RHEUMATOID ARTHRITIS OF THE ELBOW:  
THE RESULTS OF SYNOVECTOMY

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The elbow joints are often involved in rheumatoid arthritis but it has been suggested that such involvement is not commonly a major cause of disability in the upper limb (Merle d’Aubigné and Delbarre 1969, Torgerson and Leach 1970). It is perhaps this belief that has led to the relatively infrequent use of operative treatment for rheumatoid arthritis of the elbow, except as a late “salvage” procedure. However, the extent of the problem may have been underestimated. In a recent study by the present authors, 25 per cent of a hospital population of 225 patients suffering from rheumatoid arthritis had severe disability in one or both upper limbs resulting wholly or partly from disease of the elbow. Nearly half the patients in the whole group had pain in one or both elbows and only 28 per cent had no clinical evidence of elbow involvement.

The results of synovectomy have been studied mostly in the knee. The short-term results are good, with relief of pain after 70 to 90 per cent of operations (Geens 1969). However, this could possibly be ascribed to a “placebo effect” (Mason 1969) and the long-term value of the procedure still awaits the results of prospective studies. Reports on synovectomy of other joints are less plentiful but the short-term results quoted are similar to those in the knee (Lipscomb 1965; Valvanen 1968; Ellison, Kelly and Flatt 1971).

Early references to elbow synovectomy were made by Swett (1929), Allison and Coonse (1929) and Smith-Petersen, Aufranc and Larson (1943). Laine and Vainio (1969) gave a preliminary report on ninety-two elbow synovectomies. The average duration of follow-up was one year and most of the patients had advanced changes in the joint before operation. Even so, the short-term results were encouraging, with complete or satisfactory relief of pain in three-quarters of their patients. Other authors who have reported similar results in smaller series include Wilkinson and Lowry (1965), Anderson and Heppenstall (1971), Inglis, Ranawat and Straub (1971). Peterson and Janes (1971), Wilson (1971) and Marmor (1972).

The present paper is a study of the results of synovectomy of the elbow carried out at one centre over a period of seven years. It attempts to define the factors that influence the results and to determine whether the quality of the result deteriorates with time.

CLINICAL MATERIAL AND METHOD OF STUDY

Between October 1962 and November 1969, 282 elbow synovectomies were performed at the Rheumatism Foundation Hospital at Heinola, Finland. For each patient a record was made of the erythrocyte sedimentation rate immediately before operation, a test for rheumatoid factor, the duration of the disease, the range of elbow movement and the severity of pain (rated none, slight, moderate and severe). About half of the patients were asked to attend for review, the selection being made on a geographical basis because many patients lived in remote areas. A careful study of the case records suggested that the patients thus selected were representative. No patient was called for review less than twelve months after operation.

One hundred and eighteen patients were seen by one or both of the two authors who had not been involved in the original treatment (B. B. P. and C. R.). The patients were questioned about pain and other symptoms and were asked to relate their functional capacity (in particular the ability to perform certain activities at home or at work) to that existing before operation. Finally they were asked whether or not they were pleased with the result.
Radiographs of a rheumatoid elbow showing a moderate degree of erosive change but little reduction of the cartilage space (Grade II).
The elbows were carefully examined and the range of movement measured. Particular attention was paid to evidence of recurrent synovitis, instability and peripheral neuropathy. Antero-posterior and lateral radiographs of both elbows were obtained. The findings at review and the pre-operative features were then compared.

In addition to the 118 patients who were seen, five patients who had been subjected to elbow arthroplasty after a synovectomy were also included in the series. They were classed as failures of synovectomy at the time of the arthroplasty.

Seven joints had a further synovectomy. The first synovectomy was counted as a failure at the time of the second operation. The results of five repeat synovectomies are included in the general statistics and are also noted separately. The other two operations had been performed less than a year earlier and are not included.

The 123 patients studied comprised forty-one men and eighty-two women. Most of the patients were between thirty and sixty years of age, the range being from eighteen to sixty-five. There were 154 operations, twenty-six patients having had bilateral synovectomy. The right elbow was operated upon eighty-eight times and the left elbow sixty-six times.

