vertebrae, and eleven have firm fibrous ankylosis. Fourteen still have an unstable spine though some of these are much improved. Thus fifty-one out of sixty-five (or 78 per cent) have a stable and comfortable spine.

4. The duration of treatment of these patients has been considerably less than that formerly necessary. There has been no death among patients treated by this operation. These results show a considerable improvement over those hitherto reported.

I wish to acknowledge the encouragement and help received from the late Mr Paul Swett of Harford, Connecticut, United States of America, Mr S. L. Higgs, and Dr Jack Dixon, whose skill in anaesthesia contributed so much to the safety of the patients. I wish also to thank Mr A. Rocyn Jones for permission to use his illustration.

REFERENCES

SYNOVECTOMY OF THE KNEE IN RHEUMATOID ARTHRITIS

An Essay in Surgical Salvage

P. S. London, Bath, England

Synovectomy was recorded in 1877 by Volkmann, who operated on a tuberculous knee, but the operation was not attended by any success until in 1899 Mignon carried it out for chronic arthritis (Bernstein 1933). The practicability of the operation was established by Swett (1923, 1939), who first performed it in 1915, unaware that he was not the first to do so. He laid down the principles governing the selection of knees for operation and, referring to "chronic infectious arthritis," stressed the importance of restricting synovectomy to knees in which the changes were largely or exclusively synovial. An opinion commonly expressed by American writers (Bernstein 1933, Ghormley and Cameron 1941, Pardoe 1948) is that whereas synovectomy gives good results in persistent or recurrent hydrarthrosis, villonodular synovitis, synovioma and some cases of osteoarthritis, it is less successful in cases of rheumatoid arthritis. Boon-Itt (1930) and Inge (1938) reported improvement in nearly two-thirds of ninety-three knees affected by rheumatoid arthritis or "chronic proliferative synovitis," but an attempt to assess critically the possible value and limitations of synovectomy in rheumatoid arthritis does not appear to have been made except by Swett (1923, 1939).

The purpose of the operation is to try to preserve what useful function the joint still possesses and to relieve pain and swelling. Although the synovial membrane is but one of the tissues affected in rheumatoid arthritis, the fact that its proliferation is associated with progressive damage to articulating surfaces and ligaments makes it seem reasonable to remove this destructive tissue at an early stage. Sometimes it happens that synovectomy—or any other operation—is followed by remission of the rheumatoid process as a whole. Whether such remissions are due to the effect of any stress (including operation) upon the endocrine system or to modification of an allergic process (Novotny 1948) is debatable.

SELECTION OF CASES

Synovectomy was not considered in any case unless treatment by rest and by the accepted medical and physical methods had failed to afford relief. With this proviso, the following were accepted as indications for the operation: 1) pain; and 2) persistent synovial swelling. Operation was not advised unless there was at least 45 degrees of movement (a flexion contracture of up to 30 or 40 degrees does not necessarily rule out synovectomy, for the deformity may yield to preliminary manipulation or to capsulotomy and similar releasing procedures (Pfeiffer and Bach 1940; Preston 1953). Radiographically there should be a good joint space and little or no lipping or subchondral sclerosis. Finally, the patient should be in satisfactory general health and ready and able to co-operate effectively in the post-operative treatment. Anaemia can be corrected fairly quickly by the intravenous injection of iron compounds (Jeffrey 1953), or rapidly by infusing blood. The existence of an acute phase of rheumatoid arthritis must stay the surgeon's hand, although now that A.C.T.H. is available the danger of exacerbation of the disease after operation has been much reduced.

MATERIAL

This paper deals with thirty-four knees of twenty men and seven women who have been subjected to synovectomy since 1946 for suspected rheumatoid arthritis. Nineteen knees have been observed for more than two years after operation. Histological reports were
available in every case except two, and a definite diagnosis of rheumatoid arthritis was made in twenty-eight. In one patient with a clinical diagnosis of rheumatoid arthritis the histologist could find no evidence of the disease and thought the condition might be traumatic. In three instances the appearances were suggestive but not typical of rheumatoid arthritis. The histologist's opinion was based on material selected by him from all or most of the synovial tissue removed at operation, and in many cases also on a small piece of muscle from the site of operation. The importance of histological examination has been mentioned by Heyman (1928) and by Allison and Coose (1929), who found unsuspected tuberculosis in some of their cases. We have been similarly disconcerted by two of our patients (not included in this series) who had had what was regarded as rheumatoid arthritis for several years but were later proved to have tuberculous arthritis (Kersley 1954). Fortunately, in these days of anti-tuberculous drugs, synovectomy also has a place in the treatment of tuberculosis (Wilkinson 1954).

