Bilateral hip surgery in severe cerebral palsy
A PRELIMINARY REVIEW
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When cerebral palsy involves the entire body pelvic asymmetry indicates that both hips are ‘at risk’. We carried out a six-year retrospective clinical, radiological and functional study of 30 children (60 hips) with severe cerebral palsy involving the entire body to evaluate whether bilateral simultaneous combined soft-tissue and bony surgery of the hip could affect the range of movement, achieve hip symmetry as judged by the windsweep index, improve the radiological indices of hip containment, relieve pain, and improve handling and function.

The early results at a median follow-up of three years showed improvements in abduction and adduction of the hips in flexion, fixed flexion contracture, radiological containment of the hip using both Reimer’s migration percentage and the centre-edge angle of Wiberg, and in relief of pain. Ease of patient handling improved and the satisfaction of the carer with the results was high. There was no difference in outcome between the dystonic and hypertonic groups.

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Cerebral palsy is a heterogeneous non-progressive central motor deficit which is seen in 1.5 to 2.5 children per 1000 live births.1 The non-progressive central pattern of the disease contrasts with the progressive deterioration of peripheral motor function which occurs during growth. This results in increasing muscle contractures. Secondary bony deformities may develop around the hip including coxa valga, malorientation of the femoral head and acetabular dysplasia. These often progress and joint stiffness and/or dislocation may occur.2,3

The incidence of hip dysplasia and dislocation in patients with cerebral palsy varies according to the clinical pattern. The frequency of incongruity of the hip correlates well with the severity of motor and intellectual impairment4 and the patients’ independent mobility.5 Patients with spastic diplegia who can walk rarely present with subluxation of the hip.5 In patients with cerebral palsy producing quadriplegia instability of the hip has been reported in up to 60%.7 This figure increases as fixed flexion-adduction contractures develop.9 Subluxation or dislocation of the hip in total body involvement is often bilateral2 with the clinical pattern of contractures being asymmetrical. This can be associated with pelvic obliquity and spinal deformity.1 A windsweep deformity may develop with the adducted, flexed and internally rotated hip tending to sublux posteriorly7 and the contralateral abducted, extended and externally rotated hip displaced anteriorly (Fig. 1). Subluxation of the abducted hip is difficult to identify on the anteroposterior (AP) pelvic radiographs, but can be detected clinically by a palpation of the femoral head in the groin and a progressive abduction contracture.

Our aim was to determine whether bilateral, simultaneous, soft-tissue and bony surgery around the hip can improve the range of movement, achieve hip symmetry, increase radiological congruity of the hip, relieve pain, ease the handling of the patient and improve the level of function in patients with total body involvement. We also compared the outcomes for dystonic and hypertonic patients.

Patients and Methods
The medical records of 30 children (60 hips) with cerebral palsy with total body involvement were reviewed after approval of the Ethical Committee had been obtained. All had undergone bilateral simultaneous combined soft-tissue and bony surgery around the hip between 1991 and 1997. There were 12 boys and 18 girls with a mean age at the time of surgery of 7.7 years (3.1 to 12.2). In the 19 dystonic patients, five were windswept towards the left and 14 to the
right, while in the 11 hypertonic patients, five were windswept towards the left and six to the right.

Seven of the dystonic patients and three of the hypertonic patients had undergone various soft-tissue procedures at other hospitals before being assessed in our tertiary referral centre. The effect of previous soft-tissue surgery on the outcome was determined.

All patients were called back to designated research clinics at a median time of follow-up of three years (0.25 to 6.5). Two were unavailable for clinical review, but functional data were obtained from the physiotherapist. One had died from an unrelated cause and was therefore excluded. Since our study was carried out retrospectively information was incomplete for the preoperative range of movement in a further six patients. Statistical analysis was only carried out on hips with complete preoperative and postoperative data (Table I). Radiological records were complete for 25 patients and functional assessment for 29. Only 25 carers returned completed questionnaires.

Clinical assessment. Our physiotherapist (JP) and the paediatric orthopaedic consultant surgeons (PJW and MFG) recorded the full range of passive movement and fixed flexion contractures of each hip before operation under general anaesthesia and at the latest follow-up clinic. The total range of hip movement was assessed before and after operation as the sum of the difference between hip flexion and fixed flexion deformity, plus the internal rotation, external rotation, abduction and adduction of the hip recorded in flexion.

The windsweep deformity was assessed by measuring hip abduction and adduction in flexion. The windsweep index (WI) was calculated as the difference between the sum of abduction of one hip and adduction of the contralateral hip and vice versa (i.e. abduction R + adduction L minus adduction R + abduction L) and was also recorded before and after operation. A reduction in the WI at follow-up was considered to be an improvement in the symmetry of the movements of the hip. The length of follow-up was compared with the difference in WI.

