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Open adductor tenotomy in the prevention of hip subluxation in cerebral palsy

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Abstract We reviewed radiographs of 76 hips in 41 patients with cerebral palsy treated with open adductor tenotomy because of hip subluxation. The majority of patients suffered from spastic diplegia. The aim of our study was to evaluate the effect of adductor release on hip subluxation. We measured the centre-edge angle and migration percentage pre-operatively and 1 and 3 years post-operatively. We considered the results according to patients' age at time of surgery (younger or older than 4 years of age) and ability to walk. Children younger than 4 years of age had better results than children older than 4 years of age. In children without walking ability, more than half of the hips had further radiological subluxation. In children with walking ability, we observed stabilisation or improvement of femoral-head subluxation in more than three quarters of the cases.

Résumé Nous avons examiné les radiographies de 76 hanches de 41 malades avec une paralysie cérébrale traitée par ténotomie à ciel ouvert des adducteurs en raison d'une subluxation de la hanche. La majorité des malades souffrait de diplégie spasmodique. Le but de notre étude était d'évaluer l'effet de la suppression des adducteurs sur la subluxation de la hanche. Nous avons mesuré l'angle de couverture externe et le pourcentage de migration avant l'intervention et à un an et trois ans post-opératoires. Nous avons considéré les résultats en fonction de l'âge des malades à la chirurgie (en dessous ou au-dessus de quatre années d'âge) et de la capacité de marche. Les enfants de moins de quatre ans avaient des meilleurs résultats que les enfants plus âgés. Chez les enfants sans capacité de marche, plus de la moitié des hanches avait une plus grande subluxation radiologique. Chez les enfants avec capacité de

marche, nous avons observé une stabilisation ou amélioration de la subluxation de la tête fémorale dans plus de trois quarts des cas.

Introduction

In cerebral palsy (CP), contractures of the adductors may be associated with lateralisation, subluxation and even dislocation of the femoral head [16]. This pathological sequence may be prevented by a surgical release of the adductor muscles [15] but there is neither consensus on the optimal age for surgery nor on the degree of subluxation that can be treated successfully by release of the adductors [3]. In this retrospective study, we assessed the effectiveness of open adductor tenotomy in these two respects.

Materials and methods

Between 1980 and 1999, 374 children with CP underwent open adductor tenotomy in the orthopaedic department of the Semmelweis University (Budapest, Hungary). From this large group, 41 children with at least one set of pre- as well as of post-operative pelvic radiographs were included in this study. Of the 41, 25 had spastic diplegia, ten had spastic quadriplegia and six were hemiplegics. The average patient age was 4.9 (range 2–12) years. A standard open adductor tenotomy was performed in 76 hips. In 38 of these, the surgery was performed before the age of 4 years and in 38 after the age of 4 years. After operation, the hips were immobilised in an abduction spica for 3–4 weeks and then treated with intensive physiotherapy.

Pre- and post-operative hip status was studied by measuring Wibergs centre-edge (CE) angle and Reimer's migration percentage (MP). Changes in the CE angle of $\pm 4^\circ$ and in the MP of $\pm 4\%$ were considered insignificant. We compared the pre- and post-operative MP and CE values. When the post-operative radiographs showed no further subluxation, we considered the hip to be stable. If subluxation continued, we considered the hip to have

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Table 1 Mean values of the centre-edge (CE) angle pre-operatively and in the first and third post-operative years according to patients' age and walking ability

	Pre-operative CE (°)	First post-operative CE (°)	Pre-operative CE (°)	Third post-operative CE (°)
Younger than 4 years	10.84±11.04	12.2±14.26	13.26±12.8	16.74±15.5
Older than 4 years	16.5±13.06	19.42±17.06	18.77±15.3	22.64±17.13
Ambulatory	18.08±11.1	22±10.07	21.56±11.2	26.42±12.7
Non-ambulatory	13.9±12.9	15.15±14.5	11.57±15.6	15±16.66

deteriorated. The numbers of deteriorated or stable hips were compared with the total number of hips in each group. The numerical difference between the pre- and post-operative radiological measurements was calculated and the well-matched results were compared using a two-tailed T-probe.

Results

In children younger than 4 years, 71% (27 of 38) hips were considered as stable in the first post-operative year (pre-operative CE 10.8±11.0°; post-operative CE 12.2±14.2°) and 79% (30 of 38) in the third year (pre-operative MP 40%±14.5; post-operative MP 37%±16.6) (Tables 1, 2).

In children older than 4 years, 74% (28 of 38) were found to be stable after the first year when considering Wibergs angle (pre-operative CE 16.5±13.0°; post-operative CE 19.4±17.0°) and 79% (30 of 38) after the third post-operative year (Table 1). However, only 61% (23 of 38) and 58% (22 of 38) hips, respectively, were found to be stable when considering the MP (Table 2). In children who could walk, 74% of hips were considered stable after the first post-operative year and this increased to 90% in the third year according to Wibergs angle. Using the MP, however, the figures were 72% and 77%, respectively. In children with no walking ability, 73% hips were considered stable after 1 year using Wibergs angle and 59% using the MP. In the third post-operative year, the corresponding figures were 68% and 46%, respectively (Tables 1, 2).

