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Surgical treatment for large and massive tears of the rotator cuff

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Abstract Patients with a large or massive tear of the rotator cuff were, when possible, treated with the McLaughlin procedure. A patch graft was used when it was impossible to perform this procedure. The patch group (group P) consisted of nine patients with nine shoulders (six men, three women) with a mean age of 62.8 ± 6.9 years. The McLaughlin group (group M) consisted of 12 patients with 12 shoulders (ten men, two women) with a mean age of 52.3 ± 8.6 years. Mean follow-up was 2 years 11 months in group P and 4 years 2 months in group M. Using the shoulder scoring system of the Japanese Orthopaedic Association (JOA score), the total score improved post-operatively in both groups. In group P, the post-operative score was 91.7 (pre-operative score 47.9) and in group M 92.0 (pre-operative score 54.2). Tears recurred in three shoulders within 2 months of the McLaughlin procedure, and these patients were excluded from the study. The rate of 're-tearing' was lower with a patch graft (0/13) than with the McLaughlin procedure (3/17).

Résumé Des malades avec une large déchirure de la coiffe des rotateurs furent traités soit par le procédé de McLaughlin quand c'était possible soit par une greffe en patch. Le groupe avec greffe (groupe P) était constitué de 9 épaules chez 9 malades (6 hommes, 3 femmes) avec un âge moyen de 62.8 ± 6.9 années. Le groupe McLaughlin (groupe M) comportait 12 épaules chez 12 malades (10 hommes, 2 femmes) avec un âge moyen de 52.3 ± 8.6 années. Le suivi moyen était de 35 mois dans le groupe P, et 50 mois dans le groupe M. En utilisant le système de cotation de l'épaule de l'Association Orthopédique Japonaise (JOA score), le score total a été amélioré en postopératoire dans les deux groupes. Dans le groupe P le score postopératoire était 91.7 (47.9 avant l'opération) et dans

le groupe M le score postopératoire était 92.0 (54.2 avant l'opération). Les déchirures ont récidivés dans 3 épaules dans les 2 mois suivant le procédé de McLaughlin et ces malades a été exclus de l'étude. Le taux de récurrence était plus faible avec une greffe en patch (0/13) qu'avec la méthode de McLaughlin (3/17).

Introduction

The use of various surgical procedures has been reported for large or massive rotator cuff tears, and these include the McLaughlin (McL) procedure [7]; transfer of the subscapularis [2], supraspinatus [4], infraspinatus [9], teres minor [12], deltoid [16] or latissimus dorsi muscle [5]; and use of the long head of the biceps tendon [10] or of the fascia lata [6]. There are also reports of successful results obtained with freeze-dried allografts [11] and with patch grafts (PG), in which the rotator cuff defect is closed with a synthetic material such as Teflon, Marlex or GorTex [14].

Our preferred option for the repair of large and massive tears is to attach the end of the cuff to the anatomical portion of the humeral head. If this is impossible, an allograft is used to close the defect. The purpose of this study was to compare the results of two different methods of surgical treatment for large rotator cuff tears: the McL and PG procedures.

Materials and methods

Sixty-five patients received surgical treatment for rotator cuff tears at Yokohama Municipal Citizen's Hospital between 1983 and 1997. There were 28 patients (30 shoulders) with large or massive tears. Twenty-one shoulders in 21 patients were available for clinical assessment more than 2 years after surgery. Mean age of these 21 patients was 52.3 ± 8.6 (range: 36–70) years. Mean follow-up period after surgery was 3 years 8 months (range: 2–8.42 years).

Diagnosis was based on history and clinical findings together with the results of pneumo-arthrographic and MRI investigations. Patients who continued to experience pain and loss of function after conservative rehabilitation therapy were treated surgically.

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Table 1 Pre-operative and post-operative mean Japanese Orthopaedic Association (JOA) scores in the patch group (P) and the McLaughlin group (M)

	Pre-operation	Post-operation
Pain (30 points)	10.0±5.6 (P) 9.2±2.9 (M)	27.8±3.6* (P) 28.3±3.3** (M)
Function (20 points)	9.1±5.5 (P) 10.7±4.0 (M)	18.4±2.3* (P) 18.9±2.8** (M)
Range of motion (30 points)	16.2±6.2 (P) 15.9±5.0 (M)	26.7±2.7* (P) 25.4±4.2** (M)
Roentgenographic evaluation (5 points)	3.2±1.6 (P) 4.3±1.0 (M)	4.3±0.9 (P) 4.2±0.9 (M)
Joint stability (15 points)	10.0±6.6 (P) 14.2±2.9 (M)	15.0±0.0 (P) 15.0±0.0 (M)
Total (100 points)	47.9±13.3 (P) 54.2±9.7 (M)	91.7±7.0* (P) 92.0±7.6** (M)

* $p < 0.01$ versus pre-operative mean score by Wilcoxon signed rank test

** $p < 0.005$ versus pre-operative mean score by Wilcoxon signed rank test

Arthrography was performed in all patients prior to surgery, and MRI was performed in some patients.

