Between 1988 and 1995, we studied 91 club feet from a series of 120 recalcitrant feet in 86 patients requiring surgical treatment. There were 48 boys and 20 girls. The mean age at operation was 8.9 months. Surgery consisted of an initial plantar medial release followed two weeks later by a posterolateral release. This strategy was adopted specifically to address the problems of wound healing associated with single-stage surgery and to ascertain the rate of relapse after a two-stage procedure. Immobilisation in plaster was used for three months followed by night splintage. The feet were classified preoperatively and prospectively into four grades according to the system suggested by Diméglio et al. Grade-1 feet were postural and did not require surgery. All wounds were closed primarily. One superficial wound infection occurred in a grade-4 foot and there were no cases of wound breakdown. The rate of relapse was 20.4% in grade-3 and 65.4% in grade-4 feet.

Two-stage surgery for the treatment of club foot seems to be effective in the reduction of wound problems but does not appear to give significantly better results in terms of relapse when performed for more severe deformities.

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The surgical management of talipes equinovarus remains a major challenge. There is little agreement on operative treatment and a variety of procedures are described in the literature. The lack of a reproducible classification system remains a fundamental problem when comparing different studies. Recent work by Bensahel, Catterall and Diméglio has highlighted the need for a pragmatic classification to enable comparison to be made between cases of similar severity. Many reports group all cases together which makes analysis difficult and confusing. The assessment of complications and the outcome of surgery are only significant if a reproducible system for classification is used.

In this prospective study we have used staged surgery to address the problems of wound healing which are often seen after extensive one-stage soft-tissue procedures. It is recognised that with more severe deformities the skin on the medial side of the foot may be under tension which may lead to increased breakdown and wound infection. Many strategies have been described to reduce such complications including leaving wounds open to granulate, the use of skin grafting and rotation flaps, and casting with sub-optimal correction followed by further serial manipulations. Our study describes the incidence of wound complications and relapse of the deformity after two-stage surgery.

Patients and Methods

Since 1988 all children presenting with talipes equinovarus undergo a programme of physiotherapy starting from birth which is initiated and supervised by the senior author (NMPC). Passive stretching and serial plaster casts are used in combination. Those with recalcitrant deformities undergo a two-stage surgical correction before they start walking, usually at the age of nine months. The range of movement and degrees of equinus, varus and supination are recorded and all feet are photographed.

Between 1988 and 1995, 86 children (61 boys, 25 girls) with 120 primary club feet underwent surgical treatment. In 19 boys and 11 girls the deformity was bilateral. Twenty-nine feet were excluded of which 19 required only a posterolateral release to achieve correction. Six children (ten feet) were excluded because they had arthrogryposis, spina bifida, cerebral palsy, hemipelvic hypoplasia or the Larsen syndrome.

Accordingly, 68 children (91 feet) had the two-stage operation and form the basis of our study. Their mean age at surgery was 8.9 months. Of the 91 feet, 73 (80.2%) were available for follow-up at a mean of 5.7 years (2.2 to 9.6).

Operative technique. This has been described in detail by Carroll, McMurtry and Leete as a one-stage procedure.
our study the plantar medial and posterolateral procedures were carried out at an interval of two weeks and were performed through separate incisions. Two weeks after the first stage the medial plantar wound was inspected for signs of infection and if there was doubt the second stage was delayed for a further two weeks. The skin incisions used are designed to give excellent exposure of the entire anatomy, allow protection of the neurovascular structures, preserve the tendon sheaths of the tibialis posterior, flexor hallucis and flexor digitorum tendons and promote healing with minimal scarring and good cosmesis. The landmarks for the medial incision form a triangle and are the centre of the os calcis, the front of the medial malleolus and the base of the first metatarsal. The incision is parallel to the base of the triangle but is curved in the plantar direction proximally and over the dorsum of the foot distally (Fig. 1a). The posterolateral incision runs obliquely from the mid-line of the distal calf posteriorly to a point mid-way between tendo Achillis and the lateral malleolus (Fig. 1b).

The following structures are divided:

1) Plantar medial incision: abductor hallucis, deep fascia, plantar fascia, flexor digitorum brevis, abductor digiti quinti, the long and short plantar ligaments, the talonavicular joint capsule, and the medial and plantar capsule of the calcaneocuboid joint.

