Surgical management of ulnar nerve compression at the elbow: an analysis of the literature

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Object. Surgical treatment for cubital ulnar nerve compression includes medial epicondylectomy, simple decompression, or anterior transposition (subcutaneous, intramuscular, or submuscular). There is a dearth of prospective randomized studies on which to base guidelines for choosing one operative treatment over another. The authors review the literature on this subject and present their findings.

Methods. The authors reviewed the literature from January 1970 to July 1997. Two authors decided independently whether an article should be included for review based on previously formulated inclusion and exclusion criteria. In addition to demographic information, data concerning preoperative status and outcome were extracted. For statistical analyses chi-square and Kruskal–Wallis tests were performed.

Irrespective of their preoperative status, patients with simple decompression had the best outcome, whereas those with anterior subcutaneous and submuscular transposition had the worst. If outcome was related to the patient’s preoperative status, a significant difference was not found among the various groups for those patients with a preoperative McGowan Grade 2. However, for those with McGowan Grade 3 (severe) symptoms, patients with anterior intramuscular transposition had the best outcome followed by those with simple decompression and anterior submuscular transposition. Statistical analysis was not possible for patients with McGowan Grade 1 because of the small numbers of patients in several treatment modality groups.

Conclusions. Formulating a uniform guideline for operative treatment is not possible based on the results of this study. However, the authors believe that support is given to their policy, which is primarily to perform a simple decompression. Its surgical simplicity with preservation of the anatomy, especially the vascularization, and the possibility of rapid postoperative rehabilitation are also taken into consideration. If subluxation is found intraoperatively, anterior transposition is proposed.

Key Words • ulnar nerve • cubital tunnel syndrome • elbow • surgical approach • review

Ulnar nerve compression at the elbow is very frequently encountered in clinical practice. After carpal tunnel syndrome, it is the most frequently occurring compression neuropathy in the upper limb. Description of the clinical syndrome is beyond the scope of this article; however, many excellent surveys have been written.

When conservative treatment fails, patients are considered for surgery. Operative management includes three major categories: simple decompression (incision of the arcuate ligament); medial epicondylectomy, alone or in combination with simple decompression; and anterior transposition. Anterior transposition is either subcutaneous, intramuscular (within a shallow tunnel in the underlying flexor–pronator muscle), or submuscular (placing the nerve deep in relation to the flexor–pronator muscle mass).

Despite the enormous volume of literature concerning surgical treatment of ulnar nerve compression at the elbow, which option is the most effective is still open to question. At present, guidelines based on prospective randomized studies for choosing an operative treatment are not available. This prompted us to search more recent (1970–the present) literature thoroughly and to analyze the results of each study carefully so that we could compare results of different treatments.

Clinical Material and Methods

We searched the literature by using Medline Express (Winspirs version 2.0; SilverPlatter Information BV, Amsterdam, The Netherlands). Each list of references from the retrieved articles was also searched for new articles and standard textbooks were consulted for additional undetected references. Inclusion and exclusion criteria for reports are listed in Table 1. The literature between 1970 and 1997 was searched to minimize differences due to development of diagnostic (electroneurophysiological) tools or anesthesia or surgical techniques. Accessibility of reports was guaranteed by requiring that each article be written in the English, German, or French language. To avoid case reports or small case series, we only included those studies comprising 10 or more patients. A minimum mean age of 18 years for patients was chosen, because in
Surgery for ulnar nerve compression at the elbow

### TABLE 1
Criteria for inclusion and exclusion of literature review

<table>
<thead>
<tr>
<th>Type</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>inclusion</td>
<td>publication of study between January 1970 &amp; July 1997</td>
</tr>
<tr>
<td></td>
<td>language of report: English, French, or German</td>
</tr>
<tr>
<td></td>
<td>treatment group consisting of &gt;9 patients</td>
</tr>
<tr>
<td></td>
<td>mean age of patients ≥18 yrs</td>
</tr>
<tr>
<td>exclusion</td>
<td>neuropathy due to leprosy</td>
</tr>
<tr>
<td></td>
<td>ulnar nerve neuropathy mainly postraumatic (50% of treatment group)</td>
</tr>
<tr>
<td></td>
<td>adequate data retrieval not possible</td>
</tr>
</tbody>
</table>

### Results

From a total of 192 retrieved papers, 60 reports were included. Only three prospective studies were found, two of which met the criteria for inclusion. Some studies offered a comparison of two or more surgical options; however, none of these was a randomized study. In 14 reports the authors discussed medial epicondylectomy in 20, simple decompression in 2,4,5,8–10,13,15,17,35,37,39,41,44,47,49,52,63,64,68,69 in 19, anterior subcutaneous transposition in 6,9,10,11–15,17,21,22,25,31,32,36,42,48,54,58,59,62 in eight, anterior intramuscular transposition in 11,20,21,26,28,33,35 and in 10, anterior submuscular transposition. 3,7,18,29,34,35,38,46,53,57 Nineteen (31.7%) of the 60 reports were published in the neurosurgical literature.

