Short-term results of musculotendinous release for paralytic hip subluxation in children with spastic cerebral palsy

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ABSTRACT

INTRODUCTION Children with paralytic hip subluxation secondary to spastic cerebral palsy were treated with a standard protocol that depended on early detection of the subluxation using clinical examination detecting limited range of hip abduction of $\leq 30^\circ$ and anteroposterior pelvis radiographs detecting subluxation $\geq 33\%$ migration as indications.

PATIENTS AND METHODS Patients underwent open adductor longus, proximal gracilis and proximal rectus femoris myotomy, and iliopsoas lengthening with immediate postoperative immobilisation in abduction bar for 3 weeks followed by physiotherapy. The protocol was applied to 50 children with a mean age of 3.6 years with 100 hips surgically corrected. Of these hips initially, 52% were mildly subluxated with $\leq 33\%$ migration, 42% were moderately subluxated with $> 33\text{--}66\%$ migration, and 6% were severely subluxated with $> 66\%$ migration.

RESULTS At a final postoperative follow-up of at least 24 months, 22% of these hips were classified as excellent with full containment and no migration, 54% were good with $< 20\%$ migration, and 24% were fair with $20\text{--}25\%$ migration. No poor result with $> 25\%$ migration was obtained. No child developed an abduction contracture or wide-based gait that required treatment.

CONCLUSIONS Early detection and application of this treatment algorithm for children with spastic hip disease should have satisfactory outcomes. Longer follow-up will be required to determine how many children will need bony reconstruction to maintain stable containment of hips at maturity.

KEYWORDS

Cerebral palsy – Hip subluxation – Soft-tissue release

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Spastic hip subluxation and dislocation are common problems in children with spastic cerebral palsy.¹ Spastic hip disease occurs when the spastic adductor and flexor muscles about the hip exert forces that are too strong or in the wrong direction or both, particularly the adductor longus, the gracilis, the rectus femoris and the iliopsoas causing subluxation, dislocation and subsequent acetabular dysplasia.² Children with spastic hip disease have hip-force magnitude 3 times that of children with normal hips in the normal physiological position. The resulting muscle imbalance causes abnormal hip positioning in adduction, flexion and internal rotation.³ They suffer painful seating, abnormal gait and difficulty in personal hygiene.⁴ Secondary effects due to the adducted hip position include pelvic obliquity and scoliosis.⁵ The problems are more prevalent in non-walking children or in those with total

body involvement (TBI). The aim of the work was to normalise the direction of the hip force to put the extremity in the normal physiological position to prevent progression into dislocation and acetabular dysplasia, and also to avoid secondary effects. The impact of decreasing the acetabular dysplasia, the femoral anteversion or femoral neck-shaft angle had little additional effect on the direction or magnitude of hip forces.⁶

Patients and Methods

The study consisted of a group of 50 children with spastic cerebral palsy who underwent open adductor longus, proximal gracilis, and proximal rectus femoris myotomy, and iliopsoas lengthening, in the National Institute of Neuromotor system, Imbaba, Giza, Egypt, between

Figure 1 Hip flexion, adduction, and internal rotation deformity as seen from the front (A) and back (B).

Figure 2 Limited hip abduction $< 30^\circ$ with both hips and knees fully extended (A), and 90° flexed (B).

September 2003 and September 2004, to treat spastic hip subluxation. Results in this group after at least 2 years of follow-up were reported in September 2006. Thirty-six children (72%) had total body involvement (TBI) and 14 (28%) had spastic diplegia. All of the spastic TBI children were unable to walk. The spastic diplegic children were at least able to walk with support; three were community and 11 domestic ambulatory. Twenty-eight children (56%) were boys, and 22 (44%) girls. All 50 children had bilateral surgical correction, for a total of 100 treated hips. The mean age at the time of the surgery was 3.6 years (range, 3–5 years).

A standard protocol for spastic hip subluxation was used as a guide to indicate surgical treatment. It depended on clinical examination to detect the limited range of hip abduction and anteroposterior pelvis radiographs to detect hip migration percentage.

Clinical examination revealed shortening, flexion, adduction, and internal rotation deformity (Fig. 1). Limited range of hip abduction was measured clinically with the child supine; at first, with the knees and hips fully extended to detect the contribution of the medial hamstrings, then with the knees fully flexed and hips 90° -flexed to eliminate the contribution of the medial hamstrings (Fig. 2).^{7,8}

The hip migration percentage of Reimers was measured by anteroposterior pelvis radiographs taken with the patient supine, both lower limbs in neutral abduction-adduction position relative to the pelvis, and the patellae facing anteriorly. A vertical line (the Perkins' line) is drawn from the lateral edge of the acetabulum perpendicular to a horizontal line connecting both triradiate cartilages of the pelvis (the Hilgenreiner line; Fig. 3). The portion of the femoral head lateral to the Perkins' line is measured, and this measurement is expressed as a percentage of the entire horizontal width of the femoral head.⁹