Radiological assessment. The Reimers migration percentage (RM%) and centre-edge angle of Wiberg (CEA) were measured for both hips on AP radiographs of the pelvis. Hips were considered to be subluxed when the RM% was greater than 33 and dislocated when it was 100.

Functional assessment. The patients’ level of function was assessed and recorded by the physiotherapist at the time that the other examinations were carried out. This involved determining the ability to sit independently, to go into a standing frame and to walk with an assistant or with a frame. Pain in the hip was also noted. Since this group of patients had little verbal communication this could only be subjectively assessed by the carers and physiotherapist and was dependent upon apparent distress on movement of the hip.

Table I. Preoperative and postoperative data for children with quadriplegic cerebral palsy who underwent bilateral hip surgery

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Number of hips</th>
<th>Preoperative (mean ± sd)</th>
<th>Postoperative (mean ± sd)</th>
<th>Preoperative postoperative difference</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abduction and adduction in flexion in degrees</td>
<td>21</td>
<td>97 ± 38</td>
<td>135 ± 30</td>
<td>38 ± 39</td>
<td>21 to 56</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>Fixed flexion deformity in degrees</td>
<td>53</td>
<td>15 ± 14</td>
<td>8 ± 11</td>
<td>-7 ± 14</td>
<td>-11 to -3</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>Flexion in degrees</td>
<td>54</td>
<td>113 ± 11</td>
<td>111 ± 15</td>
<td>-2 ± 17</td>
<td>-6 to 3</td>
<td>0.446</td>
<td></td>
</tr>
<tr>
<td>Total range of movement in degrees</td>
<td>43</td>
<td>251 ± 54</td>
<td>256 ± 42</td>
<td>5 ± 56</td>
<td>-12 to 22</td>
<td>0.536</td>
<td></td>
</tr>
<tr>
<td>WI in degrees</td>
<td>21</td>
<td>50 ± 45</td>
<td>44 ± 44</td>
<td>-6 ± 55</td>
<td>-31 to 19</td>
<td>0.626</td>
<td></td>
</tr>
</tbody>
</table>
hip during daily activities. A confidential questionnaire was given to all parents/carers to establish their opinion on the ease of handling of the patient and function, including transfers, seating and nursing before and after operation, and their overall satisfaction with the outcome.

Operative technique. The indications for surgery were increased asymmetry, radiological subluxation or dislocation and pain. The operation involved both bony and soft-tissue surgery. All patients underwent bilateral femoral varus derotation osteotomies placing the femur in the mid-range of rotation in flexion and extension. All femora were shortened. Each acetabular osteotomy was hinged on the triradiate cartilage to give the most congruous joint. All hips were fully reduced at the end of the operation as confirmed by an AP radiograph of the pelvis in the spica. Soft-tissue surgery was also carried out selectively, depending on the preoperative assessment and the intraoperative examination of hip movements under anaesthesia after the corrective bony procedure had been carried out.

Of the 19 dystonic patients, eight had an acetabuloplasty on the adducted side only and three had bilateral procedures. Psoas and/or adductor releases were carried out unilaterally in three patients and bilaterally in seven. All patients were put into a full hip spica for six weeks and given a spica transporter to take home, allowing early reintegration of the child into the community (Fig. 2). Pain and spasm were controlled postoperatively by intravenous midazolam and epidural anaesthesia for two to four days under close supervision from the pain control team.

At six weeks, all patients were readmitted to hospital for removal of the spica and controlled mobilisation in gaiters with physiotherapy for five days. The aim was to reduce the risk of fractures in osteoporotic bone and to retrain the carers in the handling and positioning of their child who had a new body shape after the corrective surgery. They were then discharged home with a fitted sleeping shell and continued to have daily community physiotherapy for one month. The initial postoperative combined follow-up assessment was carried out after three months.

Postoperative complications in both groups were recorded.

Statistical analysis. The results were analysed using Student’s t-test for paired data and McNemar’s and marginal homogenicity tests to assess improvement of radiological and functional indices. The non-parametric Mann-Whitney U test was used to determine the significance of any difference in change between the dystonic and hypertonic groups, and between those who had had previous surgery and those who had not.

Results

Clinical outcome. The combined range of abduction and adduction in flexion for each hip increased significantly from a mean of 97° to 135° (Table I). There was no difference between the dystonic and hypertonic groups (p = 0.62) or between those who had had previous surgery and those who had not (p = 0.72). Fixed flexion deformity improved from a mean of 15° preoperatively to 8° at follow-up and mean hip flexion and total range of movement were preserved (Table I).