In all but four cases the erythrocyte sedimentation rate exceeded 15 millimetres in the first hour at the time of operation. Among the four exceptions was the case in which the histological appearance was not like that of rheumatoid arthritis. In five patients the knees were the only joints affected at the time of operation, one of them being the case already mentioned with unproven diagnosis.

THE OPERATION

A parapatellar incision, usually medial, was used in all cases. It gives good access to both sides of the knee. Provided the extensor muscles are split for a hand’s-breadth above the patella, this can be turned conveniently aside without effort; incisions that split the patella or cut across its tendon have nothing in their favour. From three knees no more than the suprapatellar pouch was removed, but from all the others as much synovial tissue as could be reached was taken away. Most of the intrapatellar pad of fat was also removed.

An effusion was rarely absent, though its quantity varied much and it sometimes contained solid or semi-solid matter ranging from melon-seed bodies to large masses of greenish-yellow clot-like material. Occasionally the synovial membrane was only slightly thickened, with a smooth, pale pinkish-yellow inner surface, but more often it showed some degree of gelatinous thickening with congestion and polypoid hypertrophy. In extreme cases the membrane resembled purplish seaweed and filled the joint cavity in its profusion. Erosion of articular cartilage by pannus was seldom marked in the knees selected for operation, but, since most of the patients were over thirty, some degeneration of the apposed femoral and patellar surfaces was common and occasionally marked. Softened, velvety cartilage was shaved off and if bare bony surfaces were apposed a sheet of nylon was stitched over the back of the patella to prevent adhesion. This was done on six occasions and appeared to have no disadvantages. We have not used nylon to separate the quadriceps from the femur (McKeever 1943). In one case the back of the patella was sawn off to leave a flat surface; though the patient had smooth, painless movement from 175 degrees to 90 degrees a year later, it remains to be seen what effect the consequent incongruity of the patellar and femoral surfaces will have. If the patellar cartilage is grossly degenerate removal of the patella seems preferable to merely sawing off its articular surface. In this series the policy was to retain the patella whenever possible, and it was removed only twice—once at the time of synovectomy and once six months later, because it had stuck to the femur. Six and a half years after the primary removal the range of movement was 175 degrees to 105 degrees; the delayed removal was followed by a range of 180 degrees to 125 degrees. Provided the patella is shelled out and the extensor mechanism repaired from side to side and not from above down, there seems to be no reason to advise against primary removal of the patella or to modify the post-operative programme for the sake of the healing tendon.

The semilunar cartilages had disappeared from two knees and were damaged enough to be removed from twelve more. Softening and narrowing with ragged concave margins was
the usual finding. Though in most cases the cruciate ligaments were invested by thickened, congested synovium, they were only once recorded as being significantly slack.

At the conclusion of the operation the limb was immobilised on a long plaster back splint. **Post-operative treatment**—Three weeks after operation the knee was bent to about a right angle under anaesthesia and returned to a straight back splint. Pain and swelling after manipulation usually subsided in a few days. Quadriceps exercises were begun before operation and continued for a long time afterwards. Apart from the manipulation, occasionally repeated, the patient’s own efforts aided by slings, exercises in water, and the physiotherapists’ encouragement were relied upon to achieve the final range of movement. When the reaction to manipulation had settled down, the patients were encouraged to walk with a short back splint. This was discarded when the effusion had disappeared and the quadriceps was reliable.

During the period of this survey A.C.T.H., cortisone and hydrocortisone were used in only four instances. The best use of these substances has yet to be finally decided (Medical Research Council 1954), but A.C.T.H. and cortisone are of value in cutting short an exacerbation of the rheumatoid disease, and hydrocortisone injected into the joint has a dramatic though temporary effect in preventing or mitigating flares (Kersley and Desmarais 1952; Hollander 1953).