Fifty-two hips in 26 children (52%) were mildly subluxated with limited range of hip abduction up to 30° and with $\leq 33\%$ migration of whom 18 were boys (36%) and 8 girls (16%). Forty-two hips in 21 children (42%) were moderately subluxated with limited range of hip abduction between 20° – 30° and with 33–66% migration of whom 9 were boys (18%) and 12 were girls (24%). Finally, six hips in three children (6%) were severely subluxated with limited range of hip abduction $< 20^\circ$ and with $> 66\%$ migration of whom one was a boy (1%) and two were girls (4%).

The surgical procedure in all children in the study consisted of myotomy of the adductor longus, gracilis, and proximal

Figure 3 Migration percentage of Reimers.

rectus femoris and tendon lengthening of iliopsoas. The approach was through the inguinal 'bikini' oblique incision below, and parallel to, the inguinal ligament for cosmesis.¹⁰ The adductor longus tendon was easily palpable with the hip abducted and externally rotated and was divided at the muscu-

lotendinous junction.¹¹ No adductor brevis myotomy was done as it is necessary to preserve hip stability particularly in the non-walkers. No neurectomy of the anterior branch of the obturator nerve was performed. The fleshy proximal gracilis fibres were easily identified as a long flat muscle at the medial side of the adductor longus and the muscle was divided. The iliopsoas tendon was exposed lateral to the pectineus muscle with great care to avoid injury to femoral neurovascular bundle; the tendon was lengthened by the Z-plasty technique.¹² All muscle fibres of the iliacus were carefully preserved in order to save the hip flexor power of the muscle. The proximal rectus femoris muscle was exposed in the lateral aspect of the wound in the gap between the sartorius muscle medially and the tensor fasciae latae muscle laterally with care to avoid injury to the lateral femoral cutaneous nerve. The fleshy proximal rectus femoris fibres were divided with care to preserve the hip joint capsule.¹⁵ Hip reduction was checked intra-operatively by the use of a C-arm image intensifier and by checking the range of hip abduction. The wound was closed by the subcuticular technique.

After the surgery, immobilisation in bilateral above knee POP casts with abduction bar maintaining both hips in at least 60° abduction without pelvic rotation was applied for 3 weeks. Physical therapy 3 times a week for 6 weeks was prescribed.

Results

Fifty children with spastic hip subluxation underwent musculotendinous procedures on a total of 100 hips and were followed up at a mean of 2.3 years (range, 2–3 years) postoperatively. The mean age at the time of surgery was 3.6 years (range, 3–5 years). All children had both hips operated on simultaneously to correct a migration percentage of $\geq 33\%$. Sixteen children had previous soft-tissue correction in other parts of the lower limb (12 for hamstring lengthening and four for gastrocnemius recession).

The age group of the study group (3–5 years) had a great impact on the results. With older age groups not included in this study, secondary acetabular dysplasia, femoral neck-shaft valgoid angle change, and excess femoral neck anteversion are possible rendering soft-tissue correction alone as a sole measure insufficient. Additional osseous correction in such conditions will be necessary.

Twenty-two hips in 11 children (22%) were classified as excellent with full containment of the femoral head into the acetabulum and with no migration, of which all were mildly subluxated hips initially before surgical correction, all diplegic (7 boys, and 4 girls). Fifty-four hips in 27 children (54%) were classified as good with $< 20\%$ migration, of whom 15 were boys and 12 girls. Twenty-four hips in 12 children (24%) were classified as fair with 20–25% migration, of whom all were moderately and severely subluxated hips initially before surgical correction, all with TBI (6 boys

Figure 4 Results in general (A) and in relation to gender (B).

and 6 girls). No poor results with $> 25\%$ migration percentage were obtained (Fig. 4). No child developed an abduction contracture or wide-based gait that required treatment. No complications (such as wound infections and femoral neurovascular injuries) or other acute problems related to the surgery were recorded in the study.

Of the 52 initially mildly subluxated hips with limited range of hip abduction but up to 30° and with $\leq 33\%$ migration, 22 had excellent results, 30 good, and no fair result. Of the 42 initially moderately subluxated hips with limited range of hip abduction between $20\text{--}30^\circ$ and with $33\text{--}66\%$ migration, 24 had good results, 18 fair, and no excellent results. Of the six initially severely subluxated hips with limited hip abduction $< 20^\circ$ and with $> 66\%$ migration, all had fair results with neither good nor excellent results (Fig. 5).

Of the 36 children with total body involvement, 12 had fair results, 24 good results, and no excellent results. Of the 14 diplegic children, 11 had excellent results, three good, and no fair results (Fig. 6).