The WI was not significantly reduced from a mean of 50° preoperatively to 44° at follow-up (Table I). Only nine of 21 (43%) patients with complete data were found to have more symmetrical hips using the WI, despite increased abduction and adduction in flexion in 17 (81%). The median time of follow-up for these patients was 2.8 years. The nine patients with improved symmetry had a median follow-up of 2.3 years compared with 3.2 years for those with deteriorating symmetry (p = 0.25). There was no age-related difference between these two groups.

There was no statistical difference between the dystonic and hypertonic groups (p = 0.54) or between those who had had previous surgery and those who had not (p = 0.11) in the evaluation of change in mean WI (Table II).

Radiological outcome. On the 25 complete sets of radiographs a significant reduction in the incidence of subluxa-
tion and dislocation of the hip was detected. Preoperatively, 36 of 50 hips (72%) had an RM% >33 of which nine of the 25 patients (36%) had bilateral subluxation or dislocation. This compares with eight of 50 hips (16%) found to be subluxed postoperatively. Of the 36 with an RM% >33 preoperatively, six had an RM% of 100 and were, by definition, dislocated, compared with none at follow-up. Of the 50 hips which suffered recurrent subluxation, eight did so over a median follow-up of 3.0 years compared with 2.7 years for the rest of the group (p = 0.70) although the range was the same. Six of these eight hips were in the dystonic patient group, with a mean age of 7.9 years compared with two in eight hypertonic patients who resubluxed at a mean age of 4.4 years.

The overall mean RM% improved from 50 preoperatively to 18 at follow-up (p < 0.001). The CEA also improved significantly from -5° to 18° (p < 0.001). There was no significant difference between the hypertonic and dystonic groups for change in RM% (p = 0.85) or CEA (p = 0.89). There was also no difference in RM% (p = 0.83) or CEA (p = 0.54) between those who had had previous soft-tissue surgery and those who had not.

**Functional outcome.** The patients’ level of function was assessed and recorded by the physiotherapist. Of the 29 patients, the number capable of independent seating improved from six (21%) preoperatively to eight (28%) postoperatively. The number with the ability to go into a standing frame improved from 26 (90%) to 28 (97%). Preoperatively, 20 patients (69%) could not walk but six (21%) could do so with the help of an assistant and three (10%) with a frame. Postoperatively, the level of mobility improved in two of the non-walkers and three of six aided walkers (50%).

Of the 13 patients who were thought to have pain in the hip before operation, 11 (85%) were free from pain at follow-up (p = 0.001).

From the completed questionnaires, 23 of 25 carers (92%) reported ‘easier handling’ of their children. Parental/carer satisfaction with their child’s management was high at 22 of 25 (88%).

**Complications.** Complications included four supracondylar fractures of the femur in three patients and one case each of trochanteric bursitis, a sinus over a plate and a plaster sore.

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**Table II.** Mean preoperative and postoperative WI values (degrees) for 21 patients divided into their different patient groups and as to whether they had undergone previous surgery

<table>
<thead>
<tr>
<th>Group</th>
<th>Preoperative WI</th>
<th>Postoperative WI</th>
</tr>
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<tbody>
<tr>
<td>Hypertonic</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Dystonic</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Previous surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10</td>
<td>76</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>37</td>
</tr>
</tbody>
</table>

**Discussion**

In patients with cerebral palsy involving the total body pelvic asymmetry is indicative of both hips being ‘at risk’. Muscle imbalance and bony dysplasia are progressive and bilateral, but often asymmetrical. A windswept attitude of the lower limbs often develops, associated with pelvic and spinal deformity, possibly due to asymmetrical central involvement of the motor cortex. When deformity is established, mobility, seating and nursing care are always affected. In the long term, instability of the hip causes premature and progressive degeneration of the joint with dislocation and severe pain in at least 50% of patients.

The aim of surgery to the hip in these patients is to reduce subluxation/dislocation and to relieve pain, improve symmetry and aid management. This is achieved by correcting the bony deformity and releasing soft-tissue contractures. A variety of procedures has been suggested to improve the containment and biomechanics of subluxing hips in these patients. Soft-tissue operations alone have had variable rates of success and uncertain long-term results. Early soft-tissue surgery may prevent further subluxation and dislocation, improve function and relieve pain when compared to conservative treatment. When soft-tissue surgery was combined with bony operations better long-term results are achieved.

The traditional concept of concentrating on the obviously subluxed or dislocated adducted hip results in incomplete treatment. Our original rationale for bilateral simultaneous hip surgery in this group of patients was that both hips are ‘at risk’. We addressed both hips simultaneously in an attempt to minimise the risk of subsequent progressive subluxation or dislocation of both the abducted hip, which was found to be a problem in previous unilateral surgery, as well as the adducted hip. This approach aims to correct pelvic asymmetry and balance, creating a more anatomical basis for retraining and physiotherapy (Fig. 3).