Radiographic features and grading—The pre-operative antero-posterior and lateral radiographs of each elbow were assessed. Evidence of soft-tissue proliferation (Fig. 1), the extent of erosive change and the width of the cartilage space were all noted and graded. An overall radiological grade of disease severity at the time of operation was then assigned to each elbow according to the following scale, based on that of Steinbrocker, Traeger and Batterman (1949): Grade 0—normal joint; Grade I—osteoarthritis and soft-tissue changes only; Grade II—mild or moderate degree of erosive change, mild or moderate reduction of "joint space"; Grade III—joint space markedly narrowed (to < 1 millimetre) and more extensive erosions; and Grade IV—subluxation or ankylosis.

Figures 2 to 5 show radiographs typical of each grade. Figure 6 shows further progression of erosion with gross widening of the trochlear notch, an appearance we have likened to a pestle and mortar. In some patients it was possible to study radiographs of the opposite elbow, not subjected to operation, at a corresponding stage of the disease, and these were valuable for comparative purposes.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number of elbows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>43</td>
</tr>
<tr>
<td>III</td>
<td>80</td>
</tr>
<tr>
<td>IV</td>
<td>30</td>
</tr>
</tbody>
</table>

As may be seen in Table I all elbows except one had radiographic features of bony involvement at the time of operation. For the sake of simplicity, in all subsequent tables the single elbow with soft-tissue changes only has been counted as Grade II.

Indications for operation—All the patients in this series had had medical treatment with anti-inflammatory agents, including gold and systemic or local corticosteroids in many cases. The duration of such treatment varied considerably.

The main indication for synovectomy was pain. In a few cases this was not prominent and the presence of thickened synovium, joint stiffness or a limited range of movement—particularly rotation of the forearm—were the main indications.
Radiographs of a rheumatoid elbow showing extensive erosions and marked narrowing of the cartilage space (Grade III).

Radiographs of a rheumatoid elbow showing extensive erosions, marked narrowing of the cartilage space and early subluxation of the medial compartment of the joint (Grade IV).

Radiographs of a rheumatoid elbow showing advanced erosive changes with subluxation of the joint (Grade IV). The gross destruction of the trochlear notch is well seen on the lateral film; this produces the "pestle and mortar" effect.
Many patients had previously undergone other operations on the upper limb, particularly at the wrist, where excision of the distal end of the ulna was commonly performed during either synovectomy or arthrodesis. When there was disease of both elbow and wrist it was usual to treat the wrist before the elbow.

OPERATIVE PROCEDURE

At the beginning of the series the elbow was approached from the lateral side only, but later most joints were opened from both aspects. The operations were performed under regional anaesthesia using axillary block; a pneumatic cuff was applied high on the upper arm.

Lateral approach—A longitudinal incision was made from 2 centimetres proximal to the lateral humeral epicondyle to 2.5 centimetres distal to the joint line. The fascia and aponeurotic fibres of the common extensor origin were divided in the line of the skin incision and the capsule of the joint exposed by separating the fibres of extensor carpi radialis. The capsule and the lateral ligament of the elbow, often quite attenuated, were incised in the same line and the head of the radius was exposed. Synovium was removed from the region of the annular ligament and the head of the radius was excised. This allowed free access to the superior radio-ulnar joint, the sacroform recess and to most of the elbow joint itself. In most instances large amounts of proliferated synovium were found and removed. A set of curved rongeurs was found to be extremely valuable, in particular for clearing the olecranon and coronoid fossae. When the joint had been completely cleared of synovium the capsule and lateral ligament were repaired around a drain and the aponeurosis and skin closed. In a number of patients the lateral approach was extended to separate the collateral ligament from the lateral epicondyle; this allowed medial displacement of the ulna on the humerus and freer access to the medial side of the joint.

