TARSAL HYPERMOBILITY AFTER ANKLE FUSION—FACT OR FICTION?

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Thirty-seven patients have been reviewed after arthrodesis of the ankle in order to determine the reduction of dorsiflexion and plantarflexion of the foot, the incidence of tarsal hypermobility and its relevance to the clinical results of this procedure. Radiological methods of measuring movements in the foot and tarsus are described and applied to patients who had a normal foot on the opposite side which could be used as a control. Our findings suggest that tarsal hypermobility is not as common as has hitherto been supposed and that a stiff foot with minor radiological degenerative changes in the tarsal joints is quite compatible with an excellent result.

The suggestion that the clinical result of arthrodesis of the ankle is affected by the amount of compensatory tarsal hypermobility that develops was first made by Kimberly (1936), who reviewed twenty-two patients submitted to ankle fusion. He stated that "the loss of motion in the ankle joint caused very little disability and was partly compensated for by an increased motion in the remaining joints of the foot". The concept of hypermobility developing after fusion and its beneficial contribution to the end result has been stressed by subsequent writers (Kennedy 1960; Said, Hunka and Siller 1978). Fisk (1969) observed that a successful ankle fusion could hardly be detected and Colton (1976), supporting this observation, suggested that the patient being offered ankle fusion should be told that the final range of movement would not be altered, but that pain would be relieved. Radiological signs of degenerative change in the tarsal joints (Thomas 1969) and tarsal stiffness (Kennedy 1960) have also been blamed for an unsatisfactory clinical result.

The recognition of tarsal hypermobility has, however, been purely subjective and no attempts have yet been made to measure tarsal movements after ankle fusion. Recent interest in total ankle replacement has emphasised the need to analyse this phenomenon more closely. The surgeon now faces a choice in selecting treatment for the patient with a painful arthritic ankle, and the clinical and radiological state of the other joints in the foot may be highly relevant to his decision. The indications for replacement arthroplasty have yet to be established, but if it is true that stiffness in the mid-foot will compromise the result of ankle fusion, then in this circumstance the balance may be tilted in favour of a joint replacement.

**Table 1. Indications for fusion**

<table>
<thead>
<tr>
<th>Reasons for fusion</th>
<th>Number of patients</th>
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<tbody>
<tr>
<td>Post-traumatic osteoarthritis</td>
<td></td>
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<tr>
<td>After fracture</td>
<td>21</td>
</tr>
<tr>
<td>After ligament injury</td>
<td>8</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>3</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Idiopathic arthritis</td>
<td>2</td>
</tr>
<tr>
<td>Osteochondritis of the talus</td>
<td>1</td>
</tr>
</tbody>
</table>

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**MATERIALS AND METHODS**

Forty-seven patients who had undergone fusion of the ankle were seen and reviewed at intervals varying between one and twenty-five years after operation. Since it was essential for this study that each patient should have a normal foot to act as his own control and that no further procedure should have been performed distal to the ankle on the operated side, ten patients had to be excluded. The remaining thirty-seven patients were seventeen women and twenty men whose ages at the time of review ranged from twenty-one to eighty with an average of sixty years. The patients had been aged between fourteen and seventy-six at the time of fusion.

The indications for fusion are listed in Table 1. Post-traumatic osteoarthritis formed the largest group, and it is significant that in eight of the twenty-nine patients in this group the primary trauma was a ligament injury alone. In two patients, listed as idiopathic, no apparent cause could be found for the degenerative changes that developed in the ankle joint. Every patient in this series achieved a solid fusion by a variety of operative methods, the details of which are not relevant to this paper.

Lateral radiographs of both feet and ankles were taken at the extremes of dorsiflexion and plantarflexion. The range of movement was then measured as shown in Figures 1 and 2. A line $AB$ was drawn in the long axis of the tibia and a second line $CD$ was drawn from the inferior surface of the os calcis to the underside of the first metatarsal head. The angle subtended by these two lines was measured and by
Lateral radiographs of a normal foot taken at the extremes of dorsiflexion and plantarflexion. The range of movement in this example is 60 degrees.

Fig. 1

Method of measuring the range of movement of tarsal and tarsometatarsal joints on the normal (Fig. 3) and arthrodesed (Fig. 4) sides subtracting the value in dorsiflexion from that in plantarflexion the extent of upward and downward movement of the foot on the tibia was determined. By comparison with the normal side we were able to assess the overall reduction in movement on the arthrodesed side.

Movements at the tarsal and tarsometatarsal joints were estimated using the same lateral radiographs (Figs. 3 and 4). A line was drawn in the long axis of the first metatarsal and by superimposing the image of the talus in the dorsiflexion and plantarflexion views, the degree of vertical movement of the first metatarsal about the talus was determined. This is a summation of the movements taking place at the intervening joints and therefore a measure of tarsal mobility. We have found this method to be easily reproducible to an accuracy of ±5 degrees.

In order to relate the degree of apparent ankle movement to the clinical result the patients were graded as follows: Group I (excellent) had a pain-free ankle, were able to walk without a limp, run with an even stride and climb stairs normally; Group II (good) were able to walk at least two miles with minimal discomfort in normal shoes with no walking aid, but were unable to run evenly; Group III (fair) had a marked limp when walking, required modifications to the shoe, had persistent discomfort, but had less pain and discomfort than before operation; Group IV (poor) had severe pain which was unchanged by the operation, depended on walking aids, calipers or ankle, and had a very limited walking range with a marked limp.