The size of the tear was measured during the surgical procedure and was based on the Cofield and Lanzer classification [3]: small tears (less than 1 cm), moderate tears (1–3 cm), large tears (3–5 cm) and massive tears (5 cm or greater and with two or more tendons involved).

Patients were divided into two groups: those treated with the McL procedure (group M) and those treated with a PG (group P). In group M, the margin of the rotator cuff was attached to the ‘anatomical insertion’ at the humeral head. In group P, a PG was placed between the margin of the rotator cuff and the anatomical insertion at the humeral head in order to avoid excessive tension. Three patients (three shoulders) experienced ‘re-tearing’ during rehabilitation after the McL procedure and subsequently received a PG. These three patients were included in the calculation of the success rate but excluded from follow-up assessments using the rating score.

Group P consisted of nine shoulders in nine patients (six men, three women) with a mean age of 62.8±6.9 (range: 49–70) years. Group M consisted of 12 shoulders in 12 patients (ten men, two women) with a mean age of 52.3±8.6 (range: 36–66) years. Mean follow-up period after surgery was 2 years 11 months (range: 2–4.165 years) for group P and 4 years 2 months (range: 2–8.42 years) for group M. There were four large tears and five massive tears in group P, and eight large tears and four massive tears in group M.

The mean time between injury or onset of symptoms and surgery was 4.1±2.9 months for group P and 5.8±4.7 months for group M and was not significantly different.

Operative technique

Patients were placed in the beach-chair position, and the upper limbs were placed on the torso so that they could be moved freely as required. Under general anesthesia, a skin incision about 4 cm long was made distally from the acromion in the direction of the deltoid muscle fibres. These fibres were separated vertically, the synovial bursa was incised, and the condition of the rotator cuff was noted. The coracoacromial ligament was excised, and the inferior surface of the acromion was ‘decompressed’. The ruptured portion of the cuff was freshened, and a groove was made in the humeral head on the medial side of the greater tuberosity adjacent to the articular surface. The torn cuff tendon was fixed into this groove using three sutures that were passed through four drill holes in the greater tuberosity, fixing the end of the cuff to the groove without extreme tension on the sutures. If this was impossible, a PG was placed between the end of the cuff and the groove. The position of the limb at the time of attachment was 60°–70° of abduction and 45° of horizontal flexion with neutral rotation. Where a gap remained even after the cuff had been mobilized, or when there was excessive tension on the sutured portion, a PG was used. These PGs consisted of a double layer of fascia lata (allografts of freeze-dried fascia lata: Biodynamics, Germany) be-

cause a single layer appeared thin in comparison with the thickness of the rotator cuff.

After the operation, airbags were used to maintain the shoulder in an abducted position for 5 weeks. Passive exercises were started on the first post-operative day and included flexion and abduction as well as internal and external rotation. After 5 weeks, active exercises were encouraged.

Assessment

Factors included in the study were clinical findings and range of motion. To assess the results, each patient was scored according to the shoulder scoring system of the Japanese Orthopaedic Association (JOA score) both pre-operatively and post-operatively.

Statistical analysis

Statistical analysis was performed using the paired *t*-test and the Wilcoxon signed rank test. The paired *t*-test was used for analysis of the significance of the range of motion. The Wilcoxon signed rank test was used for analysis of the significance of the JOA scores. A *p* value of less than 0.05 was considered statistically significant.

Results

Clinical assessment (JOA score)

Total scores were 91.7 (post-operatively) and 47.9 (pre-operatively) in group P ($p=0.0077$, Wilcoxon signed rank test) and 92.0 (post-operatively), and 54.2 (pre-operatively) in group M ($p=0.0022$, Wilcoxon signed rank test) as shown in Table 1.

In group P, there was complete elimination of pain (30 points) in six of the nine patients (67%), and in group M, there was no pain in nine of the 12 patients (75%) (Table 2).

For both groups, improvement in acute pain and function were nearly the same—pain in group P: $p=0.0059$ and in group M: $p=0.0017$; function in group P: $p=0.0076$ and in group M: $p=0.0022$ (Table 1). There was significant improvement in the range of motion score for both groups (group P: $p=0.0076$, group M: $p=0.0021$, Wilcoxon signed rank test). Although there was a slight difference in the pre-operative score at the radiographic assessment, the post-operative scores for

Table 2 Number of shoulders with each pre-operative and post-operative pain score of the shoulder rating scale of the Japanese Orthopaedic Association (JOA). ADL activities of daily living

Pain	Scores	Patch group Pre-op.	Patch group Post-op.	McLaughlin group Pre-op.	McLaughlin group Post-op.
None	30	0	6	0	9
Tenderness/minimal pain during sport or heavy labour	25	0	2	0	2
Minimal pain during light work	20	1	1	0	1
Minimal pain in ADL	15	1	0	1	0
Moderate and tolerable pain (analgesia; occasional night pain)	10	5	0	8	0
Severe pain (ADL limited, frequent night pain)	5	1	0	3	0
Totally incapacitated (pain)	0	1	0	0	0