Medial approach—After closing the lateral wound a curved incision 8 to 10 centimetres long was made in the line of the ulnar nerve and centred over the medial epicondyle. The ulnar nerve was carefully mobilised and retracted forwards with a tape, the articular branch being divided. The capsule was opened through the bed of the ulnar nerve and the residual synovium removed with the use of rongeurs. It was usually found that, in spite of apparently full clearance from the lateral approach, a variable quantity of synovium remained in the medial compartment. Any osteophytes were also removed with the rongeurs. The capsule was closed without drainage and the ulnar nerve was transposed forwards after division of the edge of the medial intermuscular septum; a suture was inserted into the fat layer to hold the nerve in its new position and the skin was closed.

On the day after operation the wounds were inspected and the drain removed from the lateral side; active shoulder, wrist and finger movements were encouraged. From the fifth day, active forearm rotation and elbow flexion and extension within the limits of the bandages were begun. The sutures were removed after ten days and resisted exercises started. The patient also exercised in the pool and later took part in group activities.

Complications of operation—A single septic wound healed soundly. Two patients who had had the bilateral approach with transposition of the ulnar nerve developed ulnar neuritis after operation; exploration with neurolysis was carried out three and five weeks later. One of these patients still had some mild ulnar paraesthesiae at review.

METHOD OF ASSESSMENT OF RESULTS

It is difficult to find an adequate method to assess the results of synovectomy, especially in upper limb joints. The simplest criterion is the patient's own degree of satisfaction. However, many patients are pleased with the result although the clinician does not regard it as wholly satisfactory; for example, there may be significant loss of movement. Further, both patient and surgeon may be satisfied with the result on clinical grounds and yet there may be radiological evidence of progression of the local disease. That there is some variation in the assessment of results of treatment according to the criteria used should be self-evident, yet it is often overlooked in comparing the results of different investigators. This point is well made in Table II.

We have taken the most pessimistic assessment and graded the results into two categories, "satisfactory" and "unsatisfactory", according to the criteria shown in Table III. Definite deterioration of the radiographic appearance excluded a result from being classed as satisfactory. Separation of the results into four categories was attempted initially but was abandoned because no clear-cut criteria could be found.
RESULTS

Seventy-one per cent of the patients were pleased with the results of 110 operations and, knowing the outcome, would willingly have submitted to operation again; 23 per cent were not satisfied; 6 per cent were uncertain. Including the examiner's objective assessment, 63 per cent were considered satisfactory. Including both clinical and radiological criteria, however, a satisfactory grading was awarded to only 55 per cent (Table II).

In all subsequent Tables the figures are based on the combined clinical and radiological assessment.

### TABLE II
**THE RESULTS OF ELBOW SYNOVECTOMY ACCORDING TO THE METHOD OF ASSESSMENT**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Patient alone</th>
<th>Patient and surgeon</th>
<th>Patient, surgeon and radiograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>71 per cent</td>
<td>63 per cent</td>
<td>54.5 per cent</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>29 per cent</td>
<td>37 per cent</td>
<td>45.5 per cent</td>
</tr>
</tbody>
</table>

### TABLE III
**THE CRITERIA FOR GRADING OF RESULTS OF ELBOW SYNOVECTOMY**

- **Satisfactory** — patient pleased
  - good pain relief (mild pain allowed if pain was severe before operation)
  - no symptomatic instability
  - range of movement preserved within limits defined below*
  - no radiological deterioration

- **Unsatisfactory** — patient dissatisfied or uncertain
  - pain same, worse or only slightly improved
  - unstable joint
  - significant loss of movement*
  - radiological deterioration

* Because it is possible to lose some movement without functional disability or even awareness, a loss of up to 25 degrees of flexion or 20 degrees of extension is accepted, provided the total loss does not exceed 35 degrees.