2) Posterolateral incision: lengthening of tendo Achillis, lengthening of tibialis posterior, division of the calcaneofibular ligament, division of the posterior talofibular ligament, posterior capsular release of the ankle and subtalar joints and release of the anterior portion of the deltoid ligament.

After operation, serial above-knee plaster casts are applied for three months with a change under general anaesthesia at six weeks. Night splints are used thereafter for as long as the child will tolerate them and usually until the age of two years.

Classification. Before operation each foot was graded into one of four groups as described by Dimeglio et al (Table I). This was favoured because of its pragmatic approach.

Results

Preoperative grade. Of the 91 feet, 11 (12.1%) were grade 2, 54 (59.3%) grade 3 and 26 (28.6%) grade 4. None was grade 1 since these do not require surgery.

Relapse. Any further surgical procedure after the initial two-stage procedure was considered to represent a relapse of the deformity. There was none in grade-2 and 20.4% in grade-3 feet. The grade-4 feet predictably had the highest rate of relapse with 65.4% requiring further surgery (Table II). Using the Cochrane-Armitage Trend test the increased proportion of relapses with increasing severity of preoperative grade was found to be statistically significant (p = 0.001). Using the Mantel-Haenszel test significantly more girls were found to relapse than boys (p = 0.018) but the proportion of relapses for patients with bilateral club feet was not significantly higher than for patients with unilateral club foot (p = 0.377). The mean age at relapse was 3.03 years (1.52 to 5.44).

Postoperative classification. The outcome for each of the

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Table I. The classification described by Dimeglio et al

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>These feet are postural and fully correctable. They respond to physiotherapy and do not require surgery. They may have slight residual deformity but have &gt;90% of flexibility</td>
</tr>
<tr>
<td>2</td>
<td>These feet remain fairly mobile with &gt;50% of reducibility. The varus, equinus and supination deformities are &lt;20°</td>
</tr>
<tr>
<td>3</td>
<td>The reducibility of the foot is &lt;50% with between 20° and 45° of varus, equinus and supination</td>
</tr>
<tr>
<td>4</td>
<td>This is the severe or teratologic foot. The reducibility of the foot is &lt;20% and the varus, equinus and supination deformities are &gt;45°</td>
</tr>
</tbody>
</table>

Table II. The rates of relapse for each preoperative grade

<table>
<thead>
<tr>
<th>Preop grade</th>
<th>Number of feet</th>
<th>Number relapsed</th>
<th>Relapse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>11</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>54</td>
<td>11</td>
<td>20.4</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
<td>17</td>
<td>65.4</td>
</tr>
</tbody>
</table>
preoperative grades of deformity is shown in Table III. No feet were worse after surgery; 96.3% of preoperative grade-2 feet, 56.0% of preoperative grade-3 and 17.4% of preoperative grade-4 feet became grade 1 after surgery. Grade-2 feet were found in 22.0% of preoperative grade-3 and 21.7% of preoperative grade-4 feet. Grade-3 feet were identified in 26.1% of preoperative grade-4 feet. Of the preoperative grades 3.7% of grade 2, 22.0% of grade 3 and 34.8% of grade 4 were assessed to be the same at follow-up. The preoperative and postoperative clinical photographs of two cases are shown in Figures 2 and 3.

**Table III.** The follow-up grades for each of the initial groups.

<table>
<thead>
<tr>
<th>Preop grade</th>
<th>Postoperative grade (%)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>96.3</td>
<td>3.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>56.0</td>
<td>22.0</td>
<td>22.0</td>
<td>0.0</td>
</tr>
<tr>
<td>4</td>
<td>17.4</td>
<td>21.7</td>
<td>26.1</td>
<td>34.8</td>
</tr>
</tbody>
</table>

**Wound healing.** One superficial medial wound infection was encountered in a grade-4 foot. The rate of infection was therefore 1.1% of cases and 0.5% of wounds. In three patients with grade-3 feet there was evidence of poor healing and the second-stage procedure was therefore delayed. No evidence of slough or necrosis was identified and no further procedures were required for any of the wounds.

