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Partial-thickness tears of the rotator cuff

A clinicopathological review based on 66 surgically verified cases

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Summary. *This review is based on 66 patients with partial-thickness tears of the rotator cuff, verified at operation. Their average age was 54 years, and all had symptoms of subacromial impingement. The duration of shoulder pain was for between 2 and 108 months (mean 11.4 months). Ultrasonography, arthrography and bursography were helpful in establishing the diagnosis. On exploration, tears were found in the supraspinatus tendon, with 9 extending into the infraspinatus. After anterior acromioplasty, excision of the diseased portion and tenorrhaphy were undertaken. Satisfactory results were obtained in 62 patients (94%) with an average follow-up of 32 months. Spontaneous repair at the torn site was never seen. In addition to Neer's staging of impingement, we propose a new classification based on the integrity of the cuff tendon. We conclude that a partial-thickness cuff tear is an important cause of shoulder disability, which deserves much more clinical attention; misdiagnosis is common and leads to mismanagement. When conservative treatment fails, accurate diagnosis and proper surgical repair are essential.*

Introduction

Many patients with shoulder pain have long been managed under a catch-all diagnosis of "bursitis" or "frozen shoulder" with a poor outcome. Arthrography [12] made possible diagnosis of the full-thickness tear of the rotator cuff, which can then be treated. However, when shoulder disability persists, it is apparent that the true cause remains undetected, and therefore untreated. Partial-thickness tears of the cuff often elude diagnosis in spite of arthroscopy, ultrasonography or MRI. A partial-thickness tear of the supraspinatus tendon is defined as "disruption of the fibres involving at least one-quarter of the tendon thickness". It can be of three subtypes with no communication between the glenohumeral joint and the subacromial bursa:

(1) a bursal-side tear, where the defect is only on the bursal side of the tendon,
(2) an intratendinous tear, where the split is only within the tendon itself without communication with the subacromial bursa or the shoulder joint,
(3) a joint-side tear, where the defect is only on the joint side.

The clinical features, diagnostic methods, surgical findings and repair, pathology, results and follow-up will be discussed.

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Materials and methods

Patients. Between 1975 and 1996, 66 patients were operated on for partial-thickness cuff tears at the Tokai University Hospital and the Tokai University Oiso Hospital. There were 54 men and 12 women, with an average age of 53.8 years (range 20–75 years). The right side was involved in 45 cases and the left in 21. The mean duration of shoulder pain was for 11.4 months, (range 2–108 months), and they had undergone an average of 5 months (range 3–10 months) of conservative treatment. All showed clinical evidence of subacromial impingement. Their clinical data are summarised in Table 1.