### TABLE IV
**THE RESULTS OF ELBOW SYNOVECTOMY RELATED TO THE STAGE OF THE DISEASE**

<table>
<thead>
<tr>
<th>Radiological grade before operation</th>
<th>Satisfactory</th>
<th>Unsatisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>III</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>IV</td>
<td>17</td>
<td>13</td>
</tr>
</tbody>
</table>

**Stage of disease** — In Table IV are shown the results of treatment subdivided according to the radiological grading of the elbow at the time of synovectomy. This grading was assumed to represent a meaningful assessment of the stage of the disease process in the joint. There were no statistically significant differences between the results for the various grades.
**Time since operation**—Table V shows the results according to the duration of follow-up. There is a tendency towards more unsatisfactory results after three years, but the figures are not statistically significant. On breaking down the results according to the radiological severity at the time of synovectomy (Table VI), it is seen that this deterioration in the results is significant only for joints with the most advanced disease (0:001 < P < 0:01).

### TABLE V

**The Results of Elbow Synovectomy Related to the Time since Operation**

<table>
<thead>
<tr>
<th>Interval (years)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satisfactory</td>
</tr>
<tr>
<td>1 to 2</td>
<td>23</td>
</tr>
<tr>
<td>2 to 3</td>
<td>33</td>
</tr>
<tr>
<td>3 to 4</td>
<td>12</td>
</tr>
<tr>
<td>4 to 5</td>
<td>16</td>
</tr>
<tr>
<td>5 to 6</td>
<td>0</td>
</tr>
</tbody>
</table>

### TABLE VI

**The Results of Elbow Synovectomy for Each Grade of Disease Severity, Related to the Time since Operation**

<table>
<thead>
<tr>
<th>Interval (years)</th>
<th>Grade II</th>
<th>Grade III</th>
<th>Grade IV</th>
<th>All grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satisfactory</td>
<td>Unsatisfactory</td>
<td>Satisfactory</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>1 to 3</td>
<td>18</td>
<td>9</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>3 to 6</td>
<td>9</td>
<td>8</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

A higher incidence of radiological deterioration accounted for the greater proportion of "unsatisfactory" results among the Grade II elbows which had been followed up for a longer time. Except in the case of joints with advanced disease, there was no falling off in the clinical results with time. Overall, just over 70 per cent of patients were pleased with the outcome both in the group followed up for less than three years and in those followed up for three to six years. In Grade IV joints, however, fourteen out of seventeen patients reviewed less than three years after operation were satisfied, as against seven out of thirteen patients operated upon more than three years previously.

**Age and sex**—Men showed more satisfactory results (66 per cent) than women (48 per cent) and this was true for each grade of severity. Age did not influence the outcome.

**Duration of disease**—The duration of the rheumatoid disease was very variable (Table VII), though mainly between five and twenty years. There was no significant correlation between duration and results, although there was a lower proportion of good results in patients who had had the disease for less than five years.

**Activity of the disease**—The activity as judged by the erythrocyte sedimentation rate at the time of operation did not influence the result. There was also no correlation with a positive test for rheumatoid factor.

**Severity of pain before operation**—In eighteen patients who had had either no pain or only mild pain in the elbow, the operation was performed for complaints of stiffness and for synovitis. Only five showed a satisfactory result.
Type of operation—The bilateral approach to the elbow gave more satisfactory results than did the lateral approach (Table VIII). This was equally true when other factors, such as time since operation and severity of disease, were taken into account. Persistent pain medially was much more common when only the lateral side had been explored. In twenty-two elbows an extended lateral approach was used, medial displacement of the ulna giving access to the

<table>
<thead>
<tr>
<th>Duration (years)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 2</td>
<td>7</td>
</tr>
<tr>
<td>3 to 5</td>
<td>8</td>
</tr>
<tr>
<td>6 to 10</td>
<td>27</td>
</tr>
<tr>
<td>11 to 20</td>
<td>29</td>
</tr>
<tr>
<td>&gt;20</td>
<td>13</td>
</tr>
</tbody>
</table>

**TABLE VII**
The results of elbow synovectomy related to the duration of the disease

**TABLE VIII**
The results of elbow synovectomy related to the operative approach

<table>
<thead>
<tr>
<th>Operative approach</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Lateral</td>
<td>16 (40 per cent)</td>
</tr>
<tr>
<td>Extended lateral</td>
<td>13 (59 per cent)</td>
</tr>
<tr>
<td>Lateral and medial</td>
<td>55 (60 per cent)</td>
</tr>
</tbody>
</table>

