A STUDY OF THE END-RESULTS OF COMPRESSION ARTHRODESIS OF THE KNEE

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This paper is a review of the results of compression arthrodesis of the knee performed during the ten-year period from 1946 to 1956. It was decided to exclude three cases of Charcot’s disease because this condition seems to offer special difficulties unrelated to the general problem of osseous union.

The documents of 171 adult cases were available for study, and it is interesting to record immediately that only two failures were encountered, so giving a success rate for compression arthrodesis of the knee of 98.8 per cent. The average time from operation to discarding plaster and walking free of external splintage, in the 169 successful cases, was nine weeks.

The operations were performed by ten different surgeons and therefore the details of operative technique and post-operative management showed minor variations; for this reason only the broadest conclusions can be drawn. In all cases the joint surfaces were resected with a saw. Compression was applied by transfixing the bones above and below the resected joint with 4-millimetre Steinmann nails and attaching compression clamps to the projecting ends (Key 1932, Charnley 1948). In most cases external splintage by Thomas’s splint or plaster cylinder was employed. In a small number of cases no external splint was used. In most cases compression was maintained for four weeks, but in a few the compression was maintained for six weeks. A plaster cylinder was applied when the compression nails were removed, and in most cases this was retained for four weeks. If consolidation was not complete at the end of this time the plaster cylinder was reapplied and retained until clinical union was sound. Weight bearing was permitted during the first week after application of the plaster. We consider the most important statistic to be the time after operation when the plaster was finally discarded.

Specially detailed operation notes were available in forty-nine of the cases which had been operated on by the principal author (J. C.). In these it was known that a compression force of approximately 100 lb. had been employed in accordance with the method of estimating the deflection of the nails described elsewhere (Charnley 1953). Although equally high forces were used by many of the other surgeons, this was not thought to be an invariable rule. Therefore an attempt was made to see whether the results in the cases in which it was known that high pressure was used showed any significant trend towards quicker union in comparison with the remaining 120 successful cases.

CLINICAL MATERIAL

The main clinical groups comprised cases of osteoarthritis, rheumatoid arthritis and tuberculosis, as indicated in Table I. Seven knees with miscellaneous pathology were also arthrodesed and are included in this Table.

BONE DENSITY

In thirty-three non-tuberculous cases the notes made specific reference to the quality of the bone encountered at operation—that is, to the presence of normal density or to the presence of a notable degree of osteoporosis. In these non-tuberculous cases the osteoporosis was almost always the result of rheumatoid arthritis. Fifteen patients with osteoporosis were walking free of plaster in an average time of 8-2 weeks after operation; eighteen patients with bone of normal density were walking free of plaster 7-6 weeks after operation.
COAPTATION IN RELATION TO UNION

Radiographs were not available in all of the 171 cases, but in those which were available twenty-two cases were discovered in which the apposition of the cut bone surfaces was incomplete. In these the anterior or the lateral views showed gaping of the cut surfaces so that intimate apposition was present over a reduced area. Union failed to occur in one case, which is reported later as presenting one of the two failures in the series. In all the remaining twenty-one cases union occurred; and the average time between operation and walking free of plaster was 9.4 weeks. Compared with the average time of nine weeks for union in the whole series, the delay from defective coaptation was thus very slight.

TABLE I
ANALYSIS OF CLINICAL MATERIAL (169 cases)

<table>
<thead>
<tr>
<th>Number of cases</th>
<th>Pathology</th>
<th>Average time to walking free (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>Osteoarthritis</td>
<td>8.5</td>
</tr>
<tr>
<td>37</td>
<td>Rheumatoid arthritis</td>
<td>9.0</td>
</tr>
<tr>
<td>68</td>
<td>Tuberculosis (adult)</td>
<td>9.5</td>
</tr>
<tr>
<td>2</td>
<td>Old deformed ankylosis</td>
<td>9.5</td>
</tr>
<tr>
<td>2</td>
<td>Spastic hemiplegia</td>
<td>9.0</td>
</tr>
<tr>
<td>1</td>
<td>Old compound fracture knee</td>
<td>8.0</td>
</tr>
<tr>
<td>1</td>
<td>Osteomyelitis of patella</td>
<td>8.0</td>
</tr>
<tr>
<td>1</td>
<td>Poliomyelitis (weak quadriceps)</td>
<td>8.0</td>
</tr>
</tbody>
</table>

CLINICAL UNION AT THE END OF COMPRESSION

The state of clinical union was recorded at the time of removal of the compression apparatus and at the time of application of the ambulatory plaster cylinder in 145 cases. The compression apparatus was removed, and the walking plaster was applied, at an average of four weeks after operation. Of these 145 knees 88.2 per cent were recorded as clinically united at four weeks. By "clinical union" we mean that no trace of movement, or of fibrous "give," could be detected when the arthrodesis was subjected to passive strain.
When the compression clamps were removed in seventeen cases it was recorded that slight movement was still present in the arthrodesis. In all of these cases clinical union developed while the patient was walking in a plaster cylinder in an average time of ten weeks from the time of operation.

COMPLICATIONS
There was no mortality. The complications are enumerated in Table II. In the six cases of mild pin-track infection the tracks all healed without trouble. The two wound infections also resolved under antibiotics and sound osseous union occurred. The four cases of supracondylar fracture were caused by using a hammer to drive the nail; no displacement of the incomplete fracture occurred and union took place at the same time as arthrodesis.

THE FAILURES
Two patients failed to achieve osseous union, which makes a failure rate of 1.2 per cent. In one case the failure was because one of the compression nails broke. The cause of failure in the other case is unknown, but it is recorded that the apposition of the cut bone surfaces was defective.

DISCUSSION
The most interesting result of this investigation is the success rate and the average time for clinical union of the whole series.

The successful results in twenty-one of the twenty-two cases in which coaptation was imperfect are of great theoretical interest when the reasons for the success of the compression technique are debated. It is often considered that the success of compression arthrodesis is the result merely of simple mechanical factors—namely, the intimate coaptation produced by pressure and the immobilisation which follows automatically from the accurate coaptation of plane surfaces of considerable area. But compression can produce rigid immobilisation only if the plane surfaces of the resected joints are in contact over the whole area. If the surfaces gape even slightly the rigidity of fixation cannot be greater than that provided by the external fixation. In only one of the twenty-two cases in which apposition was defective did union fail to occur. The combination of defective apposition and defective rigidity certainly prolonged the average time for union, but it did so only very slightly. This supports the idea that absolute immobilisation is not a primary factor in the success of compression arthrodesis of the knee, but as a secondary factor absolute immobilisation is a valuable adjunct. This reasoning supports the idea that absolute immobilisation is essential only when osteogenesis is defective or absent in one element taking part in any union, as for instance in bone grafting. When both the elements taking part in any union have a full blood supply and normal powers of osteogenesis, these experiences with compression arthrodesis of the knee suggest that the degree of immobilisation necessary for success is something less than absolute.

In comparison with normal bone the slightly longer time required to secure clinical union in the osteoporotic bone of rheumatoid arthritis is interesting in view of the common opinion that it is easier to arthrodese the knee in rheumatoid arthritis than in most other conditions.

SUMMARY
1. An analysis of 171 cases of compression arthrodesis in the knee is presented.
2. A total success rate of 98.8 per cent was revealed.
3. The average time between operation and walking free of splintage was nine weeks.
4. When the compression was removed, after an average period of four weeks, 88.2 per cent of the knees already showed clinical union.

REFERENCES