Outcome of single-event multilevel surgery in untreated cerebral palsy in a developing country

M. A. Khan

From The Bismillah Taqee Hospital, and the Medical Institute of Neurology and Rehabilitation, Karachi, Pakistan

In developed countries, children with cerebral palsy are treated from the time of diagnosis. This is usually not the case in developing countries where such patients often present at an age when it is traditionally believed that if walking has not already commenced, it is unlikely to. This study reports the outcome of the surgical treatment of 85 spastic diplegic patients at a mean of 8.5 years (5 to 12). All presented as untreated non-walkers and had achieved sitting balance by the age of five to six years. They underwent single-event multilevel surgery followed by physiotherapy and orthotic support. For outcome assessment, a modified functional walking scale was used at a mean of 3.5 years (2 to 5) post-operatively.

At all levels, static joint contractures had resolved almost completely. All patients improved and became walkers, 18 (21.2%) as exercise, 39 (45.9%) as household and 28 (33%) as community walkers.

This study shows that children with cerebral palsy who cannot walk and have not been treated can be helped by single-event multilevel surgery, provided that inclusion criteria are followed and a structural, supervised rehabilitation programme is in place.
and 34 (40%) had additional mild upper limb involvement and 18 (21%) had mild upper body involvement. They all had sitting ability, but 76 (89%) could not sit fully erect. They all had good intelligence, but this was not measured. However, mental retardation is not reported as having a significant effect on walking ability.15,16 All were non-walking at level 1 and 2 of the functional walking scale.11 Those with any significant previous treatment, hip dislocation, and mental retardation enough to prevent comprehension of post-operative instructions were excluded as were patients with ataxia, dystonia or hemiballismus. No patient had residual primitive reflexes.9

The children were treated at two centres. One was an outpatient facility (Medical Institute of Neurology and Rehabilitation, Karachi, Pakistan) dedicated to patients with neuromuscular problems and staffed by neurologists, physiotherapists, occupational and speech therapists and an orthotist. Patients were brought by their parents or referred by general practitioners and other specialists. The other centre was a secondary-care hospital (Bismillah Taqee Hospital, Karachi, Pakistan) with referral mainly from paediatricians. All the operations were performed there by the author. Rehabilitation, orthotic fitting and post-operative assessments were carried out at the outpatient centre.11

Assessment of joint deformity included spasticity and estimation of the percentage of fixed versus dynamic contracture. The entire group, predominantly, had fixed contractures at each joint. This assessment was important since it revealed the extent of the intervention required, based on repeated examination and accurate documentation. Since all the children were unable to walk observational gait analysis could not be performed. The hip was assessed by the Thomas test13 and surgery undertaken if the flexion deformity was 15˚ or more. A total of 75 children (88%) needed surgery of the hip and had a mean fixed flexion of 30˚ (15˚ to 45˚). If there was absence of at least 45˚ of abduction with the hip in extension, adductor tenotomy, without obturator neurectomy, was planned. This was undertaken in 63 children (74%). The knee was assessed using the femoropopliteal angle. A total of 53 children (62%) needed lengthening of the hamstrings, since their femoropopliteal angle was less than 90°.13,17

All the patients had tightness of gastrocnemius and soleus. If the equinus deformity was greater than 15˚, Z-lengthening of the tendo Achillis was planned and undertaken. This was performed in 55 children (65%).

Pre-operative care included anaesthetic and paediatric assessment. A total of 48 children (56.5%) required treatment for problems such as anaemia, seizures and infections of the respiratory tract. All the children were admitted on the morning of surgery. After informed consent was obtained, they were given intravenous cefamazine according to their body-weight. The operations were performed under general anaesthesia, with additional caudal block given in 23 patients (27%).