**TABLE IX**
Elbow movement after synovectomy in 149 patients

<table>
<thead>
<tr>
<th>Flexion</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased</td>
<td>&gt;10 degrees</td>
</tr>
<tr>
<td></td>
<td>±10 degrees</td>
</tr>
<tr>
<td></td>
<td>&gt;10 degrees</td>
</tr>
<tr>
<td></td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

medial compartment. The results in these few cases were comparable to those achieved using two incisions. One patient (Grade II radiographically) had partial synovectomy through a lateral approach without excision of the radial head; the result was not satisfactory.

**Peripheral nerve dysfunction**—There was no sign of median or radial nerve involvement at review. There was also no definite evidence of ulnar motor weakness. However, slight abnormalities of cutaneous sensibility in the ulnar distribution were detected in seventeen instances. Four of these cases had had a single lateral incision and in the other thirteen the ulnar nerve had been transferred.

Ten patients had complained of paraesthesiae in the ulnar nerve distribution before operation. Four had lateral synovectomy alone, and of these, three still complained of some
paraesthesiae at review. In the other six patients the medial side of the joint had also been explored; two of this group still had slight ulnar paraesthesiae. Overall, the incidence of paraesthesiae was the same after both types of operation.

**Range of elbow movement**—Most patients retained the pre-operative range of flexion and extension (Table IX). When movement was gained, the mean improvement in flexion was 21 degrees (maximum 45 degrees), and in extension 21 degrees (maximum 55 degrees). In those patients who lost movement the mean loss of flexion was 22 degrees (maximum 40 degrees), and of extension 20 degrees (maximum 35 degrees). In ten elbows flexion and extension both improved more than 10 degrees and in seven elbows both decreased.

The range of pronation and supination were measured at follow-up examination but had not been consistently recorded before operation. In only two cases was rotation of the forearm less than 60 degrees at review.

**Recurrent synovitis**—At follow-up examination of the 142 elbows which had not been operated upon again, twenty-three (16 per cent) had definite evidence of recurrent synovial proliferation. In only seven of these cases was the patient sufficiently relieved of symptoms to be pleased with the result.

In the series as a whole there were forty-four elbows in which the outcome of synovectomy was not satisfactory to the patient. Twelve of these joints had already been operated upon again, but of the other thirty-two elbows, sixteen had evidence of synovial proliferation at review. There appears to be little doubt that recurrence of synovitis was an important factor in about half the poor clinical results.

**Stability**—In most of the joints at review it was possible to elicit a slight degree of "springing" on valgus stress. In a few this was more marked, and very occasionally varus stress also resulted in a slight "spring". However, no patient complained of symptoms which could be attributed to joint instability.

**Comparison with opposite elbow**—In seventy-eight patients who had undergone unilateral synovectomy there were comparable radiographs of the other elbow taken both before operation and at review. Only six of these "control" joints showed no evidence of erosive change or narrowing of the joint space on the first radiograph.

Study of the films did not suggest that synovectomy had regularly influenced the evolution of the disease in the treated joint. Apart from those joints with advanced (Grade IV) changes initially, fifteen elbows not operated upon showed evidence of deterioration during the period when the operated side had not become worse. Against this, however, twelve "control" joints had not deteriorated while the synovectomised elbow had done so.

**Repeat synovectomy**—A second synovectomy was carried out in five elbows on account of persistent symptoms. All these elbows had been approached from the lateral side only and the persistent symptoms were mainly medial. The medial side was therefore explored and the ulnar nerve transposed, the interval between the two procedures ranging from fourteen to thirty-nine months. The results of all five were satisfactory, but the longest time from the second operation was only two and a half years.

