THE CORRECTION OF ANGULAR DEFORMITIES OF LONG BONES
BY OSTEOTOMY-OSTEOCLASIS

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The correction of angular deformities of long bones by incomplete osteotomy, followed three weeks later by manual osteoclasis, overcomes the problem of secondary displacement sometimes seen after correction by complete osteotomy and makes internal fixation unnecessary.

This paper presents an experience of twenty-six operations in eighteen patients. In all cases the deformity was corrected with excellent cosmetic and functional results. Complete bony union was achieved and there were no problems with displacement at the osteotomy site. Four cases are described in detail to illustrate use of the technique in different clinical situations.

Osteotomy of long bones to correct angular deformity is a time-honoured procedure. It can be a straightforward operation, but one of the principal complications is the secondary displacement of the bone fragments soon after operation. This can be prevented by internal fixation, but the operation is thereby made longer and more complex with an increased risk of morbidity. A later operation is often needed to remove the metal implant, and in children the use of internal fixation near the ends of growing bones is relatively undesirable.

Table 1. Sites of osteotomies

<table>
<thead>
<tr>
<th>Site of osteotomy</th>
<th>Number of operations</th>
<th>Number of patients</th>
<th>Mean age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral diaphysis</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Femoral supracondylar region</td>
<td>19</td>
<td>12</td>
<td>23.5</td>
</tr>
<tr>
<td>Upper tibial metaphysis</td>
<td>2</td>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>Tibial diaphysis</td>
<td>4</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

Osteotomy-osteoclasis is a technique in which an incomplete wedge osteotomy is followed three weeks later by completion of the osteotomy and correction of the deformity by manual osteoclasis. By this time bony union and healing of soft tissue have advanced far enough to prevent secondary displacement of the osteotomy fragments, yet still allow easy correction of the angular deformity.

This technique was described by Moore (1947) as a method of correcting deformities of long bones. He used it first in 1934 on a severely malunited subtrochanteric fracture of the femur and subsequently performed 225 operations on a variety of deformities of long bones and on ankylosed joints. There were no malunions or non-unions, and no cases of secondary displacement. Since then, the only reference we have found to further experience of the technique is that of Marottoli (1954), who reported that the method overcame the problems arising from extensive plasters, prolonged immobilisation, delayed union and secondary displacement simply and without internal fixation. He did not, however, indicate the extent of his experience and details of cases were not given.

OPERATIVE TECHNIQUE

The bone is exposed from the convex side of the deformity, keeping the peristium as intact as possible. A wedge of bone is then removed at or near the site of maximal deformity, its base being on the convex surface. In degrees the wedge is a little larger than the deformity to ensure easy correction. It should include the cortex on three sides, the cortex on the concave side being left intact although weakened by several drill holes. The wedge is then cut into small fragments and replaced in the defect, and the peristium carefully closed to hold the bone chips in position. An incomplete plaster is then applied with the limb still in deformity. About three weeks later, when union is far enough advanced to prevent secondary displacement, the plaster and sutures are removed and, with the patient under general anaesthesia, the deformity is corrected by manual osteoclasis. A complete plaster cast is then applied and the adequacy of correction is checked radiographically before the general anaesthesia is discontinued.

In deformity of the mid-femoral diaphysis (Case 4) a complete hip spica is used at the primary operation and osteoclasis is performed after removal of an adequate segment of the plaster spanning the site of the osteotomy. In children, especially when the osteotomy is near the end of a long bone, manual osteoclasis may be difficult at three weeks due to rapid progress towards union. In such patients, osteoclasis is easier two weeks after osteotomy. In adults the technique is essentially the same as in children, but when carried out in the diaphysis (Cases 2 and 3), the predominance of cortical bone leads to a slower union.
Weight-bearing can normally start within two weeks of osteoclasis at the metaphysial level. The plaster is retained until there is union, usually at six weeks in children and eight to twelve weeks in adults.

RESULTS

In this series, twenty-six operations were performed at different sites (Table I) in eighteen patients with deformities of varied aetiology (Table II). There were no instances of secondary displacement. All osteotomies proceeded to sound clinical union in a mean time of eleven weeks.

The following reports of four cases illustrate the use of the technique in differing clinical situations.

<table>
<thead>
<tr>
<th>Cause of deformity</th>
<th>Number of operations</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rickets</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Malunions of fractures</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Congenital deformities</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Childhood osteomyelitis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>18</td>
</tr>
</tbody>
</table>

Table II. Causes of deformity

CASE REPORTS

Case 1—Bilateral osteotomy-osteoclasis at the femoral supracondylar level. A fifteen-year-old Pakistani boy had complained of pain in both knees for one year. He had a bilateral genu valgum (Fig. 1) with an intermalleolar separation on standing of 18 centimetres. After full investigation dietary deficiency rickets was diagnosed. He was given vitamin D, 1 milligram daily, and shortly after starting treatment the pain in his knees disappeared and fourteen months later his alkaline phosphatase had returned to normal. Bilateral synchronous femoral supracondylar osteotomies were performed removing medially based wedges, and long leg cylinders of plaster applied. Two weeks later the deformities were corrected by manual osteoclasis, new plasters were applied, and ten days later the patient went home weight-bearing with crutches. The plasters were removed five weeks after osteoclasis when bony union had been achieved, and thereafter the patient rapidly regained full movement of the knee with no residual deformity (Fig. 2).