Soft-tissue surgery alone was required in 67 patients (79%) and undertaken at three or more joints simultaneously. Of these, 45 (53%) required extensive procedures to release the hip flexors and adductors, the medial and lateral hamstrings and the tendo Achillis.16,17 These procedures were performed through ten separate incisions, five in each limb. Five children (5.9%) also required tendon transfers in the foot as well as soft-tissue release, while 18 (21%) required additional bony procedures. These included bilateral rotation osteotomies of the femur, either proximal or

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-walker</td>
<td>Cannot walk at all</td>
</tr>
<tr>
<td>Level 1</td>
<td>Can do some stepping on his/her own with the help of another person. Does not take full weight nor walk as a routine</td>
</tr>
<tr>
<td>Level 2</td>
<td>Walks for exercise in therapy and less than a household distance. Usually requires assistance</td>
</tr>
<tr>
<td>Level 3</td>
<td>Walks for household distances, but makes slow progress. Does not use walking at home as preferred mobility. Primarily walks in therapy</td>
</tr>
<tr>
<td>Level 4</td>
<td>Walks 15 feet to 50 feet only inside home or school</td>
</tr>
<tr>
<td>Exercise walker</td>
<td>Walks more than 50 feet outside but usually has a wheelchair or walker for longer distances or congested areas</td>
</tr>
<tr>
<td>Level 5</td>
<td>Walks outside for community distances but only on level surfaces (cannot perform curbs, uneven terrain, or stairs without assistance)</td>
</tr>
<tr>
<td>Level 6</td>
<td>Walks outside the home for community distances, can perform curbs and uneven terrain and requires minimal assistance or supervision for safety</td>
</tr>
<tr>
<td>Level 7</td>
<td>Walks easily outside the home for community distances, but has difficulty or requires minimal help with running, climbing and/or stairs</td>
</tr>
<tr>
<td>Community walker</td>
<td>Walks, runs and climbs without difficulty or assistance</td>
</tr>
<tr>
<td>Level 8</td>
<td>Walks 15 feet to 50 feet only inside home or school</td>
</tr>
<tr>
<td>Level 9</td>
<td>Walks for exercise in therapy and less than a household distance. Usually requires assistance</td>
</tr>
<tr>
<td>Level 10</td>
<td>Walks 15 feet to 50 feet only inside home or school</td>
</tr>
</tbody>
</table>
distal\textsuperscript{6} in 11 patients (13%), and extension osteotomies of the distal femur in seven (8%).\textsuperscript{18}

All the operations were performed according to standard procedures apart from the release of hip flexion contracture. The usual practice of lengthening of the psoas has been reported to cause weakness of flexion.\textsuperscript{19} In our patients, the major cause of flexion deformity was tightness of tensor fascia lata, and of the 75 patients (88%) undergoing correction of hip flexion contracture only ten (12%) required lengthening of psoas. Most were adequately managed by release of the tensor fascia lata from the iliac crest, which was confirmed by an intraoperative Thomas test. The hip release was unilateral in five patients (5.9%).

Long-leg plaster casts were applied with crossbars for those who had an adductor release. The stay in hospital was for only one day post-surgery for 74 patients (87%). Six (7%) stayed an additional day. Children with soft-tissue lengthening and tenotomies had casts, retained for six weeks in the first year of the study, and this was reduced to three weeks by the second year. After lengthening and repair of tendo Achillis the cast was removed after three weeks. Physiotherapy was started and splints made, but weight-bearing was delayed for six weeks. Patients who had osteotomies were in casts for approximately six weeks until healing was evident on radiographs. Patients who had tendon transfers at the foot retained the below-knee part of the cast for four to six weeks. All patients attended as outpatients, usually for between two and four days per week. Each session lasted for between one and three hours and consisted of physiotherapy, with speech and occupational therapy as required. The parents/guardians were given a home programme which was reinforced at each visit. These visits gradually became less frequent. All the children were taught exercises to improve their range of movement as outpatients and were provided with ankle-foot orthoses (Orthotic Department, Medical Institute of Neurology and Rehabilitation) for standing and walking. They had long-leg gutter-type night splints. Several also needed therapy and splints for their upper limbs. A total of 51 children (60%) initially needed therapy for one to two months merely to learn to stand in parallel bars from which they progressed to walkers, then crutches and sticks. The remaining patients were standing by one month after cast removal, in braces using the parallel bars. Five walked with support within two months (Fig. 1). A total of 76 patients (89%) required long-leg splints to initiate standing before needing them at night only. Ankle-foot orthoses were not discontinued in any child.