Table 1. Case profiles

Case		Trauma	Pain (mos)	Arc of pain	Impingement sign	Procaine test	Tear size (L×Wcm)	Follow-up (mos)	Results (Neer)
1	48 ♂	–	3	+	+	+	0.5×1.8	24	Satisfactory
2	72 ♂	+	10	+	+	+	1.0×1.0	20	Satisfactory
3	43 ♂	–	108	+	+	+	1.5×1.5	12	Satisfactory
4	63 ♂	–	8	+	+	+	2.0×0.7	18	Satisfactory
5	61 ♀	–	8	–	+	+	3.5×2.5	12	Satisfactory
6	63 ♂	+	7	–	+	–	1.5×1.0	10	Satisfactory
7	69 ♂	–	5	+	+	+	2.0×1.8	12	Satisfactory
8	58 ♂	–	8	+	+	+	1.2×0.5	20	Satisfactory
9	56 ♂	–	5	+	+	+	2.5×1.5	96	Satisfactory
10	47 ♂	–	14	+	+	–	2.0×1.0	7	Satisfactory
11	53 ♂	–	5	+	+	+	2.5×2.0	8	Satisfactory
12	45 ♀	–	36	+	+	+	2.5×1.5	60	Satisfactory
13	42 ♂	+	36	+	+	+	2.0×2.0	8	Satisfactory
14	48 ♂	+	3	+	+	+	2.0×2.0	12	Satisfactory
15	20 ♂	–	36	–	+	+	2.0×0.5	14	Satisfactory
16	57 ♂	+	14	invalid	invalid	+	4.0×2.5	14	Satisfactory
17	36 ♂	–	13	+	+	+	1.2×1.0	67	Satisfactory
18	51 ♀	–	5	+	+	+	2.0×1.0	12	Satisfactory
19	46 ♂	–	5	+	+	+	1.2×1.2	9	Satisfactory
20	46 ♀	+	2	+	+	+	3.0×2.0	6	Satisfactory
21	61 ♂	–	5	–	+	+	2.5×2.0	38	Satisfactory
22	62 ♂	+	5	–	+	+	1.0×1.0	6	Satisfactory
23	52 ♂	+	3	+	+	+	1.5×1.0	12	Satisfactory
24	41 ♂	–	34	+	+	+	1.5×1.0	3	Unsatisfactory
25	47 ♂	–	6	–	–	–	1.0×1.0	105	Satisfactory
26	56 ♂	–	8	+	+	+	3.0×1.5	106	Satisfactory
27	57 ♂	–	28	+	+	+	3.5×2.5	54	Satisfactory
28	38 ♂	–	6	+	+	+	1.5×1.5	67	Unsatisfactory
29	58 ♀	+	9	+	+	+	0.5×1.0	91	Satisfactory
30	32 ♂	–	7	+	+	–	3.0×3.0	50	Satisfactory
31	50 ♂	–	5	+	+	+	1.3×1.0	7	Satisfactory
32	36 ♂	–	16	+	+	+	1.0×1.0	12	Satisfactory
33	49 ♂	–	14	–	–	+	0.3×1.5	106	Satisfactory
34	66 ♂	+	8	+	+	+	2.5×1.4	3	Satisfactory
35	68 ♂	–	8	+	+	+	3.5×2.5	8	Satisfactory
36	52 ♂	+	3	–	+	+	1.5×1.5	6	Satisfactory
37	26 ♂	+	5	invalid	+	+	1.5×1.0	18	Satisfactory
38	61 ♂	+	36	+	+	+	1.5×2.0	6	Satisfactory
39	61 ♂	–	22	+	–	+	1.5×1.0	9	Satisfactory
40	61 ♂	+	6	–	+	+	1.0×1.3	12	Satisfactory
41	50 ♂	+	18	+	+	–	2.5×2.5	18	Satisfactory
42	45 ♂	–	5	+	+	–	1.5×1.0	14	Satisfactory
43	51 ♂	–	3	invalid	invalid	+	1.5×1.0	24	Satisfactory
44	42 ♂	+	8	+	+	–	3.5×1.6	26	Satisfactory
45	64 ♀	+	8	+	–	–	1.5×1.0	13	Satisfactory
46	59 ♂	–	18	–	+	+	1.5×1.0	10	Satisfactory
47	53 ♂	+	24	+	–	+	1.0×1.0	5	Satisfactory
48	53 ♀	+	9	invalid	+	+	0.8×0.8	12	Satisfactory
49	56 ♀	–	5	+	+	–	3.0×1.5	10	Satisfactory
50	68 ♂	–	4	+	+	+	2.0×1.0	12	Satisfactory
51	48 ♀	+	5	+	+	+	2.0×1.0	130	Satisfactory
52	60 ♂	+	9	–	–	–	1.5×1.0	60	Satisfactory
53	67 ♂	+	2	+	+	+	1.5×1.0	43	Satisfactory
54	62 ♂	+	2	+	+	+	3.0×2.0	38	Satisfactory
55	41 ♂	+	10	+	+	+	4.0×4.0	24	Unsatisfactory
56	61 ♀	–	8	invalid	invalid	–	2.0×2.0	62	Unsatisfactory
57	59 ♀	+	3	–	+	+	2.5×2.0	4	Satisfactory
58	62 ♂	+	2	+	+	+	2.5×2.0	14	Satisfactory
59	57 ♂	+	8	–	+	–	4.0×2.0	12	Satisfactory
60	75 ♂	+	8	–	+	+	1.5×1.0	8	Satisfactory
61	66 ♂	+	2	+	+	–	3.0×2.0	30	Satisfactory
62	72 ♂	–	5	–	–	–	1.5×1.0	10	Satisfactory
63	49 ♀	+	8	+	+	+	1.5×1.0	84	Satisfactory
64	60 ♂	+	4	invalid	invalid	–	1.0×1.0	66	Satisfactory
65	64 ♂	+	2	–	+	+	2.0×1.0	15	Satisfactory
66	50 ♂	+	6	+	+	+	2.5×1.5	39	Satisfactory