All patients had bilateral femoral varus derotation and shortening osteotomies, placing the femur in the mid range of rotation. Femoral shortening effectively lengthens the muscles which alters their action on the hip. This is necessary in addition to the soft-tissue surgery, particularly in the younger child with significant growth potential. Unilateral or bilateral hinged acetabuloplasties were carried...
out in 36 hips to correct acetabular dysplasia and to improve cover of the femoral head.20

The extent of soft-tissue surgery was tailored to each individual patient and depended on intraoperative examination under anaesthesia to assess fixed flexion and/or abduction/adduction contractures after completion of the bony surgery. There was no significant difference in the clinical or radiological outcome between those patients who had had previous surgery and those who were being operated on for the first time. A balanced soft-tissue release allowed us to prevent unnecessary disruption of the soft tissues and to obtain a better range of movement while preserving stability of the hip.

The need for acetabuloplasty and the extent of soft-tissue surgery varied between the patients, but there was a similar distribution of the type of procedure between the dystonic and hypertonic groups, making statistical analysis feasible.

Patients with this severe cerebral palsy are difficult to evaluate. Clinical assessment is complicated by the variability of tone affecting the range of movement at different times. In order to minimise the interobserver and intraobserver errors all patients were assessed jointly by the surgeon and the physiotherapist.

Radiological assessment of containment of the hip can be assessed by using methods such as the RM%, the CEA or the acetabular index, but there may be significant intraobserver and interobserver errors because of the established deformity of the pelvis and spine.21,22 Standardisation of the position of the pelvis during radiography is virtually impossible in this group of patients. In our study, we used both RM% and CEA to decrease the errors in measurement of hip congruity. We did not use the acetabular index as an indication of acetabular dysplasia23 because it does not correlate well with the migration percentage.21 Radiological assessment of containment of the abducted hip can be difficult and should be supplemented by clinical review.

Functional assessment has not been standardised for patients with severe cerebral palsy, but reliable methods were selected for this study. Pain can be difficult for an unfamiliar observer to determine in patients with little or no verbal communication, but we feel that the close relationship which develops between the patient, the carer and physiotherapist means that this can be assessed, although there are no objective criteria available.

Our results have shown a significant improvement in the range of abduction and adduction of the hips in flexion, which is important for seating and nursing care. There was a significant reduction of fixed flexion deformity without loss of the range of flexion. All except one hip had a postoperative range of flexion greater than 90°. There was no significant change in the total range of hip movement. We feel that the effect of surgery on abduction and adduction, flexion, fixed flexion deformity and hip asymmetry is more relevant to the clinical picture than is a “total range of hip movement” as suggested by some authors.13

Windsweep has previously been used as a descriptive term without any means of definitive clinical evaluation. We described the WI8 to aid in the clinical assessment of symmetry in such patients, and it was found to be a simple and useful method of evaluating a windsweep deformity. It is quick and easy to calculate from the standard chart for range of movement and we feel that it adds to the overall picture in the assessment of this complicated group of patients. Hip symmetry using the WI, however, improved

Fig. 3a
Photographs showing a) the preoperative clinical picture of windsweep deformity and b) postoperative improvement in hip symmetry and fixed flexion deformity.
Radiographs of the pelvis showing the preoperative windsweep deformity with subluxation of the right hip with acetabular and femoral head dysplasia (a), after bilateral femoral derotational osteotomies and a right Pemberton acetabuloplasty, (b) and after removal of metalwork showing improved radiological joint congruity and symmetry (c).

Postoperatively in only nine of 21 patients (43%) despite a marked improvement in the range of movement in abduction and adduction. The patients with improved symmetry had overall a shorter median duration of follow-up which suggests that there may be a deterioration in symmetry with time. A longer follow-up will be necessary to confirm this.

There was a statistically significant improvement in both radiological indices of hip containment after surgery (Fig. 4). Resubluxation was more common in the dystonic group and occurred in younger patients in the hypertonic group.

Surgery was apparently effective in relieving pain in the hip in 11 of 13 patients (85%), although objective assessment of pain in this group of patients is not possible.

Our management appears to have some beneficial effect on the mobility of these patients, although not to a significant extent. Ease of patient handling improved and satisfaction of the carers with the outcome of surgery was high. In a situation where there has been considerable input from all members of the multidisciplinary team, this may be a predictable sentiment whatever the clinical outcome.

The rate of supracondylar fracture was low compared with other series.

There were no significant differences between the preoperative and postoperative changes for the dystonic and hypertonic groups in all parameters assessed. Dystonic patients have often received minimal treatment in previous series because of the unpredictability of their response to surgery. This has not been shown to be the case so far in our patients.

These early results, at a median three-year follow-up, suggest that bilateral simultaneous combined soft tissue and bony surgery should be considered in this challenging group of children with cerebral palsy.

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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