**COMPLICATIONS**

Stiffness followed two of the thirty-four operations: one knee was so painful as to require arthrodesis five months after synovectomy; the other was in a state of painless, stable fibrous ankylosis and further treatment was not recommended. In three of the knees operated on early in the series there was enough bleeding to call for reopening of the incision and evacuation of clot. There was no case of infection or shock, though each has been reported as bringing about a fatal issue (Allison and Coose 1929, Ghormley and Cameron 1941). One patient required excision of the patella, which had become stuck to the femur. One patient wore a caliper for some months, but five years after operation spends much of his working day on his feet, and complains of no more than occasional stiffness and aching.

**RESULTS IN TERMS OF MOVEMENT**

The range of movement regained in each case is shown in Figure 1. It will be seen that of the twenty-five knees with a range of movement of at least 90 degrees before operation, seventeen retained a comparable range after operation. Only two knees suffered significant loss of movement. Though the ranges tended to be lower four or more years after operation than within two years they remained at least satisfactory, allowing patients to sit and to negotiate stairs without awkwardness.

**DISCUSSION**

**Selection of cases**—One of the decisive factors in accepting knees for synovectomy has been the retention of a good or normal joint space, as this has been assumed to indicate that the articular surfaces are good enough to allow useful function if they can be spared, temporarily at least, the ravages of erosion by pannus. It is important to try to assess the validity of this criterion for selecting knees for synovectomy. Three questions must be answered. 1) Is the radiographic appearance a reliable guide to the state of the articular surfaces as seen at operation? 2) Does the functional result depend upon the state of the articular surfaces? 3) Does any other factor influence the outcome?

**Comparison of radiographic and operative findings**—Eleven knees showed osteoporosis only: five were found to have good or normal articular cartilage, four had slight to moderate erosion and two showed marked degenerative changes. Twenty-one knees showed appreciable
narrowing of the radiographic joint space with or without osteophytes and subchondral sclerosis, but the findings at operation were recorded in only sixteen of these: two knees had good or normal cartilage, eight had slight to moderate, and six gross degenerative changes. Two knees were radiologically normal and at operation both were found to be in good condition. Thus in at least two-thirds of the cases the radiographic appearances gave a reliable indication of the condition of the articular surfaces.

TABLE I
Results in Fifteen Knees Studied for Less than Two Years after Synovectomy, Related to the State of the Articular Cartilage at Time of Operation

<table>
<thead>
<tr>
<th>Articular degeneration</th>
<th>Number of knees</th>
<th>Clinical state</th>
<th>Range of movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Much improved</td>
<td>Improved</td>
</tr>
<tr>
<td>Little</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Much</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>15</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

* Range good before synovectomy in three cases. † Range good before synovectomy.

Relationship between articular degeneration and function after synovectomy—Since some patients have a warm, swollen, painful joint, which has a good, though hesitant, range of movement, whereas others have a stiff joint but with little or no pain, swelling or warmth, it seems reasonable to separate the range of movement of the knee from its "clinical state" in any attempt to assess this relationship. The "clinical state" is admittedly a rather vague concept

TABLE II
Results in Seventeen Knees Studied for More than Two Years after Synovectomy, Related to the State of the Articular Cartilage at Time of Operation

<table>
<thead>
<tr>
<th>Articular degeneration</th>
<th>Number of knees</th>
<th>Clinical state</th>
<th>Range of movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Much improved</td>
<td>Improved</td>
</tr>
<tr>
<td>Little</td>
<td>5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td>9</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Much</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>17</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

* Range good before synovectomy in two cases. † Range good before synovectomy in one case.

but it does represent an important expression of the reaction of the knee to the rheumatoid process.

Tables I and II show the result of correlating the stage of the articular surfaces with the clinical state and the range of movement in knees studied respectively for less than two years and for more than two years after operation. The numbers are small, but in the first two years the findings seem to support the belief that the improvement is related to the state
of the joint surfaces. After two years this relationship is not evident, and a search is required for other factors capable of influencing the result.

