Surgical Procedure and Results of Repair of Massive Tears of the Rotator Cuff

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One hundred eighty-seven patients (189 shoulders) were treated surgically between 1970 and 1992 for massive rotator cuff tears using either a tendon-to-tendon repair or the McLaughlin procedure. The age of the patients ranged from 20 to 86 years; 95% of them were 45 years or older. The average followup was 6 years 9 months. Excellent or good functional results were attained in 93% of patients. Thirty-three percent of those who underwent tendon to tendon repair complained of pain after overuse compared with only 18% who had the McLaughlin Procedure.

Massive tear of the rotator cuff usually occurs in elderly people whose shoulders have unquestionable evidence of degenerative changes in the rotator cuff. In general, a longitudinal split between the supraspinatus and the subscapularis occurs, the external rotators are torn from the humeral head, and all components of the rotator cuff are retracted. Rupture of the long head of the biceps is often seen. Whereas repair of a fresh, massive tear of the rotator cuff caused by severe injury is rather easy, a complete repair of chronic or neglected massive tears with degenerated and retracted tendons is always difficult to perform.

Since 1970, 573 patients (602 shoulders) with rotator cuff tears have been repaired in the Nobuhara hospital, of which 187 patients (189 shoulders) had massive tears. The purpose of this paper is to analyze the results of repair, and to evaluate the techniques used and the limits of their suitability.

DEFINITION OF MASSIVE TEAR

Massive tears of the rotator cuff may be diagnosed by their configuration or by the diameter of the tear, but neither of these methods present an accurate picture. It is believed that a better parameter of the degree of exposure of the humeral head is made from the numerical value obtained by multiplying the length (L) of the avulsed tendon insertion by the height (H) of the torn portion. In this study, the numerical value of a massive tear is considered to be 5.5 cm or greater. This includes (1) tear of two or more tendons; (2) tear in which the diameter of the exposed portion of the humeral head is 3 cm or more; and (3) tear with a perimeter of 9 cm or more (Fig 1).
CRITERIA OF MASSIVE TEAR
IN NORUZABA HOSPITAL

\[ H \times L > 5.6 \]

\[
\begin{array}{c|ccc}
 L & 2 & 2.4 & 3 \\
 2 & 4 & 4.8 & 6 \\
 2.4 & 4.8 & 5.8 & 7.2 \\
 3 & 6 & 7.2 & 9 \\
\end{array}
\]

(cm)

Fig 1. Criteria of massive tear of the rotator cuff.

SUBJECTS

One hundred eighty-nine massive tears of the rotator cuff in 187 patients (143 men, 44 women) were treated surgically from 1970 to 1992. The age of the patients ranged from 20 to 86 years; 95% were older than 45 years old. Most tears occurred on the dominant side. The average time elapsed before surgery was 8.3 months. Trauma was involved in 125 patients (67%), of which 47 (25%) were related to severe trauma, followed by minor injury and/or overuse.

The 189 shoulders were divided into two groups: 153 with degeneration of the rotator cuff and 36 without degeneration. Classification of degeneration was based mainly on macroscopic findings obtained at surgery. However, in some instances microscopic findings had to be used to arrive at a proper classification. The age difference between the two groups was 10 years, with retracted tears being present in 86% of the degenerative group and 67% in the nondegenerative group (Fig 2). A tear of the supraspinatus tendon was present in almost all patients, and in 96% the infraspinatus tendon was involved followed by a tear of the teres minor (34%) and the subscapularis tendons (28%). However, a tear of the long head of the biceps tendon, which was thought to be frequent, was only present in 17 patients (9.1%) (Fig 3). In the group without degeneration, the tears were seen mostly anteriorly in the supraspinatus, the subscapularis tendon, and the infraspinatus. In the group with degeneration, the tears tended to extend posteriorly, frequently affecting the teres minor tendon (Table 1; Fig 4).

SURGICAL PROCEDURE

The McLaughlin procedure was used in most cases. The torn tendon end was anchored directly to the humeral head. To keep the gap between the tendons to a minimum, and to avoid excessive tension on the tendons, the following measures were employed: (a) patching the gap using the fascia

Fig 2. Graph shows the relationship between the age and the presence or absence of degeneration.
of the deep surface of the deltoid muscle; (b) medialization of the reinsertion of the rotator cuff; and (c) use of a flattened long head of the biceps tendon (Table 2).\(^4\)

In instances of fresh trauma, even when the retraction was fairly severe, the torn tendon end could be easily returned to its original position by threading a few silk sutures through the stump and pulling on them (Figs 4A–4C). On the other hand, repair of chronic tears was often difficult as the torn tendon had always retracted, completely exposing the humeral head; degeneration of the rotator cuff was severe. In these instances, repair by simple procedures was impossible and the prediction of functional results after surgery difficult. Even under these circumstances, it seemed inadvisable to select another procedure immediately. Rather, several silk sutures were threaded through the supraspinatus tendon lying below the acromion, the infraspinatus tendon, the teres minor tendon, and the subscapularis tendon, all helping to identify their relative position. Then the silk threads were pulled slowly and were tightened while all adhesions on the surface of the rotator cuff were simultaneously released by blunt dissection. This procedure was repeated many times, allowing the torn tendon ends to be repositioned. Finally all four components of the rotator cuff were reinserted in line with the direction of their fibers (Fig 5).

