Adductor tenotomy in spastic cerebral palsy

A long-term follow-up study of 78 patients

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Background **There is a risk of hip dislocation in children with spastic cerebral palsy. We evaluated the prophylactic effect of adductor tenotomy in patients with long-term follow-up.**

Patients and methods **Our material comprised 78 patients (46 boys) with a mean age of 8 (2–17) years who underwent adductor tenotomy during the period 1986–1991. 40 patients had spastic diplegia and 38 had quadriplegia. For patients who had further hip surgery, follow-up was until the next hip operation. Those who had not undergone further surgery were invited to a follow-up examination. The migration percentage (MP) was measured on the preoperative and follow-up radiographs. The radiographic result was termed good if MP at follow-up was reduced or had increased less than 10%. The follow-up period was 10 (1.6–16) years, with a mean of 6 years for patients with later hip surgery and 13 years without such surgery.**

Results **The clinical outcome was good in 51 cases, poor in 12, and uncertain in 15. The radiographic result was good in 39 of the 53 patients with radiographs available both preoperatively and at follow-up. The patients with good radiographic results had lower preoperative MP than those with poor results (MP 34% versus 49%) and lower preoperative acetabular index. The mean increase in MP (worst hip in each patient) was 1.9% per year, which is considerably less than that in nonoperated patients. Further hip surgery was necessary in 27 patients, because of increasing MP in 14 cases and for clinical reasons in 13.**

Interpretation **Adductor tenotomy reduced the trend towards lateral displacement of the hip joints. The operation had a favorable outcome in approximately two-thirds of the patients. The operation should be performed before the MP reaches 50%.**

There is increased risk of hip dysplasia and dislocation in spastic cerebral palsy (CP), especially in patients who are most severely affected (Moreau et al. 1979, Howard et al. 1985). This is due to muscle imbalance with increased spasticity in the hip flexors and adductors. Adductor tenotomy and similar soft tissue releases are common procedures aimed at preventing the hips from dislocation (Banks and Green 1960, Kalen and Bleck 1985, Turker and Lee 2000). The results of previous studies on adductor tenotomy vary considerably and are difficult to compare because of differences in patient categories, evaluation criteria, and length of follow-up. We have found no previous studies with long-term follow-up.

We evaluated the clinical and radiographic results of adductor tenotomy in a patient group with long-term follow-up.

Patients and methods

We planned to include all patients with spastic CP who underwent adductor tenotomy at Sophies Minde Orthopedic Hospital during the 6-year period 1986–1991, if they were under 18 years of age at surgery and had had no previous hip operations. 95 patients filled these criteria, but 17 were

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excluded for various reasons. 11 patients died in the follow-up period (with death having nothing to do with their hip operations). Only 3 patients had hemiplegia; this number is too small to draw reliable conclusions. In 3 patients, neither the case records nor the radiographs could be found. After exclusion of these 17 patients, the material consisted of 78 patients (46 boys), 40 with spastic diplegia (DP) and 38 patients with spastic quadriplegia (QP). The mean age at adductor tenotomy was 8 (2–17) years, 7.3 years for patients with DP and 8.5 years for those with QP.

The case records were examined to find information on type of CP, level of gait function, indications for operation, type and degree of radicality of the surgical procedure, postoperative complications, and whether or not the patient had undergone further hip operations in the follow-up period.

A questionnaire was sent to the patients and their parents and caregivers to obtain information on the aim of the operation, whether or not this aim had been achieved, postoperative complications, whether they were satisfied with the treatment, further hip operations, and present symptoms and gait function. The answers supplemented the information in the case records regarding indications for operation, complications, and whether or not the purpose of the operation had been achieved.

Most of the patients had markedly reduced physical capacity. Only 11 individuals (all with DP) could walk without support preoperatively, whereas 24 (19 with DP and 5 with QP) could walk with support from sticks, crutches or rollator. 43 patients could not walk (10 with DP and 33 with QP).

Table 1. Indications for adductor tenotomy (number of patients)

Indication	Total	Diplegia	Quadriplegia	P-value [a]
Improve gait	41	33	8	< 0.001
Improve standing	33	16	17	0.8
Improve abduction	44	19	25	0.2
Improve symmetry	24	5	19	0.001
Facilitate perineal care	24	5	19	< 0.001
Relieve pain	12	3	9	0.06
Prevent hip dislocation	57	28	29	0.6

[a] Fisher's exact test (difference between diplegia and quadriplegia)

Table 2. Anatomic structures operated on and type of operation (number of patients)

	Total	Diplegia	Quadriplegia	P-value [a]
Anatomic location				
Adductor longus	78	40	38	
Gracilis	73	36	37	0.4
Obturator nerve	72	36	36	0.7
Adductor brevis	29	6	23	0.001
Iliopsoas	18	8	10	0.6
Radicality of operation				
Standard adductor tenotomy	47	32	15	< 0.001
Radical soft tissue release	31	8	23	
Symmetry				
Symmetric operation	48	31	17	0.005
Asymmetric operation	30	9	21	
Bilateral operation	64	35	29	0.2
Unilateral operation	14	5	9	

[a] Fisher's exact test (difference between diplegia and quadriplegia)

Indications for adductor tenotomy

All the patients had one or more clinical indications for adductor tenotomy (Table 1). Most also had radiographic indication, which was defined as "hip at risk", with migration percentage > 20%. The only indication that was more frequent in DP than in QP was to improve gait function. To facilitate perineal care and improve symmetry were more frequent among the quadriplegics. Few children had problems with pain preoperatively.

