Arthroscopic synovectomy, removal of loose bodies and selective biceps tenodesis for synovial chondromatosis of the shoulder

J. V. Lunn, J. Castellanos-Rosas, G. Walch

From Centre Orthopédique Santy, Lyon, France

We retrospectively identified 18 consecutive patients with synovial chondromatosis of the shoulder who had arthroscopic treatment between 1989 and 2004. Of these, 15 were available for review at a mean follow-up of 5.3 years (2.3 to 16.5). There were seven patients with primary synovial chondromatosis, but for the remainder, the condition was a result of secondary causes. The mean Constant score showed that pain and activities of daily living were the most affected categories, being only 57% and 65% of the values of the normal side. Surgery resulted in a significant improvement in the mean Constant score in these domains from 8.9 (4 to 15) to 11.3 (2 to 15) and from 12.9 (5 to 20) to 18.7 (11 to 20), respectively (unpaired t-test, p = 0.04 and p < 0.0001, respectively). Movement and strength were not significantly affected. Osteoarthritis was present in eight patients at presentation and in 11 at the final review. Recurrence of the disease with new loose bodies occurred in two patients from the primary group at an interval of three and 12 years post-operatively. In nine patients, loose bodies were also present in the bicipital groove; seven of these underwent an open bicipital debridement and tenodesis.

We found that arthroscopic debridement of the glenohumeral joint and open debridement and tenodesis of the long head of biceps, when indicated, are safe and effective in relieving symptoms at medium-term review.

Synovial chondromatosis is a condition which may affect any cavity which is lined with synovium. It is characterised by osteocartilaginous loose bodies, is typically monoarticular and has been reported in tendon sheaths, bursae and numerous diarthroidal joints, most often affecting the knee. Around the shoulder, synovial chondromatosis has been described in the subacromial bursa, both in patients with an intact rotator cuff, in the acromioclavicular joint and in the glenohumeral joint as case reports or part of larger series. The involvement of the bicipital tendon sheath in patients with glenohumeral synovial chondromatosis has been reported in isolated cases.

Synovial osteochondromatosis has been classified by Milgram into three categories: 1) loose bodies arising from osteochondral fractures; 2) degenerative arthritis or avascular necrosis (AVN) leading to fragmentation of the joint surface and/or fractured osteophytes; 3) primary synovial osteochondromatosis. The latter is distinct from the other causes in that it arises from a primary metaplasia of the synovial membrane to produce cartilage-forming chondrocytes. Milgram described the metaplasia as having three phases: initially confined to the synovium; before progression to an active synovium with loose bodies; and a final late stage with an inactive synovium but residual intra-articular loose bodies.

Loose bodies within the joint from all causes have the potential for continued growth. In primary synovial chondromatosis, this results from a proliferation of chondrocytes. In secondary synovial chondromatosis, arising from a central nidus, such as a fragment from an osteochondral fracture, enlargement is caused by a proliferation of connective-tissue cells and subsequent cartilaginous metaplasia.

Our aim was to report the mode of presentation of synovial chondromatosis of the shoulder and the outcome after arthroscopic debridement and synovectomy with or without open biceps tenodesis with regard to the development of arthritis, the recurrence of loose bodies in the glenohumeral joint and the influence of loose bodies in the bicipital groove.

Patients and Methods

We retrospectively identified 18 patients who had undergone arthroscopic surgery for syn-
Table I. Clinical details of the patients with synovial osteochondromatosis