Changes in the MP after the third post-operative year between children either younger or older than 4 years were found to be statistically significant ($p<0.1$), as was the change in the MP after the third post-operative year between children with or without walking ability ($p<0.1$).

Discussion

Although the CE angle is an important radiographic indicator and has an adequate level of reliability and reproducibility in some cases, it may not reflect the true lateral coverage of the femoral head. Omeruglu et al. [7] reported that the classic CE angle had nearly 1° less intra-observer and inter-observer variation than the refined CE angle. Our classic CE angle measurements were obviously higher than the refined angles in the hips of children under 9 years of age.

The effectiveness of open adductor tenotomy has been examined by several authors [1, 7, 9–11]. Usually, the patients compared had different ages, different pre-operative radiological status and different walking ability and this heterogeneity had a serious effect on recorded results. Sharrard et al. [11] found that 75% of adductor tenotomies made the hips stable and reported that 48% of the patients were able to walk alone. Reimers [9] believed that the stability was maintained or improved in 57% of the hips with adductor tenotomy only. However, the walking ability of the 127 patients was not noted. Banks and Green [1] reported on 27 hips with subluxation prior to operation and found that following adductor tenotomy and obturator neurectomy, 70% were either improved or unchanged. In severely involved patients, adductor tenotomy and obturator neurectomy was reported as satisfactory in 75% if done to prevent dislocation but that it failed to reduce subluxation or dislocation in 87% (69 of 79 hips) [10].

Several authors have examined the relationship between the patient's age and the post-operative state of the hip. Some authors believe [9, 10, 14] while others do not [3, 12, 13], that age at time of adductor tenotomy influences the outcome. Harris et al. [4] examined the acetabular remodelling in congenital dislocation of the hip and found that a significant potential for remodelling remained up to the age of 4 years. Kalen and Bleck [6] took the view that surgery should be done before the age of 5 years and before definite skeletal changes, primarily acetabular dysplasia,

Table 2 Mean values of the migration percentage (MP) pre-operatively and in the first and third post-operative years according to patients' age and walking ability

	Pre-operative MP (%)	First post-operative MP (%)	Pre-operative MP (%)	Third post-operative MP (%)
Younger than 4 years	40±14.51	37±16.6	37.62±13.2	30.68±13.7
Older than 4 years	31.32±16.94	28.7±17.71	30.85±17.43	29.92±16.02
Ambulatory	31.09±13.77	26.5±12.2	30.51±14.8	22.15±13.5
Non-ambulatory	35.99±15.58	34.45±18.06	41.2±22.34	38.9±21.39

occur. Their successful cases were under 5 years of age and their failures averaged 6 years of age. Onimus et al. [8] reported that successful results occurred in 90% of patients under age four who had a pre-operative MP under 33%. We found that our children under 4 years of age had a significantly higher potential to obtain a better post-operative MP than children over the age of 4 years.

Howard et al. [5] stated that there was a strong correlation between the stability of the hip and the patient's ability to walk. In patients who did not bear weight on their lower limbs, subluxation of the femoral head was more likely. Cornell et al. [3] documented that the pre-operative MP was a significant predictor of the outcome of adductor tenotomy. He reported that patients who had lower pre-operative MP had a much better functional and radiological status in the fifth post-operative year than those patients who had higher MP values. Čobeljić et al. [2] and Vidal et al. [14] stated that dislocation could be predicted by annual monitoring of the MP and that this could help when selecting the best treatment. They said that if the annual increase was only 1%, dislocation was not expected. Any increase from 1% to 4% per year requires regular checks every 3–6 months. They suggested that an operation was necessary when the MP was increasing by 4% or more per year for hips that were not dislocated or where there was subluxation. Our opinion is that MP values less than 1% and 1–4% cannot always be measured accurately and so it is not always helpful to separate these categories. Kalen and Bleck [6] thought that soft-tissue surgery alone was often too inadequate for non-walkers. In their study, 41% of the patients needed further surgery and there was radiographic evidence of progression of subluxation in 33%.

In our study, ambulatory patients had better post-operative CE angles and MPs than non-ambulatory patients. The radiological state of the hips of those patients who were not able to walk deteriorated by more than 50% in the third post-operative year. Meanwhile, the operation prevented further subluxation of the hip in 75% of ambulatory patients. It is worth continuing post-operative follow-up examinations in the non-ambulatory group for several years, as this might give a better chance of finding the 'unsuccessful cases'.

Based on our results, we suggest that surgery should be performed under the age of 4 years for both non-ambulatory and ambulatory patients.

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