Cases 1–35: Bursal-side tears; Cases 36–44: Intratendinous tears; Cases 45–66: Joint-side tears

Table 2. Clinical features

	n	Arc of pain	Impingement sign	Procaine test	Contracture
Bursal-side tears	35	27/34 (79.4%) [1]	32/34 (94.1%) [1]	31/35 (88.6%)	2/35 (5.7%)
Intratendinous tears	9	5/ 7 (71.4%) [2]	7/ 8 (87.5%) [1]	6/ 9 (66.7%)	3/ 9 (33.3%)
Joint-side tears	22	12/19 (63.2%) [3]	16/20 (80.0%) [2]	14/22 (63.6%)	5/22 (22.7%)
Total	66	44/60 (73.3%) [6]	55/62 (88.7%) [4]	51/66 (77.3%)	10/66 (15.2%)

Numbers in squared brackets indicate cases where these tests were invalid because of contracture (limited passive elevation beyond 90°)

Once a clinical diagnosis of the impingement syndrome was made, plain anteroposterior and lateral radiographs of the shoulders were taken, followed by ultrasonography, MRI, arthrography or subacromial bursography as indicated. At operation, anterior acromioplasty was carried out followed by tenorrhaphy after excision of the diseased portion of the rotator cuff. There were 35 bursal-side tears (BT), nine intratendinous tears (IT), and 22 joint-side tears (JT). Trauma was noted in 10 out of 35 patients (28.6%) with BT, in six of nine patients (66.7%) with IT and in 17 of 22 patients (77.3%) with JT. The results were assessed by Neer's criteria [14].

Clinical features

While all 66 patients experienced spontaneous pain and pain on movement in various degrees, those with BTs suffered the most. While the arc of pain, impingement sign (Neer) and procaine test were positive in 73.3% and 88.7% and 77.3% respectively of the 66 patients, they were positive in 79.4%, 94,1% and 88.6%, respectively, of the 35 patients with BTs (Table 2). Contracture, defined as limitation of passive elevation beyond 90°, was present in 15.2% of the 66, in 5.7% of BTs, 33.3% of ITs and 22.7% of JTs. Those tests requiring a nearly full range of movement, such as the arc of pain and the impingement sign, were invalid in the presence of contracture or severe pain.

Swelling of the subacromial bursa (the fluid sign) was noted in 4 BTs. The drop arm sign and muscle weakness in abduction and external rotation were difficult to assess without relief of pain. However, these two signs and atrophy of the spinati were not particular features of partial-thickness cuff tears. Crepitus, palpable or audible, was occasionally seen in BTs, and rarely in ITs and JTs.

Investigations

Plain radiographs

Acromial spurs were found in 6 of 35 BTs (17.1%) and 1 of 9 ITs (11.1%) and in none of the JTs. No other specific findings were noted.

Ultrasound

Of 46 patients thus examined, partial thickness cuff tears were diagnosed in 35 (76.1%). Suspicion was raised in other cases. A horizontal hyperechoic band within the supraspinatus tendon in the transverse plane, suggesting an IT in a 52 year old man, was confirmed as an IT at operation (Fig. 1).

MRI

Out of 7 cases so examined, the correct diagnosis was made in 5 on T2-weighted fast spin echo (FSE) images. An area of abnormal, bright intensity, deemed to be an indented bursal surface in a 72 year old man, was observed to be a deep BT upon exploration (Fig. 2).

Arthrography

Single-contrast arthrography was performed in 65 cases. It was positive in 19 out of 22 JTs (86.1%), demonstrating a disruption on the capsule and the joint-side layer of the cuff, accompanied frequently by intratendinous lamination (Fig. 3).