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age at presentation (yrs)</th>
<th>Gender</th>
<th>Shoulder trauma</th>
<th>Interval from trauma/symptomatic onset to first operation (yrs)</th>
<th>Loose bodies in bicipital groove at presentation</th>
<th>Procedures</th>
<th>Grade of arthritis at follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>M</td>
<td>No</td>
<td>0.0/5.3</td>
<td>No</td>
<td>Arthroscopic removal loose bodies Anterior release No synovectomy or tenodesis</td>
<td>Severe</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>F</td>
<td>No</td>
<td>0.0/8.0</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies + synovectomy Arthroscopic removal loose bodies + synovectomy Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>M</td>
<td>Fall on shoulder</td>
<td>1.9/1.1</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies No synovectomy or tenodesis</td>
<td>Moderate</td>
</tr>
<tr>
<td>4</td>
<td>42</td>
<td>M</td>
<td>Anterior dislocation</td>
<td>20.6/2.2</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>Severe</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
<td>M</td>
<td>Anterior dislocation</td>
<td>17.7/1.2</td>
<td>No</td>
<td>Arthroscopic removal loose bodies Synovectomy</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>27</td>
<td>F</td>
<td>No</td>
<td>0.0/0.6</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>Mild</td>
</tr>
<tr>
<td>7</td>
<td>33</td>
<td>F</td>
<td>Fractured shoulder aged 6 yrs</td>
<td>38.5/11.5</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>Severe</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>F</td>
<td>No</td>
<td>0.0/0.6</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>Mild</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>M</td>
<td>Dislocated acromioclavicular joint</td>
<td>0.5/2.0</td>
<td>No</td>
<td>Arthroscopic removal loose bodies No synovectomy or tenodesis Arthroscopic removal loose bodies No synovectomy or tenodesis</td>
<td>Mild</td>
</tr>
<tr>
<td>10</td>
<td>34</td>
<td>F</td>
<td>No</td>
<td>0.0/0.9</td>
<td>No</td>
<td>Arthroscopic removal loose bodies Synovectomy, no tenodesis</td>
<td>None</td>
</tr>
<tr>
<td>11</td>
<td>18</td>
<td>F</td>
<td>No</td>
<td>0.0/1.4</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>None</td>
</tr>
<tr>
<td>12</td>
<td>49</td>
<td>M</td>
<td>Anterior dislocation</td>
<td>24.1/0.1</td>
<td>No</td>
<td>Arthroscopic removal loose bodies Synovectomy, no tenodesis</td>
<td>Moderate</td>
</tr>
<tr>
<td>13</td>
<td>19</td>
<td>F</td>
<td>No</td>
<td>0.05/0.5</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies No synovectomy or tenodesis Arthroscopic removal loose bodies Synovectomy, no tenodesis Arthroscopic loose bodies + synovectomy of the shoulder joint and biceps tendon No tenodesis</td>
<td>Mild</td>
</tr>
<tr>
<td>14</td>
<td>47</td>
<td>M</td>
<td>Anterior dislocation</td>
<td>18.2/2.2</td>
<td>No</td>
<td>Arthroscopic removal loose bodies Synovectomy, no tenodesis</td>
<td>None</td>
</tr>
<tr>
<td>15</td>
<td>41</td>
<td>M</td>
<td>Anterior dislocation</td>
<td>28.7/5.7</td>
<td>Yes</td>
<td>Arthroscopic removal loose bodies Synovectomy and tenodesis</td>
<td>Severe</td>
</tr>
</tbody>
</table>
Arthroscopic treatment for synovial chondromatosis of the shoulder between 1989 and 2004 by the senior author (GW). Patients who had loose bodies secondary to osteoarthritis (OA) or inflammatory arthritis were excluded. Four patients had undergone their initial surgery at a different institution. We were able to review 15 patients. Three had been lost to follow-up. The mean follow-up of the available patients was 5.3 years (2.3 to 16.5) after shoulder arthroscopy. There were eight men and seven women. The dominant arm was involved in ten and the non-dominant in five patients and all had isolated uniarticular disease. Histological analysis was carried out on all patients except four who had loose bodies present after anterior dislocation, with the diagnosis being made on clinical grounds. The seven patients who presented with primary synovial chondromatosis had a mean age at onset of 25 years (18 to 40). The eight patients with secondary synovial chondromatosis had a mean age at onset of 38 years (20 to 42; Table I). Of those with secondary synovial chondromatosis, six had a history of recurrent anterior dislocation of the shoulder which began at a mean of 18.5 years (1.9 to 28.7) before presentation. Of the remaining two patients with secondary chondromatosis, one had fractured her shoulder as a child and the other had undergone operative treatment of a grade-3 acromioclavicular dislocation five years prior to presentation.