In total, 3024 patients were included. The male/female ratio ranged from 1.67 to 3.63 (overall mean 2.2). The mean age of the patients varied from 45.1 to 50.5 years (Table 2). The mean duration of symptoms before surgery lasted from 11.3 to 28.4 months. In 52.3% of the reported limbs the right side was affected and in 39.3% the left side was affected (Table 3). Both sides were affected in the remaining 8%. In some reports the authors only reported the number of patients with bilateral involvement without mentioning the number of patients with right- or left-sided involvement. A discrepancy was created, because in this group (1898 limbs) it was found that 11.8% had bilateral involvement (Table 3). The dominant arm was involved in 55.4%.

The distribution of McGowan grades among different treatment options is represented in Table 3. McGowan grades were not equally divided (p < 0.001; chi-square test). Patients with lower grades were seen more frequently in the group treated by simple decompression, followed by those who underwent anterior subcutaneous transposition and medial epicondylectomy, and less frequently in the groups treated by either anterior intramuscular or anterior submuscular transposition (p < 0.0001; Kruskal–Wallis test).

Follow-up review ranged from 22.2 to 39.6 months with an overall mean of 32 months (Table 4). Data on outcome for 3153 limbs were retrieved (Table 4). In some studies only an excellent or poor result was mentioned; therefore, it was not possible to grade outcome for 598 limbs and statistical analysis of the outcome was not justified. However, it seems that the patients treated by anterior subcutaneous transposition had an unfavorable outcome. When we only included those studies from which
complete data retrieval was possible, outcome in 2040 limbs could be studied (Table 5) and difference in outcome was significant \((p < 0.001; \chi^2\text{-test})\). Patients who underwent simple decompression had the most favorable outcome, followed in order by those who had anterior or intramuscular transposition, medial epicondylectomy, and anterior submuscular transposition. Those patients who underwent anterior subcutaneous transposition had the worst outcome \((p < 0.0001; \text{Kruskal–Wallis test})\).

When outcome was graded more simply (Table 6), a significant difference was also found \((p < 0.001; \chi^2\text{-test})\). Patients who underwent simple decompression and anterior intramuscular transposition had the best outcome, followed by those who had medial epicondylectomy, anterior subcutaneous transposition, and finally, anterior submuscular transposition. It is remarkable that between 0.6% and 4.4% \((\text{overall mean 2%})\) of patients experienced deterioration even after surgical treatment.

Table 7 shows how outcome stratified by the various treatment modalities was related to the patients’ preoperative status. Data from only 18 studies (total 740 limbs) could be used to compose this table. For McGowan Grade 1, it was not possible to draw any conclusions, because of the few patients treated by anterior subcutaneous, intramuscular, and submuscular transposition. Statistically significant differences were not demonstrable for the patients with McGowan Grade 2 \((p = 0.3997; \chi^2\text{-test})\). For patients with a preoperative McGowan Grade 3, those treated by anterior intramuscular transposition had the best outcome, whereas patients who underwent simple decompression or anterior submuscular transposition fared better than those treated by medial epicondylectomy or anterior subcutaneous transposition \((p < 0.0001; \text{Kruskal–Wallis test})\).

Finally, complications are listed in Table 8. It is remarkable that authors of most studies did not explicitly mention the number of complications or their absence.\(^{2, 3, 6, 10–16, 20–22, 26, 28, 31–34, 36, 37, 41, 47–52, 54, 60, 62–64, 68}\)

### Discussion

Treatment of ulnar nerve compression at the elbow is either conservative or surgical. Patients are considered for surgery when conservative management fails or the severity of symptoms does not permit a conservative attitude. Prudence is called for in interpreting studies like ours. For instance, in this study, only two of the studies examined were prospective. Furthermore, the McGowan and outcome grades were retrospectively assigned for each study in which they were not plainly reported. Although we believe the assessment was done accurately and conscientiously, small inconsistencies are always possible.
Surgery for ulnar nerve compression at the elbow

TABLE 5
Outcome in 2040 limbs treated for ulnar nerve compression*

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>epicondylectomy</td>
<td>181 (44.6)</td>
<td>101 (24.9)</td>
<td>80 (19.7)</td>
<td>44 (10.8)</td>
</tr>
<tr>
<td>decompression</td>
<td>300 (50.8)</td>
<td>133 (22.5)</td>
<td>85 (14.4)</td>
<td>73 (12.3)</td>
</tr>
<tr>
<td>transposition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subcutaneous</td>
<td>124 (33.9)</td>
<td>81 (22.1)</td>
<td>107 (29.2)</td>
<td>54 (14.8)</td>
</tr>
<tr>
<td>intramuscular</td>
<td>118 (44.4)</td>
<td>83 (31.2)</td>
<td>37 (13.9)</td>
<td>28 (10.5)</td>
</tr>
<tr>
<td>submuscular</td>
<td>180 (43.8)</td>
<td>121 (29.4)</td>
<td>23 (5.6)</td>
<td>87 (21.2)</td>
</tr>
<tr>
<td>total</td>
<td>903 (44.3)</td>
<td>519 (25.4)</td>
<td>332 (16.3)</td>
<td>286 (14.0)</td>
</tr>
</tbody>
</table>

* Includes only those studies from which all different outcome grades could be extracted. Outcome is stratified by the number of limbs, and the percentages are given in parentheses.