Effect of other factors—Experiments with rabbits (Key 1925) have shown that the synovial membrane can regenerate almost perfectly within about sixty days of synovectomy.

No comparably detailed study appears to have been undertaken in man, but synovial regeneration certainly occurs. Efskind (1941) has reported subsynovial fibrosis and a relative lack of blood vessels in regenerated human synovium, and Hosford (1937) reported a normal arthrogram six years after synovectomy. Swett (1923) operated a second time, and successfully, on a knee which relapsed early after the first synovectomy, and Inge (1938) reported regenerated and diseased synovium at a second arthrotomy; so it is clear that reformed synovial tissue is not immune to the rheumatoid process.

From the detailed histories of the patients it has been possible to separate two groups. In one the rheumatoid process had followed a definitely unfavourable course with repeated flares and had involved more and more joints. The other group contained patients whose disease died down at an early stage or else smouldered quietly with little progression. Figure 2 shows the relationship between the range of movement after operation and the course of the disease. It will be seen that of the twenty-one
Serial radiographs, over five years, of a knee treated by synovectomy. Figure 3—Initial radiograph. Figure 4—Two years later. Figure 5—After three years. Figure 6—After five years. The rheumatoid process was inactive. Despite the progressive development of osteoarthritis a wide range of movement was preserved and function was good.
knees that retained or attained a range of movement of at least 90 degrees after operation, eighteen belonged to patients in the "favourable" group. The twelve knees in which the final range was less than 90 degrees were equally distributed between the "favourable" and "unfavourable" groups. Looked at from another point of view, an unfavourable course was associated with twice as many poor (six) as good (three) ranges whereas in the favourable group, good ranges (eighteen) outnumbered poor (six) by three to one. It therefore seems clear that the activity and progression of the rheumatoid process is an important—perhaps the most important—factor in determining the final range of movement after synovectomy. Support for this belief is provided by the knee illustrated in Figures 3 to 6. In spite of the progressive development of osteoarthritis over a period of five years the range of movement decreased only from 180-85 degrees to 180-100 degrees. During this time the rheumatoid process was quiescent, as indicated by the facts that the knee was cool and there was little effusion and no synovial thickening. Five and a half years after operation function remained good in that the patient was able to do an ambulant job with no more than occasional aching and stiffness after exertion or in bad weather.

**SUMMARY AND CONCLUSIONS**

1. Synovectomy was carried out in thirty-four knees, of which thirty-one were certainly or probably afflicted by rheumatoid arthritis.
2. Synovectomy was considered only when adequate medical and physical treatment had failed to afford relief. Its purpose is to preserve useful function, and one of the principal factors influencing the decision to operate was the retention of a normal or good radiographic joint space in a persistently painful, warm and swollen knee.
3. Radiographic appearances constituted a useful but not infallible guide to the true state of the articular surfaces.
4. The method of operation, findings and subsequent care are described.
5. Up to two years after operation it appeared that improvement might be related to the state of the articular surfaces, but after two years this relationship was not evident and an attempt to explain this difference has been made.
6. It seems clear that the longer-term results are determined mainly by the course taken by the rheumatoid process. An unfavourable course was associated with considerably less satisfactory results than was a favourable course.
7. It is concluded that in rheumatoid arthritis which has resisted rest and medical treatment synovectomy of the knee is most likely to be successful when the radiographic joint space is good or normal, and when the rheumatoid process follows a favourable course. To undertake the operation at an early stage in the disease is to leave in doubt the outcome, as this is dependent upon the as yet undeclared general course of the disease. Even so, early synovectomy is worth considering when nothing else has given relief. The fact that arthrodesis has only once been necessary after synovectomy appears to justify the policy of salvage described.

It is with pleasure and gratitude that I acknowledge the assistance, criticism and permission to record their patients that Dr G. D. Kerley, Mr John Bastow and Mr A. E. Burton have provided.

**REFERENCES**

SYNOVECTOMY OF THE KNEE IN RHEUMATOID ARTHRITIS


Swett, P. P. (1939): The Use of Synovectomy in Chronic Arthritis. New York State Journal of Medicine, 39, 2,125.