All patients had been clinically assessed at initial presentation. Constant scores26 for both shoulders were obtained prospectively on 13 patients and calculated from inspection of the clinical notes in two. All patients had pain at presentation with the exception of one who was diagnosed incidentally because of a chance X-ray, after minor trauma. Locking occurred in two patients with primary and in four with secondary chondromatosis. Pain and activities of daily living were the most affected fields of the Constant score at presentation with the symptomatic shoulder having a mean score of 8.9 (4 to 15) and 12.9 respectively (5 to 20), which represented only 57% and 65%, respectively of the unaffected side (Table I). The pre-operative range of movement and power parameters had mean scores of 33.2 (18 to 40) and 15.9 (6 to 24), respectively, which were 87% and 88% of the mean scores, respectively, of the normal side. Limitation of movement was present in six patients at presentation with a mean active range of flexion in these patients of 130˚ (100˚ to 160˚), a mean range of external rotation with the elbow at the side of 35˚ (0˚ to 60˚) and a median height at which the hand could be placed on the back to the level of the third lumbar vertebra ranging from the buttock to the 12th thoracic vertebra.

All patients had pre- and post-operative anteroposterior (AP) radiographs with the shoulder held in internal, external, and neutral rotation and also a supraspinatus view.

The AP radiographs were inspected by all authors (no measure of reproducibility used) and the presence of OA was classified as none, mild, moderate or severe according to Samilson and Prieto.27 Osteoarthritis was absent in six patients, mild in four, moderate in two and severe in three at presentation.

Computerised tomographic arthrography was performed on eight patients, four of whom had loose bodies in the bicipital groove. These could be seen on both plain radiography and CT arthrography, but the CT arthrogram assisted in the localisation of the loose bodies especially in the subcoracoid recess. Overall, CT was not found to be better than plain radiography for visualising loose bodies in the bicipital groove.

Operative technique. All operations were performed by the senior author (GW) with the patient in the beachchair position. Shoulder arthroscopy was performed using standard anterior and posterior portals and accessory ports as required. All visible loose bodies were extracted and in addition, in 13, a synovectomy was performed leaving the capsule intact. The two patients who did not have a synovectomy had no evidence of synovial activity, one patient had a clear history of trauma and the other had severe arthritis.

An open subpectoral biceps tenodesis was performed on seven of the patients who had loose bodies in the bicipital groove. These patients had a mean age at surgery of 33.2 years (18.7 to 44.6). The indication for the tenodesis was the presence of loose bodies in the bicipital groove in association with an inflamed or damaged biceps tendon. An intra-articular biceps tenotomy was performed at the time of the glenohumeral arthroscopy. After the debridement and synovectomy, an incision 2 cm to 3 cm long was made at the level of the inferior part of the anterior axillary skin crease. The bicipital groove was debrided and the tenodesis was performed by suturing the tendon of biceps to that of pectoralis major with a non-absorbable suture. In one patient, tenosynovectomy and debridement were performed

### Table II. Mean (range) Constant scores for each category

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean score pre-operatively in affected shoulder</th>
<th>Mean score pre-operatively in the unaffected shoulder</th>
<th>Mean score at final follow-up</th>
<th>p-value (t-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>8.9 (4 to 15)</td>
<td>14.7 (12 to 15)</td>
<td>11.3 (2 to 15)</td>
<td>0.04</td>
</tr>
<tr>
<td>Activities of daily living</td>
<td>12.9 (5 to 20)</td>
<td>19.9 (19 to 20)</td>
<td>18.7 (11 to 20)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Range of movement</td>
<td>33.2 (18 to 40)</td>
<td>20 (20 to 40)</td>
<td>38.1 (34 to 40)</td>
<td>0.12</td>
</tr>
<tr>
<td>Strength</td>
<td>15.9 (6 to 24)</td>
<td>18 (10 to 26)</td>
<td>17.7 (12 to 22)</td>
<td>0.4</td>
</tr>
<tr>
<td>Total</td>
<td>70.9 (40 to 95)</td>
<td>92.6 (85 to 101)</td>
<td>85.8 (67 to 95)</td>
<td>0.008</td>
</tr>
</tbody>
</table>

**Note:** Total score = 100. All categories are scored 100% of the maximum score.
without a tenodesis. One patient with bicipital loose bodies had a glenohumeral arthroscopic procedure only.

**Statistical analysis.** This was carried out using GraphPad Prism software version 3.00 (GraphPad, San Diego, California). The Mann-Whitney U test was used for non-parametric data, Fisher’s exact test for 2 × 2 tables and unpaired t-tests for parametric data. Statistical significance was set at a p-value of < 0.05.