Case 2—A malunited compound fracture of the tibia with scarring of the overlying skin. A thirty-nine-year-old man fell and sustained a compound comminuted fracture of the lower end of his left tibia. This was primarily fixed internally at another hospital, but three months later the plate broke and revealed a non-union in deformity. Five months after injury the patient had a cancellous graft; a posterior access was used because the skin over the anteromedial surface of the non-union was unsuitable for incision due to considerable scarring. Union was eventually achieved ten months later, and after a further ten months the broken plate and screws were removed. The patient was able to walk slowly but had pain over the dorsum of the left ankle. There were 4 centimetres of shortening of the left leg, with a 15-degree valgus and a 10-degree posteriorly angulated malunion of the left lower tibia (Figs. 3 and 4).

Four years after the original injury an incomplete wedge osteotomy of the tibia was performed above the level of the malunion.

Fig. 1

Case 1. Figure 1—Bilateral genu valgum. Figure 2—After correction by bilateral osteotomy-osteoclasis.
using an anterior approach through healthy skin above the site of the original operation. A long leg plaster was applied, and three weeks later the deformity was corrected by manual osteoclasis combined with fibular osteotomy. After three months bony union had been achieved and the plaster was removed (Figs. 5 and 6). Six months after operation the patient was walking normally with full movements in the ankle and subtalar joints; he had no pain and no clinical deformity.

and weight-bearing was started at four weeks. Six months after operation there was clinical union, but radiographically the dense cortical bone was not fully consolidated, and so normal use and full weight-bearing were continued but with the protection of a below-knee Orthoplast brace. Within a further three months, consolidation was complete (Fig. 9) and the brace was removed. When the patient was last seen for review eighteen months after operation

Case 3—Tibial deformity resulting from childhood osteomyelitis, with scarring of the overlying skin. A forty-one-year-old woman complained of an unsightly deformity of her right leg which was a result of osteomyelitis and a drainage operation of her right upper tibia at the age of three (Fig. 7). When she was twenty-two years old another surgeon had achieved partial correction by an osteotomy just below the tibial tubercle, but a 26-degree varus deformity of the right upper tibia was still present (Fig. 8) with 6 centimetres of shortening. The patient also complained of an aching pain in her right knee which had limitation of flexion to 120 degrees with radiographic evidence of moderately advanced osteoarthritis. The skin over the anterior aspect of the right leg was considerably scarred and adherent to bone over the upper and middle regions of the subcutaneous surface of the tibia.

A posterior approach was used to expose the tibia and the adherent anterior scar was mobilised by subperiosteal dissection using a Pennybacker elevator. A one-centimetre wedge of bone, based laterally, was removed at the summit of the deformity, just proximal to the middle of the tibial diaphysis; the fibula was weakened by an incomplete transverse saw cut. A long leg plaster was applied. Manual osteoclasis was carried out three weeks later, a new plaster was applied the deformity was fully corrected and she walked well without pain, although flexion of the knee was still limited to 90 degrees.

Case 4—A malunited fracture of the femur. A sixteen-year-old girl was involved in a road accident while riding as a pillion passenger on a motorcycle. She sustained a comminuted fracture of the mid-shaft of the left femur and a compound fracture of the shaft of the left tibia. After wound excision, the fractured tibia was immobilised in a below-knee plaster cast, and the femoral fracture was treated by sliding skeletal traction for three months and then by a plaster spica for five weeks. The tibial fracture united unevenly, but the femoral fracture failed to unite, and so five months after injury a cancellous graft was performed. This led to bony union of the fracture (Figs. 10 and 11), but with a 30-degree varus deformity and 3 centimetres of shortening of the left leg.

Three years after the injury an incomplete osteotomy was performed removing a laterally based wedge of bone from the site of the previous bone graft. A hip spica was applied, and three weeks later the deformity was corrected by osteoclasis. After three months in a new plaster spica the osteotomy had united with full correction of the deformity (Figs. 12 and 13) and only 1 centimetre of shortening.
Case 3. Figure 7—Tibial deformity as a result of childhood osteomyelitis. Figure 8—Deformity remaining after partial correction by an osteotomy below the tibial tubercle at the age of twenty-two years. Figure 9—Appearance nine months after correction of the deformity by osteotomy-osteoclasis.

CONCLUSION
The results of these twenty-six operations lead us to believe that osteotomy-osteoclasis is a valuable technique for correcting angular deformities of long bones. The operation is straightforward, the incision needed is relatively small, internal fixation is unnecessary, and the size and alignment of the wedge of bone removed is not critical, it usually being slightly larger than necessary to allow for easy correction. The technique is equally applicable and valuable to adolescents and adults: in the former, care has to be taken to avoid the epiphysial plate; in the latter, particularly when operating at diaphyseal level, the predominance of cortical bone may result in a slower rate of union.

When deformity is complicated by adherent scarred skin the operation can be performed proximal or distal to the site of deformity, or by a different access (as in Case 3), separating the skin and periosteum together from the underlying bone.

The reliability of the method is shown by the absence of secondary displacement of the osteotomy fragments in all our patients, and the achievement of sound bony union with good cosmetic and functional results.

REFERENCES