### Results

The final assessment was at a mean of 3.5 years (2 to 5) after operation.

At all levels, the static contractures in all the children were almost completely resolved except for a few degrees of static flexion at the knees in 15 (17.6%). An estimated 10° of dynamic flexion was retained at the knees in 23 children (27%) when walking unaided, but this did not compromise function. Static hip flexion contractures resolved in all patients. None had residual adductor or ankle contracture.

The functional walking scale\textsuperscript{11} was undertaken by the author. All the children improved and moved out of the non-walking grade; 18 (21.2%) progressed to therapeutic walkers (level 3 and 4), 39 (45.9%) to household walkers (level 5) and 28 to community walkers (level 6 to 10) (Table II). None improved beyond level 8 and only six (7%) reached this level.

### Complications

These were few. One child (1.2%) had an intra-operative haemorrhage during lengthening of psoas, but did not require blood transfusion. One (1.2%) had a superficial wound infection which settled with oral antibiotics and
one (1.2%) developed mild spasticity of rectus femoris after lengthening of the hamstrings but this did not require further surgery. Six (7%) developed a minor abduction contracture after adductor tenotomies. These complications may be ascribed to operations which may have been unnecessary and suggest that pre-operative assessments in the absence of instrumented gait analysis can be prone to error.

As the children have grown, some of those operated on in 2001 and 2002 have developed problems, more commonly in those under six years of age at surgery. Four (94.7%), all of whom had soft-tissue procedures initially, required femoral rotational osteotomies in 2006. Two others (2.3%) underwent further soft-tissue operations; lengthening of the hamstrings alone in one and additional lengthening of tendon Achilles in the other. These operations were performed before there was any deterioration in the functional walking scale and since they were undertaken some years after the study period, it is considered that they did not negate the results or count as complications.

Discussion
While the aim in this study was to initiate walking in an untreated group, it was not expected that all the children would become fully and independently ambulant. However, since all were walking and most had improved beyond therapeutic walking, the results are satisfactory. The fact that only 18 (21%) became walkers at the exercise level is not disapproving overall.

While the principles of single-event multilevel surgery for CP are easily understood, they have been recommended for improving gait in patients who are walking and have not hitherto been evaluated as an initiator of this process. Various authors have attempted to estimate the walking potential of a patient with CP. Bleck used the presence or absence of primitive reflexes as a prognostic indicator. Da Paz recommended the attainment of certain milestones and reported that achievement of head balance by nine months, independent sitting by the age of seven to eight years would not be able to do so. Molnar and Gordon, however, felt that independent sitting at two years was an important prognostic indicator. They also noted that a child who could not walk by two years does not preclude walking potential. Also, whereas Nene, Evans and Patrick felt that the ideal age for intervention was after seven years in children who did not improve. This is a different scenario when compared with the patients in this study.

I have shown that patients with CP and spastic diplegia who are untreated, present late, and cannot walk can be helped by single-event multilevel surgery provided that the inclusion criteria described are followed. Even children over seven or eight years of age can be helped, but it is important that they should have attained independent sitting by the age of four to five years. For a child with spastic diplegia, surgery alone is not enough. They will not walk automatically and a fully-staffed rehabilitation centre is essential for satisfactory results to be obtained.

The functional walking scale proved easy to implement and, when combined with the measurement of improvement of fixed joint deformity, allowed a good assessment of function. It is important that follow-up of these children is maintained beyond two years post-operatively, since changes in growth can lead to deterioration.

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