**Discussion**

Wound complications are acknowledged to be a problem in treating talipes equinovarus. The risk of infection and sloughing increases with more severe deformities and the incidence is higher in older children and in revision cases. Wound problems in association with primary correction have been recorded frequently in the literature although the exact incidence is not known. Greider et al reported three significant skin complications in 19 older patients (15.8%) whose mean age was 6.3 years. Napiontek described the use of transposing skin grafts in nine patients, two of which failed. Bethem and Weiner found an incidence of skin necrosis of 3.7% and Hutchins et al that of wound breakdown and infection of 3.6%. In Turco’s review of 240 club feet, primary surgery was performed in 74%. Two of six cases of wound dehiscence or necrosis occurred in the
primary surgery group. Similarly, Crawford, Marxen and Osterfeld describe six cases of slough, one of wound drainage and one of skin necrosis in a series of 154 feet. Of 38 patients with talipes equinovarus, they found one wound problem but it is not clear whether there were others. Thompson, Richardson and Westin report one case of wound slough, which required a skin graft, in a series of 93 feet. In the series of Porat and Kaplan, in which Carroll’s approach had been used, the first two patients had superficial wound sloughs, caused by undermining of the edges of the skin flaps. Once this problem was identified no further wound problems were encountered.

There are many descriptions of strategies to avoid wound problems and techniques to treat them when they occur. It is difficult to discover the true incidence of wound complications although it appears to be less than 4% when treating primary idiopathic talipes.

Our study shows that two-stage surgery seems to be effective in reducing wound complications. In 91 operations the wounds were closed primarily and there was only one superficial wound infection. The second-stage procedure was delayed in a further three cases as a precaution although the wounds were not clinically infected. Neither wound sloughs nor necrosis occurred and there was no requirement for skin grafts or other plastic procedure. The precise incisions used are of great importance in preventing complications and their safety has been confirmed by studies identifying specific vascular territories or angiosomes.

The two-incision approach used at the same operation has been described by Carroll et al. Coleman has discussed using staged surgery for more severe deformities but we are not aware of any other series using a staged protocol. Pandey and Pandey have described using two incisions but have not reported their results. Porat and Kaplan reviewed 33 feet at a mean follow-up of four years and found unsatisfactory or failed results in 18%. No criteria for preoperative assessment were given but the authors comment that “Postoperatively, the foot with the worse result was usually the one with more resistance preoperatively”. Magone et al reported 35 idiopathic club feet treated surgically with a follow-up of 25 months but five patients had had nine previous procedures. The results were ‘poor’ in 23% and ‘fair’ in 29% but no preoperative classification was used.

The overall rate of reoperation reported in our series is 30.8%. Hutchins et al report further surgery in 26.6% and
Hudson and Catterall in 32%. Atar, Lehman and Grant and Harrold and Walker report a rate of reoperation of 10% but many series do not state the exact number of cases which required further surgery. It would seem therefore that a two-stage procedure is not associated with less favourable results than any other form of surgery in terms of wound problems. At best it may actually confer an advantage. We also sought to establish the rate of relapse using this strategy. It seems unlikely that staged procedures would generate increased scarring in the absence of wound problems and therefore relapse can be assessed according to the severity of the initial deformity.

The effectiveness of surgery for the treatment of club foot can only be properly judged if the deformity is classified preoperatively. Since Dangelmajer described a scoring system in 1961 only Harrold and Walker, Porter and Attenborough have published series on the treatment of club foot which include preoperative assessment. We have chosen the scoring system which was initiated by Dimeglio (1988, personal communication), and is pragmatic and uncomplicated. It has been developed further and is used in conjunction with a method of final evaluation to assess the outcome of surgical treatment, and we have been able to make a direct comparison between the preoperative grade and that at the final follow-up. The results presented show that preoperative grading of the feet according to severity is helpful in analysing the results of surgery. The correction obtained is less and the need for further surgery greater in those with more severely deformed feet. An overall rate of reoperation of 30.8% is biased by the fact that 65.4% of grade-4 feet required further surgery. This suggests that modifications to the procedure such as primary frame correction at a younger age are required to improve the outcome of grade-4 feet. The crux of the problem is the ability to identify preoperatively those cases with a poor prognosis. Comparison with the results of other authors is difficult as most do not include preoperative classification of the deformity.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References