Continuous passive motion versus immobilisation in a cast after surgical treatment of idiopathic club foot in infants

A PROSPECTIVE, BLINDED, RANDOMISED, CLINICAL STUDY

F. Zeifang, C. Carstens, S. Schneider, M. Thomsen

From the Orthopaedic University Clinic, Heidelberg, Germany

Continuous passive motion has been shown to be effective in the conservative treatment of idiopathic club foot. We wished to determine whether its use after operation could improve the results in resistant club feet which required an extensive soft-tissue release. There were 50 feet in the study. Posteromedial lateral release was performed in 39 feet but two were excluded due to early relapse. The mean age at surgery was eight months (5 to 12). Each foot was assigned a Dimeglio club foot score, which was used as a primary outcome measure, before operation and at 6, 12, 18 and 44 months after. Nineteen feet were randomly selected to receive continuous passive motion and 18 had standard immobilisation in a cast.

After surgery and subsequent immobilisation in a cast the Dimeglio club foot score improved from 10.3 before to 4.17 by 12 months and to 3.89 at 48 months. After operation followed by continuous passive motion the score improved from 9.68 before to 3.11 after 12 months, but deteriorated to 4.47 at 48 months. Analysis of variance adjusted for baseline values indicated a significantly better score in those having continuous passive motion up to one year after surgery, but after 18 and 48 months the outcomes were the same in both groups.

Continuous passive motion (CPM) has been used effectively after various operations such as repair of the rotator cuff, rupture of the anterior cruciate ligament, tear of tendo Achillis and total knee arthroplasty. In combination with correction of the deformity and physiotherapy it improves the outcome in the conservative treatment of idiopathic club foot. However, the use of CPM after surgical treatment of resistant club foot has not been compared with immobilisation in a cast.

Our aim in this prospective, randomised clinical study was to investigate the use of CPM after the surgical correction of club foot and to compare this with immobilisation in a cast. The Dimeglio club foot score was used as the primary outcome measure at the final review 48 months after treatment.

Patients and Methods

Between 1998 and 2001, we treated 154 infants consecutively for idiopathic club foot. Of these, 38 with Dimeglio grade 3 deformities required a posteromedial lateral release. All had undergone manipulation and immobilisation in a cast for six months which failed to correct the deformity. There were 27 boys and 11 girls with a total of 50 feet affected. The mean age at operation was 8.2 months (5 to 12).

The Dimeglio club foot score was used as the primary outcome measure. A physician not involved in the treatment assigned a score before operation and at six, 12, 18 and 48 months after surgery.

According to Dimeglio et al., the deformity in club feet has four essential features: equinus in the sagittal plane, varus deviation in the frontal plane, derotation of the calcaneoforefoot block around the talus and adduction of the forefoot on the hindfoot in the horizontal plane. Based on the individual measurement of the angles of these deformities a rating was made on a four-point scale. If the residual deformity was between -20° and 0° = 1 point, between 0° and 20° = 2 points, between 20° and 45° = 3 points, between 45° and 90° = 4 points. Additional elements such as poor peroneal muscles, marked posterior and/or medial creases or pes cavus were not taken into account in this assessment. The points for each of the four parameters were added together to give the Dimeglio club foot score.

Clinical interventions. One surgeon (MT), using a standard technique, operated on these patients. The surgery included a posterolateral medial...
release of the contracted capsule of the talocalcaneal and tibiotalar joints and lengthening of tendon Achilles by Z-plasty, as well as lengthening of the tendons of tibialis posterior, flexor hallucis longus and flexor digitorum longus and open reduction of the talonavicular joint. The correction was maintained by Kirschner (K-) wires to stabilise the talonavicular joint.

After operation the feet were randomly assigned either to immobilisation in a cast (cast group) or to CPM (CPM group). A code was developed using a computer random-number generator to select two randomly-permuted blocks. In bilateral cases both feet received similar post-operative management. In both groups of patients a cast was applied for the first ten days. Thereafter, casting was continued for another 4.5 weeks for patients assigned to the cast group while the CPM group had computer-assisted three-dimensional CPM therapy with a Kinetic 5090 Ankle CPM machine (S&U Medizintechnik, Partenheim, Germany). During rest periods removable splints were applied to the feet. The K-wires were removed from all the feet after two weeks.

Rigidly constructed and adjustable supports on the CPM machine provided a stable platform for reproducible positioning of the limb. Standardised protocols were used to move the joints through a defined range of movement (Table I). Beginning on the tenth day after operation, the unidimensional range of movement of the ankle in plantar flexion/dorsiflexion was increased gradually for 14 days (programmes 1 to 3). Three-dimensional movement of the subtalar joint was started on the 24th post-operative day using programmes 4 to 6 for the right foot and programmes 7 to 9 for the left foot and continued until the 42nd day after operation. The CPM treatment was begun while the patient was in hospital, and each foot had a minimum period of four hours each day. After six weeks, each foot was treated with a brace at night and physiotherapy was continued for a further six months in both groups. When the children began to walk, conventional shoes with heel cups were used to stabilise their feet.

