted in Table I, 17 performed open or arthroscopic acromioplasty in all or in part. Neer32 treated partial tears by anterior acromioplasty alone, unless the tendon was thin, threatening progression to a full-thickness lesion. He obtained satisfactory results in 15 of 16 patients (94%). Following Neer’s principle with the arthroscopic technique, Altchek et al25 obtained satisfactory results in 67%, Ryu17 in 86%, Gartsman and Milne10 in 88%, and Weber18 in 45%.

The late outcome after open acromioplasty for stage-II impingement was recently described by Hyvönen et al,35 with a mean follow-up of 9.5 years. The primary result was good, but after a mean of five years, 12% of their patients deteriorated with development of a tear. They concluded that the diseased supraspinatus tendon may tear even after the subacromial impingement has been removed. It is interesting to note the results of Weber’s studies18 between two comparable groups. In 32 patients treated by arthroscopic acromioplasty, satisfactory results were obtained in 45%, but in 33 other patients treated by arthroscopic acromioplasty followed by mini-open repair there were satisfactory results in 94%.

At present, if surgery is indicated for partial-thickness tears, standard open anterior acromioplasty and repair of the tendon after excision of the diseased portion appear to give satisfactory results, i.e., 82% to 95%.6,7,9,16,18,20,57,58

Conclusions

Although still not clearly characterised, degenerative partial-thickness tears are an important part of the spectrum of pathology of the rotator cuff. Functionally and morphologically, they can best be placed in the subacromial impingement syndrome, i.e. between subacromial bursitis/teninits, or the ‘pretear’ stage and the full-thickness tear. This disabling condition occurs more often in the population aged over 40 years than has been hitherto recognised. Unfortunately, the diagnosis is still elusive even with MRI, ultrasonography and other imaging techniques. As with other disorders, early recognition and appropriate treatment undoubtedly diminish the serious consequences so often encountered when the lesion is neglected.

References