**Results**

More than one operation was required in four patients, and in two a total of three operations was needed. All four of these patients had undergone previous arthroscopic surgery elsewhere. Of these patients, three required recurrent surgery for symptomatic loose bodies in the bicipital groove (Fig. 1).

**Functional outcome.** The Constant score showed a statistically significant improvement in pain and activities of daily living (Mann-Whitney test, p = 0.04 and p < 0.0001, respectively), and in the total score (Mann-Whitney test, p = 0.008; Table II). The improvement in the score for the range of movement and power was not statistically significant (Mann-Whitney test, p = 0.53 and 0.49), possibly because these were the least affected categories in the pre-operative Constant score when the affected and unaffected limbs were compared. Of the six patients who had limitation in their active range of movement pre-operatively, five had improved at review with mean increases in abduction of 32° (0° to 60°), an increase of 24° (0° to 55°) in external rotation with the elbow at the side, and by three vertebrae in the height at which they could place their hand on their back. One patient had a post-operative decrease of 30° in external rotation. A reduction in the range of movement was found at review in three patients who had no limitation pre-operatively. Two lost 10° and 30° of flexion and one lost 20° of external rotation. All three patients had OA and two had progressive changes over the duration of their follow-up. This decrease in the range of movement was not significantly associated with the presence or absence of loose bodies in the bicipital groove or the underlying aetiology (Fisher’s exact test, p > 0.05).

**Radiological analysis.** The pre-operative radiographs showed loose bodies confined to the glenohumeral joints in all patients. The mean number of loose bodies in the primary group was 34 (14 to 70) at initial presentation with a mean size of 3.5 mm (1 to 5). Those patients with a history of trauma in the secondary group had, at initial presentation, a mean of 6.3 loose bodies (3 to 14) with a mean size of 6 mm (5 to 10). Loose bodies were found to be statistically significantly more numerous in the atraumatic group (t-test, p = 0.0015) and statistically significantly larger in the traumatic group (t-test, p = 0.0017). Loose bodies were present in the bicipital groove of five patients in the primary group and of four in the secondary group. The bicipital loose bodies were best seen on an AP radiograph with the arm in external rotation when they were visible lateral to the humerus (Fig. 2). Recurrent chondromatosis with the appearance of new loose bodies in the glenohumeral joint occurred in two patients (cases 2 and 13) at three and 12 years, respectively, after their arthroscopic surgery. Both of these patients were from the primary group, one of whom had a synovectomy at the time of their initial surgery.
Incomplete removal of loose bodies from the gleno-humeral joint occurred in three patients. One patient (case 9) had recurrent symptoms and two loose bodies were removed from the subcoracoid recess at repeat arthroscopy. The other two patients (cases 2 and 10) had one and two loose bodies, respectively, noted inferiorly in the gleno-humeral joint. However, the patients were asymptomatic and radiographs taken at five and nine years from their last surgery showed no increase in the size or displacement of the loose bodies.

At review, the radiographs showed no degenerative change in four patients, mild changes in four, moderate in three and severe in four. Patients with moderate or severe OA were statistically significantly older than those with no or only mild arthritis at presentation (Mann-Whitney, p = 0.034). No significant progression was seen in the severity of the OA over the period of follow-up (Fisher’s exact test, p = 0.71). It was not seen more often in patients with a history of recurrent anterior dislocation, a feature which has been previously described as a predisposing factor for its development28 (Fig. 3), nor was there a statistically significant difference in the presence of arthritis when the primary and the secondary groups were compared (Fisher’s exact test, p = 0.71). No patient at follow-up had symptoms for which a shoulder replacement was recommended.

**Complications.** One patient developed a superficial wound infection at the site of the tenodesis, which resolved with non-operative management. There were no cases of prolonged post-operative stiffness after synovectomy.

**Discussion**

Synovial chondromatosis of the shoulder is an uncommon condition. A review of the literature shows that our understanding of this condition is based primarily on case reports and small series. Most studies with large numbers include patients with loose bodies from multiply-involved joints and few cases involving the shoulder.18,20,21,29 The two principal issues are the effect of intra-articular loose bodies and the potential of the synovium to produce further loose bodies.