**DISCUSSION**

Assessment of the results of synovectomy of any joint poses many problems. In the upper limb it is particularly difficult to evaluate the function of a single joint in a patient suffering from polyarticular disease. Clearly there is need for a more uniformly applicable method of assessing upper limb function. Although our patients were questioned about their functional capacity before and after operation, it was not possible to differentiate between incapacity from disease in the elbow and that caused by disease in the hand, wrist, shoulder and cervical spine. Also many patients were unable to return to work on account of arthritis affecting the lower limb.
The present study attempted to relate the severity of the disease process at the time of operation to the results obtained. It would have been valuable to show whether or not early synovectomy gave particularly good results; unfortunately only one elbow in the whole series was operated upon before erosions were visible radiographically. In order to assess the prophylactic value of synovectomy of the elbow it would be necessary to carry out a prospective trial of operation on joints still in the early synovial stage of the disease. There are clearly many difficulties, not the least being that so many elbows already show bony changes by the time symptoms attract attention. Also a proportion of joints with early synovitis settle down spontaneously or with simple medical treatment and cause no further significant disability. Unfortunately there is no satisfactory way to select those patients whose elbows are destined to deteriorate. It is likely that patients with early joint changes would be less appreciative of any possible benefit of synovectomy.

We consider that excision of the radial head is a necessary part of synovectomy of the elbow joint complex. This part of the procedure in itself has a certain morbidity (Taylor and O'Connor 1964), acceptable if there is pre-existing disability, but less so in a prophylactic operation.

Once erosions were visible radiographically, the severity of the changes did not significantly influence the outcome, although synovectomy performed on joints with advanced disease gave few satisfactory results more than three years later. For these patients another form of treatment, such as excision or replacement arthroplasty, should be considered.

With our radiological assessment of deterioration there was no definite evidence that elbow synovectomy has any consistent "prophylactic" value, as ascribed to synovectomy of the knee by Gariépy, Demers and Laurin (1966). On occasions, however, the operation did appear to have a protective role.

The operative procedure employing two separate incisions gave a higher percentage of satisfactory results than did a lateral approach alone. This would suggest that more complete clearance influences the outcome. In fact it is surprising how much extra synovium may be removed from the medial side of the joint after clearance from the lateral aspect appears to be complete. Residual pain on the medial aspect of the joint was more common when a lateral approach only had been used, but there seemed to be no difference in the incidence of post-operative ulnar nerve paraesthesiae whether or not the medial side of the joint had been explored.

A set of curved rongeurs is invaluable for reaching the less accessible parts of each compartment. With two incisions and the rongeurs a complete synovectomy is made easy, and the authors feel that osteotomy of the olecranon as described by Inglis et al. (1971) is unnecessary and potentially disadvantageous. The trochlear notch is an early site of erosive change, and the quality of the bone in the region of the olecranon is frequently unsuitable for metallic fixation.

From this study it is apparent that, in the short term at least, synovectomy of the elbow affords a large measure of symptomatic benefit. Nevertheless there may be progression of joint destruction. In the usual case of moderately advanced disease complete synovectomy can be expected to give good relief of pain in over two-thirds of elbows—at least up to six years. This fact cannot be ignored when considering the indications for synovectomy.

SUMMARY

1. One hundred and twenty-three patients with rheumatoid arthritis who had synovectomy and excision of the head of the radius performed on 154 elbows have been reviewed one to six years after operation.
2. The severity of the disease process at the time of operation was graded radiologically and an attempt made to relate this to the results.
3. Overall, the clinical results were most satisfactory; more than 70 per cent of the patients were pleased with the outcome. When radiographic deterioration of the joint was taken into account, however, only 54 per cent achieved a "satisfactory" result.

4. Clearance of the synovium through combined medial and lateral incisions gave better results than a lateral approach alone.

5. When the disease was far advanced by the time of operation any good results were likely to be short-lived.

6. The indications for synovectomy of the rheumatoid elbow are discussed in the light of these findings.

We are most grateful to Dr P. Raunio for his help and advice and for permission to study his patients. We also wish to thank Dr H. Laine and Professor V. Laine, Medical Director of the Rheumatism Foundation Hospital. For secretarial assistance we are indebted to Miss H. Auvinen and Mrs P. J. Ridyard. The theatre nursing staff at Heinola gave invaluable help with language difficulties.

REFERENCES