In massive tears of the rotator cuff, the gap resembled a run in a stocking, and the direction of the fibers was hard to determine. If the torn tendon end of the supraspinatus was pulled to the center of the humeral head, it could be overlapped sufficiently with the help of simultaneously applied downward traction to the upper limb. When the anterior portion was pulled posteriorly and the posterior portion anteriorly, a fair amount of the gap was covered. The degree of tension was checked first before a groove was made in a suitable place.

### POSTOPERATIVE MANAGEMENT

Postoperatively, skin traction with the upper limb in zero position was applied for 5 days. Then, the patient was placed in a shoulder spica cast in the same position for a period of 3 to 4 weeks. The rehabilitation program started while the patient was in the spica

### TABLE 1. Relation Between Degeneration and Retraction

<table>
<thead>
<tr>
<th>Degeneration</th>
<th>Retraction</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>130</td>
</tr>
<tr>
<td>+</td>
<td>–</td>
<td>21</td>
</tr>
<tr>
<td>–</td>
<td>+</td>
<td>24</td>
</tr>
<tr>
<td>–</td>
<td>–</td>
<td>12</td>
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</table>
cast. On the 3rd day, the upper part of the cast was bivalved, and forward elevation exercises were performed vigorously. Four weeks later, the cast was removed to assess recovery of the shoulder muscles.

RESULTS

A completely watertight repair was achieved in 82%, whereas the repair was sufficient but not watertight in 33 shoulders, or 18%. In two patients covering could not be achieved. In the second group, where the repair was not watertight, additional methods were employed such as patching over the defect with the deep layer of the deltoid fascia, or using the flattened long head of the biceps tendon.

Complications were observed during the time in the spica cast, such as dislocation of the shoulder in three instances and nerve palsy in 17 instances (4 radial, 2 axillary and 11 ulnar nerves). The three dislocations were reduced immediately, and the head gear fixation (a special contraption worn as a hat to which the wrist can be attached with a strap) in the 90–60–30 position was employed instead of a spica cast. Seventeen
TABLE 2. Surgical Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Number</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>McLaughlin’s procedure</td>
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<td>85</td>
</tr>
<tr>
<td>Tendon to tendon</td>
<td>27</td>
<td>14</td>
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<tr>
<td>Tenotransfer</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Additional methods</td>
<td></td>
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<tr>
<td>Patching using deltoid fascia</td>
<td>10</td>
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<tr>
<td>Use of LHB tendon</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Preparation of a suitable groove</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

LHB = long head of the biceps tendon.

patients having a nerve palsy were treated with low frequency stimulation while in the same fixation. However, all complications improved and recovered within 3 months.

FOLLOWUP STUDIES

One hundred eighty-seven patients underwent followup evaluation. The average time interval between surgery and followup was 9 months. Excellent or good functional results were obtained in 177 (97%) patients. In 136 patients (73%) the muscle power was restored to almost normal. Forty-six patients who had severe atrophy of the infraspinatus did not recover. A search for the causes of this negative outcome revealed that these patients were older than the overall average, and that the time elapsed between tear and surgery was twice as long as in the others. One hundred forty-four patients (77%) were completely free of pain. However, analysis on the 39 patients with pain on motion, pain at certain positions of the upper limb, or pain after overuse showed that 33 of them were heavy laborers who continued to work in the same field as before the injury. Moreover, their tears were associated with soft tissue injuries at the same time. The average length of time elapsed between tear and surgery was 13 months. Thus, many tears were chronic or inveterate. Pain on exertion was reported by 33% of the patients where end to end tendon sutures were performed, as compared with only 18% in patients where the McLaughlin technique was performed.

DISCUSSION

The authors’ experience suggests that a tendon to bone anchorage gives results superior to tendon to tendon suture. However, of the 34 patients in whom overlap was sufficient, pain on motion was observed in 8 as compared with 15 of the 68 patients in whom tension of the rotator cuff was too high after repair. These low ratios suggest that an interdependence between pain and the degree of overlap or the amount of tension in the rotator cuff does not exist.

In massive tears, the subdeltoid bursa communicates with the glenohumeral joint. As a result, because of leakage of joint fluid, a flat curve of intracapsular pressure can be seen. The authors have observed, in some instances, a remarkable postoperative increase in intracapsular pressure, with values similar to normal. The technique of rotator cuff repair plays an important role in the restoration of a normal intracapsular pressure. Watertight coverage of the humeral head should be attempted at all times to maintain a normal level of intracapsular pressure. Restoration of the normal relationship between the humeral head and the glenoid can also be attained by a meticulous

Figs 5A and 5B. (A) Directions of the fibers in each ruptured tendon (arrow). (B) How to repair the tendons and how to prepare a suitable groove. (LHB = long head of the biceps.)
repair. This study also demonstrates that a
diligent rehabilitation program must be in-
cluded in the postoperative treatment regi-
men, and that the rotators of the shoulder
must be strengthened to ensure restoration
of function.

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