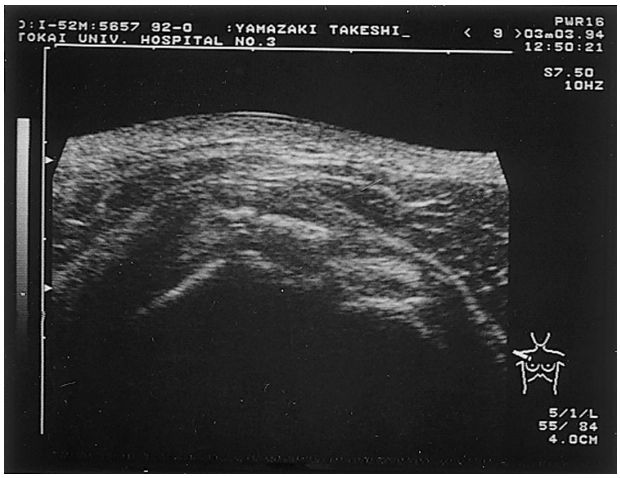

Fig. 1. A horizontal hyperechoic band within the supraspinatus tendon in the transverse plane on ultrasonogram, lateral to the long head of the biceps brachii, suggests an IT in a 52-year-old man. It was confirmed at operation

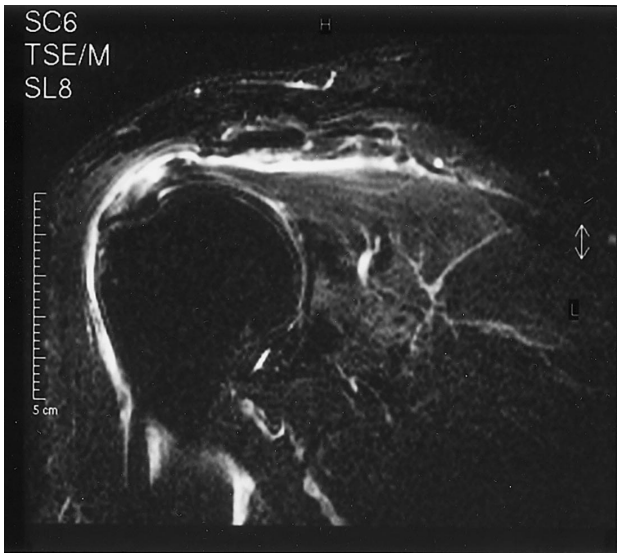

Fig. 2. An area of abnormal, bright intensity on T2-weighted fast spin echo(FSE) MRI image was deemed to be an indented bursal surface in a 72-year-old man. A deep BT was found on exploration

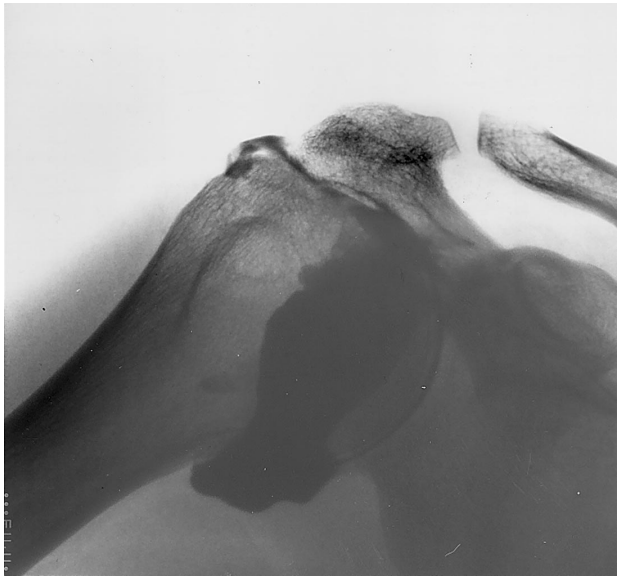

Fig. 3. An arthrogram demonstrating a disruption on the capsule and the joint-side layer of the cuff accompanied by intratendinous lamination in a 60-year-old man. This was verified as a JT at operation

Subacromial bursography

This was carried out as described by Fukuda et al. (5), when arthrography proved negative. It was positive in 13 of 22 BTs (59.1%) showing, as in arthrography, a break on the bursal layer of the cuff often with concomitant intratendinous lamination (Fig. 4). In doubtful cases, arthroscopy, bursoscopy

Fig. 4. A subacromial bursogram demonstrating disruption on the bursal layer of the cuff with concomitant intratendinous lamination (*arrows*) in a 45-year-old woman. This was confirmed as a BT at operation

and/or exploration were carried out in various combinations. The diagnosis of all nine ITs was only established by trial tenotomy along the tendon fibres.