The symptoms of synovial chondromatosis in our series were predominantly pain and loss of function both of which responded well to surgery. The classical sign of locking because of an intra-articular loose body occurred in only six patients. The removal of loose bodies from within the shoulder improved the symptoms early in the post-operative period. The potential complication of stiffness after synovectomy of the shoulder did not occur. In six patients with a pre-operative limitation of movement, there was improvement in five. In all the patients, the loose bodies in the glenohumeral joint were identifiable on plain radiography. It is reported that early primary synovial chondromatosis can result in radiolucent non-ossified cartilaginous loose bodies provoking symptoms28 but we
saw no patients at this early stage. The loose bodies in the bicipital groove were all visible on plain radiography and were best seen on an AP view with the humerus in external rotation. Computerised tomographic arthrography gave no additional findings, showing the bicipital loose bodies as well as plain radiography. However, it helped to localise loose bodies in the subcoracoid recess.

The natural history of primary synovial chondromatosis in diarthroidal joints is unclear. It has been suggested that the condition is self-limiting leading to an inactive synovium. This is supported by the finding that progression is not invariable. The surgeon’s ability to judge when the synovium has become inactive has not been substantiated and recurrence of loose bodies does occur. Complete synovectomy is supported by series such as that of Lim et al who reported a more frequent recurrence of synovial chondromatosis at the hip when dislocation, allowing an almost total synovectomy to be carried out, was not performed. Similarly, Ogilvie-Harris and Saleh found an increased recurrence at the knee in the absence of a synovectomy. Overall rates of recurrence vary between 0% and 31%. We believe that in the shoulder an arthroscopic synovectomy is prudent, particularly in those patients with an active synovium, and we perform this routinely in nearly all patients undergoing arthroscopic removal of loose bodies. Of the two recurrences found in our series, both in patients with primary chondromatosis, one did not undergo a synovectomy at the time of arthroscopy.

The development of osteoarthritic changes is well documented in other joints and can be thought of as biological third-body wear. We observed radiological evidence of arthritis in 11 patients, in seven of whom it was moderate or severe, but these changes did not progress during follow-up. This suggested that with the small numbers in our study, removal of the loose bodies may have protected the joint from further degeneration. This is similar to findings reported in a series of patients with chondromatosis at the elbow. In our study, the diagnosis of primary or secondary chondromatosis had no influence on the development of arthritis which was also found by Kamineni et al, in their review of chondromatosis at the elbow. Although non-operative treatment of chondromatosis of the shoulder has been advocated, we believe that the removal of the loose bodies will prevent further articular damage and should be performed even in asymptomatic patients.

Two patients in our series had loose bodies identified in the inferior glenohumeral joint on plain radiography after arthroscopy. These remained asymptomatic and non-mobile at late review leading us to suspect that they were incorporated into the inferior synovium and may have been concealed at the time of surgery.

Loose bodies in the bicipital groove and bicipital tenosynovitis can cause damage and inflammation of the long head of biceps with resulting pain. This phenomenon occurred in nine of our patients in both primary and secondary synovial chondromatosis. The failure to remove loose bodies in the bicipital groove was directly responsible for secondary surgery in three patients. Previous case reports have described various methods of dealing with this problem from arthroscopic retrieval to a limited deltopectoral approach to allow open debridement. We undertook an open approach to allow a thorough bicipital tenosynovectomy since we believe that current arthroscopic techniques do not allow adequate decompression of the bicipital groove. We also carried out tenodesis of the long head of the biceps since this was frequently found to be damaged.

Our study was limited by the lack of histological confirmation of the nature of the loose bodies in four patients with a history of recurrent anterior dislocation. It has been proposed that a patient may appear to be affected with primary synovial chondromatosis, but in fact has the secondary form because of a forgotten injury. We recommend that loose bodies should be sent for routine histological analysis based on the observations that patients with primary synovial chondromatosis are more prone to recurrence and the presence of intra-articular loose bodies is associated with OA. Patients with primary synovial chondromatosis should remain under long-term surveillance.

We have found that arthroscopic debridement of the glenohumeral joint, and open debridement and tenodesis of the long head of biceps are safe and effective in relieving symptoms and slowing the progression of OA at medium-term review.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References