Table 3 Pre-operative and post-operative mean active range of motion of the shoulder in flexion, abduction and external rotation. P patch group; M McLaughlin Group

	Pre-op. (P)	Post-op. (P)	Pre-op. (M)	Post-op. (M)
Flexion	84.4±32.4	159.6±14.8*	94.6±43.9	145.8±27.1*
Abduction	62.2±31.1	163.3±28.7*	85.0±43.9	146.4±27.1*
External rotation	43.9±16.9	41.7±24.7	36.3±44.6	35.4±37.8

* $p < 0.005$ versus pre-operative mean active motion by paired t -test

the two groups were nearly the same, as were post-operative scores for stability (Table 1).

Range of motion

Flexion and abduction improved after the operation in both groups: flexion in group P: $p = 0.0005$, abduction in group P: $p = 0.0007$; flexion in group M: $p = 0.0032$, abduction in group M: $p = 0.0019$, paired t -test. However, there was no improvement in external rotation in either group (Table 3).

Rates of re-tearing during rehabilitation and other complications

Following surgery, there were examples of re-tearing during rehabilitation. This was diagnosed from clinical symptoms such as pain and the 'drop-arm' sign. In patients with these symptoms, re-tearing was confirmed by pneumo-arthrographic and MRI findings. This means that any 'concealed' tears without clinical symptoms were evaluated as no re-tearing clinically. The cases of re-tearing were considered to be failures and were not included in the assessment of scores. All of these three failures followed use of the McL procedure. Overall failure rate in the 30 patients who underwent surgery between 1983 and 1997 was 10% (3/30). Failure rate for the McL procedure was 18% (3/17) and for the PG group was 0% (0/13). Symptoms of re-tearing appeared within 2 months of the operation. There were no other complications such as infection or neuroparalysis.

Discussion

During rotator cuff repair at our hospital, the rotator cuff is fixed to the anatomical portion of the humeral head. However, for patients in whom it is difficult to pull out the cuff, or if there is excessive tension on the sutured portion, a graft is used to achieve continuity from the rotator cuff to the humeral head.

In JOA score evaluations, there was no difference in the results of the two groups, but there were three cases of re-tearing after surgery with the McL procedure. This is believed to have occurred because there was excessive tension on the rotator cuff when it was attached to the head of the humerus, or the degenerated portions of the rotator cuff were not fully resected, or as a result of bone atrophy at the attachment points.

One method of repair that does not use grafts on the sutures of the cuff is to make a trough in the bone at the point where the rotator cuff can be brought into contact with the humerus. Nobuhara et al. have reported treatment of massive tears with 93% "excellent" or "good" post-operative scores and no re-tearing [13]. Burkhart et al. performed partial repair and reported that good recovery was achieved even when there was a defect averaging 1×3 cm remaining in the cuff after surgery [1]. However these reports [1, 13] did not describe the angle of abduction. In our own study, excluding the three cases of re-tearing, good results were obtained with regard to eliminating pain and restoring range of motion.

Reports on treatment methods that make use of grafts include studies of dried allografts [8, 11], Teflon and GorTex [14]. Neviasser et al. reported that 12 of 16 patients treated with freeze-dried allografts achieved "excellent" or "good" post-operative scores [11], while

Nasca et al. reported that pain was eliminated in five of seven cases [8]. For Teflon grafts, Ozaki et al. reported that 23 of 25 cases remained completely free of pain through follow-up periods that averaged 2.1 years after surgery [14]. Paulos et al. studied the use of GorTex grafts, reporting one "excellent" and four "good" scores for five cases at an average of 43.2 months after the procedure [15]. In our results, pain was completely eliminated in six of nine cases with no evidence of re-tearing.

In contrast, unsatisfactory results were reported in two of 16 patients by Neviasser et al. [11] and in two of seven by Nasca et al. [8]; however, in these cases the allografts were applied as a single layer. In our study, a double layer was used, which is believed to increase mechanical resistance thus making it possible to achieve good results.

Ozaki et al. reported improvement in active abduction in patients treated with Teflon grafts: 21 of 25 patients with 0–30° of abduction before surgery, 16 regained full function and seven achieved a range of motion of 120–140° [14]. We also obtained good improvement in both flexion and abduction, suggesting that using grafts to close cuff defects due to large or massive tears is important for obtaining improvements in motion.

For cases in which a patch was used, it is assumed that there was a decrease in abductor strength and in the abduction range of motion since the supraspinatus muscle grafted with the patch was atrophic and unlikely to contract with abduction of the upper limb. However, clinical results in this study revealed no difference in abduction range of motion between the groups. According to the results, closure of a cuff-tear defect and covering the glenohumeral joint provide good function, even in the presence of rotator cuff muscle atrophy.

Bases on this study, PGs are considered to have the advantages of achieving anatomical repair with minimal restriction of range of motion and minimal occurrence of re-tearing.

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