Surgical findings

All 66 partial-thickness tears developed from near the insertion to the critical portion (Codman) of the supraspinatus tendon, and in 9 patients extended to the infraspinatus tendon. The site of the tear showed impingement by the anterior margin on the acromion and by the coracoacromial ligament with elevation of the arm. The average length and width of the tear were 2 cm and 1.5 cm respectively, and the depth varied from shallow to very deep.

The BTs were readily observed on opening the bursa. The site was surrounded by red, oedematous and proliferated bursal tissue in most cases. The proximal stumps of the tendon had a blunt edge and were retracted from the distal ends like a flap (Fig. 5). The tears were continuous in the tendon in the superomedial direction. In both ITs and JTs the critical portion of the supraspinatus tendon was inflamed and softer than the surroundings. Puckering of the tendon was readily produced on elevation of the involved arm. Concomitant subacromial bursitis was found in 90% of all partial-thickness tears. The ITs were found within the mid-layer of the tendon with the axis parallel to the tendon fibres. The surfaces of the tear appeared

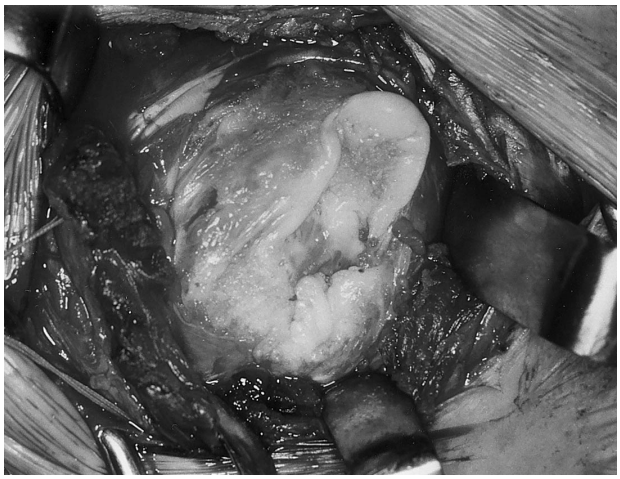

Fig. 5. An intraoperative photograph of a classical BT in the supraspinatus tendon in a 66-year-old man. The proximal tendon stump had a blunt edge and was retracted from the distal end like a flap

smooth and shiny resembling that of the bursae. The JTs developed from adjacent to the synovial reflection (the rim rent of Codman) and ran either parallel to the insertion of or vertical to the tendon fibres to the intratendinous lamination.

Specimen preparation

Evidence of subacromial impingement was sought at operation. A triangular or elliptical piece of full-thickness tendon containing the diseased portion was excised. Where appropriate, a specimen of the greater tuberosity and the articular cartilage near the synovial reflection was also obtained. For combined JTs and ITs, classified as JTs in this paper, an intraoperative colour test [7] was employed to locate the lesion through the bursal floor. The combined BTs and ITs are likewise grouped as BTs.

After fixation in 10% buffered formalin for 24 to 48 h and decalcification in 10% formic acid for another 24 to 48 h, the specimens were dehydrated and embedded in paraffin. The coronal sections wer stained with azan (6 to 8 μ) and haematoxylin and eosin (4 to 5 μ). The slides which showed the partial-thickness tears most clearly were examined under low magnification. Special attention was paid to the orientation of the pattern of tearing and adjacent histological changes.

Pathological findings

Bursal-side tears

All 20 BTs developed within 1 cm of the insertion of the supraspinatus tendon slightly distal to the critical portion. At the tendon insertion, local tissue disruption of the normal 4 transitional layers was observed in every case. Areas of hypervascularity were always present in the distal stumps. In 18 of 20 cases, the proximal stumps were rounded and retracted; they were avascular or hypovascular, and appeared to be covered, at least partly, with layers of fibrin-like material. Chondrocytes were dispersed throughout these avascular areas. In the intact or interrupted part of the tendon near the joint capsule, blood vessels were present (Fig. 6).