RESULTS

The range of dorsiflexion and plantarflexion of the normal foot and the foot with the fused ankle was compared in each patient. After arthrodesis this movement was restricted by an average of 75 per cent and even the most mobile foot had only 50 per cent of the range of the normal side. Without exception movement of the foot was considerably reduced on the operated side.

Movements of the first metatarsal about the talus were then compared (Fig. 5). Tarsal and tarsometatarsal movements were increased in ten and reduced in twelve

Comparison of tarsal movements of the normal foot and the foot with the arthrodesed ankle. Patients falling inside the shaded area were considered to have the same range of movement on each side. Tarsal hypermobility was present in those falling above this line.
patients as compared to the normal side after allowing for an accuracy of ±5 degrees in the method of measurement. Of the ten hypermobile feet, the average increase in movement was 8 degrees with a range of 6 to 13 degrees, whereas the average reduction in movement of the twelve stiff feet was 11 degrees with a range of 6 to 26 degrees. Tarsal hypermobility after ankle fusion is therefore not as common as has previously been supposed. Only 27 per cent of our patients exhibited this phenomenon and in all cases it was of mild degree. Thirty-three per cent of patients in this series were found to have stiffer feet than on the normal side, and in the remaining 40 per cent there was no significant difference.

We think that degenerative changes in the mid-foot account for the fact that hypermobility is not the rule. Twenty-two of our patients had radiological evidence of osteoarthritis in the tarsal joints and ten of these developed a characteristic dorsal limiting osteophyte above the talonavicular joint (Fig. 6). In six of the twenty-two patients, the tarsal and tarsometatarsal degenerative changes were noted to be moderate or severe and only one of these patients was judged as having an unacceptable clinical result.

In view of the large range of age and the variable time interval since fusion in this series we considered the effect of these two factors on tarsal movements before considering the relevance of our results. A comparison of the range of dorsiflexion and plantarflexion in nine patients under the age of fifty and twenty-eight patients over this age, is shown in Table II. Both the normal and fused sides were measured. As can be seen, there was no significant difference in the two groups. Similarly, we compared tarsal movements in patients who had been followed up for less than ten years with those who had been reviewed after a longer period (Table III). Again no significant difference was found between the two groups, supporting the view that significant deterioration of tarsal movements did not occur with the passage of time.

Our measurement of tarsal movements did not take into account the subtalar joint. This joint was stiff in all the feet with arthrodesed ankles that we have examined. Frequently there was only a jog of movement at the subtalar joint and the amount of movement never exceeded half that found on the normal side.

The range of upward and downward movement of the foot was then compared with the clinical result of operation (Table IV). Using our criteria there were only three patients who we considered had achieved a truly excellent result. It is highly significant that two of these had a range of dorsiflexion and plantarflexion of less than 10 degrees, and none of the hypermobile feet achieved an excellent result. These figures indicate that a flexible mid-foot is not an essential factor in attaining an acceptable result after ankle fusion and our experience suggests that the best results are associated with average mobility.
DISCUSSION

Arthrodesis of the ankle will eliminate pain originating from an arthritic ankle joint providing solid fusion is achieved. Satisfaction with this aspect of the operation and surprise at the residual range of foot movement has led previous authors to suggest that tarsal hypermobility is an important factor in achieving a good result. However, the contribution made by the joints distal to the ankle in normal dorsiflexion and planarflexion has never been determined. Conversely, stiffness and degenerative changes in the tarsal joints have been blamed for an unacceptable outcome in some patients.

We have found that the foot is much stiffer after ankle fusion than has previously been estimated. The loss of movement results from the primary disease or injury of the ankle joint as well as from the arthrodesis. After fusion, mobility at the tarsal and tarsometatarsal joints still allows some degree of upward and downward movement of the foot and in our patients this was restricted to approximately 25 per cent of that on the normal side. The assumption that this residual movement is due in part to hypermobility has been analysed. Hypermobility was found in only 27 per cent of our patients and in no case was the increase in tarsal movement significant. On the other hand stiffness in these joints was demonstrated in 33 per cent of patients after operation. Tarsal mobility did not appear to be affected by the time interval between fusion and assessment.

The finding of subtalar stiffness in all our patients is in keeping with the observations of Ratliff (1959), but we disagree with his suggestion that arthrodesis has an adverse effect on subtalar movement. It seems more likely that damage to this joint in most cases precedes the fusion and this was seen to be the case in eighteen out of twenty-four patients in our series whose history was sufficiently well documented.

A comparison of the clinical result with the range of movement after fusion failed to demonstrate any significant correlation. A stiff foot is compatible with an acceptable result, as demonstrated by six patients who were graded as excellent or good, and who had less than 10 degrees of residual foot movement.

Radiological evidence of osteoarthritis in the tarsal joints was not a universal feature of the patients examined. The radiographs of fifteen of our patients, with an average follow-up of seven years, showed no evidence of degenerative changes. Furthermore, in the six patients with significant changes in the tarsal joints only one was found to have an unacceptable clinical result. However, subtalar and tarsal osteoarthritis can give rise to significant symptoms to merit triple arthrodesis and this occurred in two out of the original forty-seven patients that we reviewed. Conversion to pantalar arthrodesis excluded them from this study which was primarily concerned with tarsal mobility after ankle fusion.

In the light of these findings, very careful consideration should be given to the selection of patients for total ankle replacement, with its attendant complications. We feel that this operation cannot be justified solely on the basis of providing greater mobility, since residual stiffness after arthrodesis of the ankle is compatible with a good result.

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REFERENCES