Discussion

The prevalence of spastic hip subluxation in children with cerebral palsy is variable, being highest among those with total body involvement (TBI) and the non-walker.¹⁴

The children in the current study were a group of 50 children with cerebral palsy and spastic hip subluxation who had been operated upon and followed-up for a mean of 2.3 years (range, 2–3 years) postoperatively. The results were satisfactory (rated excellent, good, or fair) in all of the 50 children – 22% excellent, 54% good, and 24% fair. No poor results were recorded. However, longer follow-up periods, during which children will reach skeletal maturity, is crucial to demonstrate the effectiveness of the treatment and to validate the protocol used at the National Institute of Neuromotor System, Imbaba, Egypt since 2003, as spastic hip subluxation does not stabilise until skeletal maturity.¹⁵

The protocol, based on Reimers' study¹⁶ in 1980, was designed to decrease spastic hip subluxation and prevent

hip dislocation in children with cerebral palsy. Reimers found that contracture of the adductor muscles was the primary cause of spastic hip subluxation. Reimers demonstrated that, after the hip becomes subluxated, there is a risk of a 10% increase in the migration percentage per year, and stated that bilateral adductor myotomy should be performed as soon as hip subluxation is noted. Miller and Bagg¹⁵ agreed with Reimers that spastic hip subluxation does not improve spontaneously in patients with cerebral palsy and reported that the risk of progression was 23% (12 of 53 patients) after skeletal maturity if the migration percentage was $\geq 30\%$. The current study added iliopsoas, rectus femoris, and gracilis contracture as other contributing factors.

The rates of satisfactory results following musculotendinous releases for spastic hip subluxation have ranged from 33% (12 of 36 patients)¹⁶ to 90% (10 of 11 patients)¹⁷ in the literature. This wide range of success rates is due to differences among the series regarding age at surgery, limited hip abduction, hip migration percentage, surgical technique, postoperative care, the degree of neurological involvement, definitions of success and failure, and duration of follow-up. In the current study, the protocol prevented hip dislocation or substantial subluxation in all 50 children followed for a mean of 2.6 years. In the study with the longest follow-up in the literature (mean, 8.1 years; minimum, 4 years), by Turker and Lee,¹¹ the rate of success was 42% (19 of 45 patients).

Regarding the influence of age on the final outcome, the current study was based on young children with an upper age limit of 5 years. The younger the age of the child, the better was the outcome. Onimus *et al.*¹⁷ reported good results in 11 of 12 patients in whom the surgery had been performed before the age of 4 years.

Children with higher pre-operative migration percentage in the current study had a less favourable final outcome (Figs 7 and 8). Reimers¹⁶ recommended that adductor elongation be performed as soon as subluxation, defined by a migration percentage of $\geq 33\%$, is observed. Onimus *et al.*¹⁷

Figure 7 (A) An anteroposterior pelvic radiograph of a 4-year-old girl with spastic diplegia pre-operatively with 40% migration in the right hip and 33% migration in the left hip. Repeat anteroposterior pelvic radiograph at 2 years' postoperatively with full containment and correction of hip abduction classified as excellent.

reported good results in children who had had subluxation of $< 33\%$ pre-operatively. Turker and Lee¹¹ reported that patients with a successful outcome had had a lower mean value for pre-operative subluxation than had patients with a higher mean value.

The level of neurological involvement in children in the current study affected the final outcome. Children who were able to walk and had a spastic diplegic pattern of involvement had significantly better results (Fig. 9), a finding consistent with those reported by others.^{16,18–20}

Although all of the children in the current study showed secondary osseous acetabular dysplastic changes with an acetabular index $< 30^\circ$, the acetabular index was preserved or even improved in the follow-up period.

Conclusions

Musculotendinous release can be used effectively to treat hip subluxation and to prevent dislocation in children with cerebral palsy and spastic hip disease. The hip migration percentage postoperatively is a good predictor of final outcome. The final outcome depends on the age at the time of surgery, the limited hip abduction and the degree of migration percentage before surgery, the surgical technique, and the

Figure 8 (A) An anteroposterior right hip radiograph of a 5-year-old boy with spastic diplegia pre-operatively with 60% migration. (B) Anteroposterior right hip radiograph at 3 years' postoperatively with 25% residual migration classified as fair.

postoperative physiotherapy. Longer follow-up will be required to determine how many children will need bony reconstruction to maintain stable containment of hips at maturity.

Figure 9 (A) An anteroposterior pelvic radiograph of a 5-year-old boy with total body involvement (TBI) pre-operatively with 33% migration in both hips. (A) Anteroposterior pelvic radiograph at 3 years' postoperatively with $> 20\%$ residual migration in the left hip classified as good.

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