Intratendinous tears

Four specimens were obtained from pure intratendinous tears. Approximately half of the ITs co-existed with BTs or JTs. The inner surfaces of ITs were lined by a single layer of flattened cells and covered with a thin veil of fibrin-like material. The blind ends of the tears often contained necrotic areas, tissue debris, and free red cells. Granulation

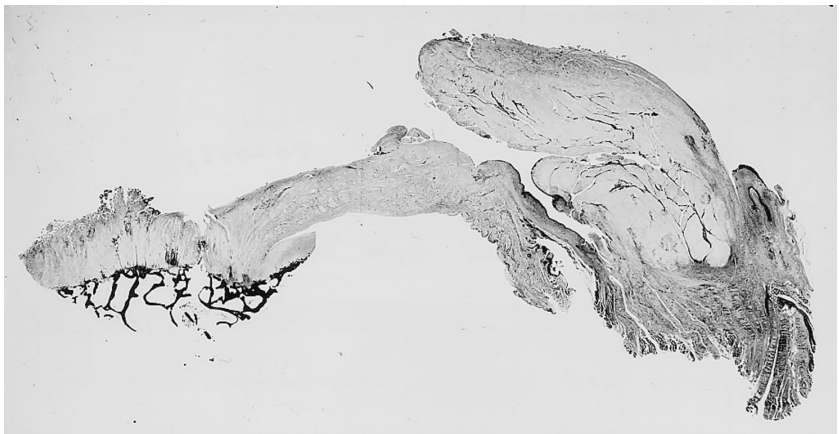

Fig. 6. A photomicrograph of resected specimen of BT in a 46-year-old woman, involving more than two-thirds of the supraspinatus tendon thickness. The proximal stump is round, hypovascular and retracted. In the distal stump, there is a disruption with areas of hypervascularity. Concomitant intratendinous lamination is partly covered by fibrin-like material. (Stain, azan; original magnification, ×0.7)

Fig. 7. A photomicrograph of resected specimen of IT in a 50-year-old man, shows that the tear continues to the local disruption of the tendon attachment by granulation. The vascularity adjacent to the torn surfaces is poor, except for the area near the attachment. (Stain, azan; original magnification, ×0.7)

Fig. 8. A photomicrograph of a JT in a 67-year-old man developing from near the synovial reflection and reaching almost four-fifths of the tendon thickness. The distal end continued to the local disruption of the insertion. (Stain, hematoxylin-eosin; original magnification, ×0.7)

tissue was seen at the site of tendon insertion in 3 cases, and the bone trabeculae around the granulations had been resorbed by osteoclasts. The vascularity on both sides of the ITs was poor, except for the areas near the tendon attachment (Fig. 7).

Joint-side tears

All JTs developed within 1 cm of the synovial reflection. The depth of the tear varied. In all cases, vascularity near the tear margin was retained. In 7 of 11 cases, continuation of tears to the local disruption of the insertion was noted (Fig. 8). Although concomitant subacromial bursitis with oedema, erosions and softening was seen in 17 of 21 patients, only non-specific microscopic evidence of bursitis was found in 6 of 11 cases. In all, 35 specimens showed non-specific subacromial bursitis with no evidence of spontaneous healing. The incidence of intratendinous tearing associated with JTs was 54.5%.

Treatment and results

Operation is indicated for partial-thickness cuff tears when conservative treatment fails and pain persists. If symptoms were present after 5 month's treatment we performed open anterior acromioplasty with excision of the damaged tendon and repair. An anterosuperior approach allows wide exposure of the supraspinatus with minimal detachment of the deltoid. BTs were readily identified, but synovial proliferation could mask the small cuff defect. To locate ITs and JTs, the critical portion and its adjacent area should be carefully palpated for a thinned segment. Puckering may be seen when milking the tendon digitally or with a probe. It may be necessary to inject dye into the glenohumeral joint [7] or incise the tendon along its fibres in order to find the concealed tear on the undersurface or within the tendon. The torn portion of the tendon was excised in an elliptical or triangular shape until healthier tissue was exposed and the sides were then oversewn side to side or to a trough in the great tuberosity with non-absorbable sutures.