TABLE 6
Outcome in 3148 limbs treated for ulnar nerve compression*

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Improved</th>
<th>Unchanged</th>
<th>Worse</th>
</tr>
</thead>
<tbody>
<tr>
<td>epicondylectomy</td>
<td>427 (86.1)</td>
<td>49 (9.9)</td>
<td>20 (4.0)</td>
</tr>
<tr>
<td>decompression</td>
<td>1186 (88.8)</td>
<td>141 (10.6)</td>
<td>8 (0.7)</td>
</tr>
<tr>
<td>transposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>subcutaneous</td>
<td>417 (81.0)</td>
<td>75 (14.6)</td>
<td>23 (4.5)</td>
</tr>
<tr>
<td>intramuscular</td>
<td>277 (89.1)</td>
<td>31 (10.0)</td>
<td>3 (1.0)</td>
</tr>
<tr>
<td>submuscular</td>
<td>378 (77.0)</td>
<td>103 (21.0)</td>
<td>10 (2.0)</td>
</tr>
<tr>
<td>total</td>
<td>2685 (85.3)</td>
<td>399 (12.7)</td>
<td>64 (2.0)</td>
</tr>
</tbody>
</table>

* Outcome is stratified by the number of limbs, and the percentages are given in parentheses.

Therefore, the results should be interpreted carefully. However, this is the largest review of the literature concerning the surgical treatment of ulnar compression neuropathy at the elbow, comprising more than 3000 patients. The preoperative condition of the patients was not equally divided among the different treatment groups. Patients treated by simple decompression more frequently had a lower McGowan grade (fewer symptoms), whereas those treated by anterior submuscular transposition more often had a higher McGowan grade. This is important for interpreting outcome because patients with fewer symptoms are likely to have a better outcome, although in some reports the authors found that outcome was not related to preoperative status. When outcome was analyzed without taking into account the patients’ preoperative status, those who underwent simple decompression had the most favorable outcome. Patients who underwent anterior subcutaneous or submuscular transposition had the worst outcome. However, when outcome was related to the patients’ preoperative status, no difference in outcome was found between the treatment modalities for patients with minor or moderate symptoms (McGowan Grades 1 and 2), whereas anterior intramuscular transposition offered the best results for those with severe symptoms (McGowan Grade 3). In the last group of patients, simple decompression and anterior submuscular transposition provided the next best outcomes.

Most authors did not report complications or their absence. The absence of complications in the group treated by anterior intramuscular transposition was certainly due to the very small number of patients and studies. Complications such as hemorrhage and infection were equally distributed among different treatment groups. However, decreased function of the elbow joint was only related to medial epicondylectomy and anterior submuscular transposition (limited extension in 5.3% and 4.5%, respectively). This is not surprising considering the nature of these procedures.

Because of its surgical simplicity with preservation of normal anatomy, especially vascularization, and the possibility for the patient to start rehabilitation immediately afterward, we favor using simple decompression, especially in patients with McGowan Grade 1 or 2. We find support for this choice in this review. Anterior intramuscular transposition provided the best outcome in the group of patients with the highest McGowan grade; however, one must bear in mind the small number of patients. In patients with McGowan Grade 3, anterior submuscular transposition or simple decompression are good alternatives. The higher rate of complications affecting elbow function should be kept in mind when choosing an anterior submuscular transposition. The main reason for failure of simple decompression was related to anterior subluxation, which occurs in 2.4 to 17% of cases. This might be an indication for an anterior transposition procedure. Therefore, our policy is to perform a simple decompression, carefully preserving the perineurium and mesoneurium, and dynamically test intraoperatively for nerve function should be kept in mind when choosing an anterior submuscular transposition.
subluxation. If the ulnar nerve does not remain stable within the ulnar groove while the elbow is being flexed (the medial aspect of the ulnar nerve should not rise above the level of the medial epicondyle), we transpose anteriorly.

Finally, it is very striking that only 31.7% of the articles were published in the neurosurgical literature. We believe it clearly demonstrates the scant interest the neurosurgical community has paid to peripheral nerve surgery. As a consequence, we have lost this field to other surgical disciplines. Only a few neurosurgeons are committed to surgery of the peripheral nerves.

Conclusions

Simple decompression is a very adequate surgical procedure in cases of ulnar nerve compression at the elbow. However, anterior intramuscular transposition provides the best outcome for patients with the highest McGowan grade, whereas simple decompression and anterior submuscular transposition provide the second best. When choosing one or another treatment, one should always consider the nature of the procedure, the need for postoperative immobilization, and the possible complications. The need for prospective randomized studies is obvious.

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Surgery for ulnar nerve compression at the elbow

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