**Statistical analysis.** The mean and 95% confidence interval (CI) were calculated. The association between age and the outcome measure, the Dimeglio club foot score at six, 12, 18 and 48 months, was tested by Pearson’s correlation coefficient. The association between continuous and discrete variables was tested by Student’s t-test. Analysis of variance was applied under adjustment according to the formula:

$$\text{post-operative value} = \text{baseline value} + \text{group.}$$

If bilateral club feet were treated, either the left or the right side was selected for analysis by tossing a coin. All tests were two-sided and a p value ≤ 0.05 was considered to be significant. Analysis of data was performed using SPSS for Windows 12.0.1 (SPSS Inc, Chicago, Illinois).

**Results**

Both feet of one child in the cast group with bilateral deformity had to be revised shortly after surgery because of an early relapse and were therefore excluded. In 22 children the operation was performed on the right foot and in 15 on the left. Both groups were similar in regard to clinical details and the side of operation (p > 0.05). After surgery and treatment in a cast the Dimeglio club foot score improved from 10.3 pre-operatively to 4.17 at 12 months and to 3.89 at 48 months (Table II). At 48 months after operation five feet in each

<table>
<thead>
<tr>
<th>Program number</th>
<th>Mode</th>
<th>Side</th>
<th>Settings for range of movement (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plantar/dorsal</td>
<td>Bilateral</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Plantar/dorsal</td>
<td>Bilateral</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Plantar/dorsal</td>
<td>Bilateral</td>
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</tr>
<tr>
<td>4</td>
<td>3-dimensional</td>
<td>Right</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>3-dimensional</td>
<td>Right</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>3-dimensional</td>
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<td>21</td>
</tr>
<tr>
<td>7</td>
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<td>18</td>
</tr>
<tr>
<td>9</td>
<td>3-dimensional</td>
<td>Left</td>
<td>21</td>
</tr>
</tbody>
</table>

**Table I.** Continuous passive motion (CPM) group: programmes of three-dimensional CPM

<table>
<thead>
<tr>
<th>Outcome values</th>
<th>Cast group (n = 18)</th>
<th>CPM group (n = 18)</th>
<th>p values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative (T0)</td>
<td>10.33 (9.50 to 11.17)</td>
<td>9.68 (9.02 to 10.35)</td>
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<tr>
<td>6 mths post-operative (T1)</td>
<td>4.22 (3.57 to 4.87)</td>
<td>3.21 (2.77 to 3.65)</td>
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</tr>
<tr>
<td>12 mths post-operative (T2)</td>
<td>4.17 (3.52 to 4.81)</td>
<td>3.11 (2.65 to 3.56)</td>
<td>0.009</td>
</tr>
<tr>
<td>18 mths post-operative (T3)</td>
<td>4.06 (3.25 to 4.86)</td>
<td>3.21 (2.71 to 3.71)</td>
<td>0.090</td>
</tr>
<tr>
<td>48 mths post-operative (T3)</td>
<td>3.89 (2.47 to 5.30)</td>
<td>4.47 (2.72 to 6.23)</td>
<td>0.554</td>
</tr>
</tbody>
</table>

* a analysis of variance; p value for the group effect under adjustment for baseline score. No baseline and no interaction effect was significant
Discussion
The detrimental effect of temporary immobilisation on synovial joints and articular cartilage has been described by Salter et al. and Salter. CPM has become established in the early rehabilitation after surgical treatment of the knee, shoulder, elbow and hand.11,12 Early intermittent or continuous movement promotes metabolic activity in the cell, improves blood flow and facilitates the transport of metabolites out of the joint leading to a reduction of swelling and oedema.13,14

Further beneficial effects such as reduction in pain, avoidance of muscle contractures and early restoration of function have also been recognised, although quantifying these results has been difficult.

The use of a CPM machine in the conservative treatment of congenital club foot was described by Diméglio et al. They demonstrated that 68% of grade II club feet, 25% of grade III, and 10% of grade IV club feet could be successfully treated by non-invasive orthopaedic treatment combined with the use of a CPM machine.5

Most club feet treated by surgery are immobilised in the cast for up to six weeks. There have been no previous studies of the use of CPM after postero-medial lateral release describing the results at 48 months after operation.

Our study demonstrated that the range of movement in the feet treated by CPM was significantly increased at six and 12 months after operation compared with those treated by casting (p = 0.013 and p = 0.009, respectively). However, no significant difference was found after 18 and 48 months. One reason may be that as children stand and begin walking they do their own mobilisation. Other authors have reported the temporary positive effects of CPM after repairs of the rotator cuff or total knee replacements in adults.19,21 The optimal duration for CPM is still undefined.21,22 In general, daily CPM for six to eight hours is recommended for adults.23 Specific recommendations for children have yet to be developed. In our study, CPM was applied for a minimum of four hours per day for each foot in the CPM group. Early range-of-movement exercises by physiotherapists or parents may be more cost-effective, but are less intensive. Soft-tissue injury can be avoided with the CPM machine by carefully setting the range of movement of the joint to be applied and by the automatic shutdown reaction when resistances are encountered.

Unlike other studies, we did not find a correlation between the age at surgery and the early post-operative results (p = 0.283), but the number of feet treated was small. A limitation of the study was that the recommended duration of the CPM treatment could not be verified. Since no additional benefit could be shown in the long term with the use of CPM and the number of feet requiring additional surgery was similar in both groups, it is difficult to recommend the use of CPM treatment which is also much more expensive. Our results agree with those in other published series.

References