Rehabilitation was started on the second postoperative day with early passive exercises to gain movement first and strength later. Active motion was begun at the 6th week. Recovery and return of full use of the arm after a successful repair required at least 12 weeks. Assessed by Neer's criteria, 62 of 66 shoulders (93.9%) were rated satisfactory at an average follow-up of 31.7 months. In 4 patients, moderate pain persisted in overhead activity.

Discussion

A new classification of subacromial impingement syndrome

The impingement syndrome encompasses a wide range of abnormality, including strain, inflammation, fibrosis, partial and full-thickness tears and, ultimately, cuff-tear arthropathy [14]. Neer felt that once impingement was established the situation would worsen and he classified the syndrome as [15]:

Stage I, reversible oedema and haemorrhage in patients under 25 years of age,
Stage II, fibrosis and tendinitis affecting the rotator cuff, typically between 25 to 40 years of age,
Stage III, bone spurs and tendon ruptures over the age of 40 years.

However, clinically, distinction between Stages I and II is often difficult and therefore Fukuda proposed a new classification based on the integrity of the cuff tendon [4]:
Grade I, subacromial bursitis and/or tendinitis ("pre-tear"),
Grade II, partial-thickness cuff tears, and
Grade III, full-thickness cuff tears.

Pre-tear is defined as the cuff which has been abraded but not torn or penetrated. Differentiation between Grades I and II may be difficult. Modern imaging technology has enabled us to detect a defect of 1 cm or more. Invasive procedures such as arthroscopy and exploration are still necessay in some cases for a definitive diagnosis. We believe that this new classification of the impingement syndrome, based on the integrity of the cuff tendon is specific and practical.

Analysis of signs and symptoms of impingement syndrome

Pain is the most prominent symptom. Of the 3 subtypes of partial-thickness cuff tears, we found that BTs were the most painful (Table 2). This is because of the bursal sensitivity to inflammation and impingement. The physical signs and symptoms can be categorized into two groups, those caused mainly by the inflammation of subacromial bursitis and tendinitis (Category A) and those mainly due to the torn tendon (Category B). Category A may include many kinds of pain, the fluid sign, the arc of pain, the impingement sign and procaine test, and contracture; included in Category B are the drop arm sign, crepitus, muscle weakness and the atrophy of the spinati (Table 3).

Table 3. Analysis of signs and symptoms of subacromial impingement syndrome

Those caused by inflammation (Category A)	Those caused by torn tendon (Category B)
Pain	Drop arm sign
Fluid sign	Crepitus
Arc of pain	Muscle weakness
Impingement sign	Spinati atrophy
Procaine test	
Contracture	

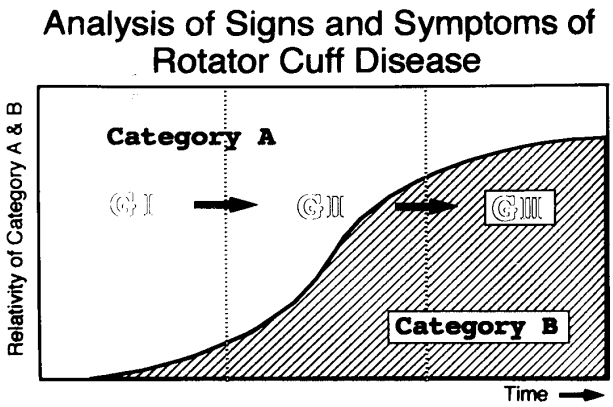

Fig. 9. A schematical figure showing how the signs and symptoms, categorized as *A* and *B* (see text) are distributed in the spectrum of subacromial impingement syndrome. Category *A* relates closely to Stage I and Grade I, and Category *B* to Stage III and Grade III. Both Categories *A* and *B* may coexist in a given patient, and their balance has implications in the choice of treatment

Category A relates totally to Stage I and Grade I and Category B to Stage III and Grade III (Fig. 9). Both Categories A and B may be experienced by the patient, and their relative balance may influence the choice of conservative or surgical treatment.

Is there spontaneous healing in the partial-thickness cuff tear?

Codman's assertion that spontaneous healing occurred [1] was not substantiated by histological evidence. In our series of 35 en bloc histological sections, and in our previous studies on BTs [6] and ITs [8], no active repair was seen in any portion examined. Hamada et al demonstrated positive signs of mRNA of procollagen α 1 type I, a precursor of collagen type 1, in the stumps of partial-thickness cuff tears [10]. In spite of this interesting finding on the molecular level, spontaneous healing appears clinically unlikely because of the physical separation of the stump ends, avascularity of the site of the tear and subacromial impingement.

Treatment

Treatment depends on accurate recognition of the abnormality. If spontaneous tendon healing is unlikely, operation is required. However, conservative therapy has "cured" many cases of arthrographically verified full-thickness tears of the cuff. If Category A symptoms subside, or if

Category B problems are compensated by the residual cuff and intrinsic muscles, then the patient is clinically "cured". Conservative treatment is often suitable for Category A symptoms. If pain relief is achieved within a couple of months, muscle exercises are then prescribed to regain scapulohumeral rhythm. However, if pain persists, and/or Category B symptoms continue, surgical repair is indicated in patients with notable disability. About 40% of JTs responded favourably to conservative therapy but BTs did poorly. We therefore operate on BTs as soon as the diagnosis is established.

Anterior acromioplasty, whether open, mini-open or arthroscopic, has become the standard procedure to achieve subacromial decompression [11, 15, 18]. Different opinions exist as to the management of cuff tears. We recommend an open procedure with acromioplasty and tenorrhaphy after excision of the diseased portion. By this method, good tendon repair and anchoring can be accomplished, decompression is reinforced by tenorrhaphy, excision enhances tissue repair, progression of the tear can be prevented by a good repair, concomitant intratendinous lamination can be treated and tendon surgery can be achieved with the same exposure with minimal risk. Neer [16] treated the partial-thickness cuff tears with anterior acromioplasty alone; when the tendon was thin, with a probability of a full-thickness tear, he undertook repair. Ellman [2] developed arthroscopic subacromial decompression (ASD) and in 1985 reported 15 satisfactory results out of 20; 5 required additional surgery. Gartsman [9] showed that ASD was effective for chronic tendinitis and partial-thickness tears, obtaining good to excellent results in 85% of patients at an average follow-up of 29 months. However, Ogilvie-Harris et al. [17] achieved satisfactory results in only half of 57 such patients with arthroscopic debridement alone.

Intratendinous lamination

Yamanaka and Fukuda [19] studied 249 specimens of the supraspinatus tendon and noted partial-thickness tears in 33 (13%) of which 6 (2.4%) were BTs, eight (3.6%) were JTs and 18 (7.2%) were ITs. In clinical practice, intratendinous laminations were associated with approximately 50% of BTs and JTs. Such laminations are also frequently found in full-thickness tears and if they are extensive, the repair may become difficult. Nakajima et al. [13] found that the histological and biomechanical properties of the superficial (bursal) and deep (articular) tendon layers were different. The bursal layers, composed primarily of tendon bundles, elongate to a tensile load, and are resistant to rupture, whilst the articular layers, a complex of tendon, ligament and joint capsule, are unstretchable and tear easily. They suggest that intratendinous lamination is caused by the shear within the supraspinatus tendon.

At operation, all torn and degenerated marginal tissues are excised, which sometimes causes a large defect. The repair of this debrided defect by suturing both superficial and deep layers together has not always been satisfactory in our experience. If one layer has to be excised, it should the articular layer, because it is usually contracted and structurally weaker than the superficial layer. The extensive intratendinous lamination in the rotator cuff remains an unsolved therapeutic problem.

Conclusions

Partial-thickness tears of the rotator cuff are not rare but have been poorly defined. This important cause of shoulder disability has three subtypes, namely bursal-side, intratendinous, and joint-side tears, and they occupy a prominent place in the subacromial impingement syndrome. The clinical diagnosis is often difficult, and has been mistaken for periarthritis, bursitis, tendonitis, bicipital tenosynovitis or frozen shoulder. Arthrography, arthroscopy, bursography, ultrasonography and MRI are available for accurate diagnosis. When conservative treatment for three to six months has failed, operation is indicated. We recommend a combined procedure of anterior acromioplasty and subsequent tenorrhaphy after excision of the torn portion of the tendon.

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