Operative procedures

Adductor tenotomy was performed through a short oblique incision in the groin. The adductor longus tendon and the gracilis muscle were cut close to their attachments and about 1 cm of the anterior branch of the obturator nerve was resected in nearly all of the patients (Table 2). More radical release

with myotomy of the whole or part of the adductor brevis muscle was done more frequently in the QP group. Through the same incision, tenotomy of the iliopsoas tendon just proximal to the lesser trochanter was done if a hip flexion contracture was present. Additionally, distal release of the medial hamstrings was performed in approximately half of the patients. Most patients (53 individuals) were immobilized for 5–6 weeks in abduction plaster (from the toes to mid-thigh) with a broom-stick fixed to the plaster to secure abduction of about 30° in both hips. All patients had postoperative physical therapy to maintain and improve range of joint motion and function.

When adductor longus, gracilis, and the obturator nerve had been operated on, the procedure was termed standard soft tissue release. Radical release implied simultaneous release of the adductor brevis and/or iliopsoas. Radical release was more frequent among the quadriplegics (Table 2). An asymmetric procedure meant that the operation was more radical on one side than on the other, or that one side only was operated on. Symmetric procedures were more common in the DP group. Even though there was a trend towards more frequent bilateral operations in DP than in QP, the difference was not statistically significant.

Radiographic evaluation

On the AP radiograph of the pelvis and hip joints, we measured the migration percentage (MP; Reimers 1980), which is the percentage of the femoral head lateral to the acetabulum (lateral to Perkins' line). The more laterally displaced the hip is, the greater is the MP. In accordance with Reimers (1980), we used 33% as the dividing line between a located hip and a hip with subluxation. Whereas Reimers used 100% as the limit between subluxation and dislocation, we used 90%, because a hip with only 10% coverage is—for all practical purposes—dislocated. When the whole femoral head was medial to Perkins' line, the MP was given a minus sign. When the whole femoral head was located lateral to Perkins' line, MP was given the value 100%, because further grading of hips with total dislocation is of no practical interest. We used the following radiographic categories: normal (MP below 20%), hip at risk (MP 20–32%), subluxation (MP 33–89%), and dislocation (MP 90% or higher).

We also measured the acetabular index (AI), which is the slope of the acetabular roof (Hilgenreiner 1925) and the pelvic obliquity. The latter is the angle between the horizontal line and the line between the lowest point of the pelvis on both sides.

Criteria for outcome

We considered the clinical result to be good if the aim of the operation was achieved and the patient and caregiver were satisfied with the outcome. If the purpose of the operation was not realized, the result was termed poor. The outcome was considered doubtful if the questionnaire had not been answered and if the patient and caregiver were uncertain regarding satisfaction.

In accordance with the study of Kalen and Bleck (1985), we considered the radiographic result good if the MP was reduced at follow-up, or had increased by less than 10%. If the MP had increased by 10% or more, the outcome was termed poor. In order to compare the results with those of previous studies, we presented the radiographic results for both hips and, in addition, for one hip only per patient. In the latter case, the worst hip was chosen (the one with the largest MP). Because a hip with dislocation very rarely becomes located after soft tissue release, only hips with a preoperative MP of less than 90% were included in this analysis of the radiographic outcome.

Sometimes the hip dysplasia changes side. This can happen when a more radical soft tissue release has been performed on one side (or a unilateral operation). The MP on the operated side is reduced, whereas the hip on the other side deteriorates. In such cases, we used the result of the deteriorating hip for the unilateral radiographic analysis.

To facilitate comparison with previous studies, the radiographic results were also classified according to Silver et al. (1985), as modified by Turker and Lee (2000). The result is termed poor (failure) if the hip becomes dislocated or severely subluxated (MP > 80%) during follow-up, or if a further operation is needed to improve femoral head coverage. In addition, we used the classification of Onimus et al. (1991), according to which the result is termed good if MP is reduced by more than 10% and poor for the rest of the hips.

For patients with further hip operations, the result immediately before the next operation was used as

their follow-up outcome. Patients with no further surgical procedures on their hips were invited to a follow-up examination, including clinical examination (symptoms, gait function, and hip mobility) and radiographic examination.

Statistics

Student's t-test for independent samples was used for non-categorical variables to assess the difference between good and poor radiographic results, and Fisher's exact test was applied for categorical variables. Differences were considered significant when the p-value was less than 0.05.

Results

Clinical outcome

The questionnaire was answered by 64 patients and caregivers. The clinical result was good (i.e. the purpose of the operation had been achieved) in 51 patients, whereas the result was poor in 12 patients. The clinical outcome was doubtful (the aim was partly achieved or the patients were not certain) in 15 patients. The outcome was good in 8 of 11 patients with radiographically normal hips, in 14 of 21 patients with "at risk" hips, in 17 of 29 with preoperative subluxation, in 7 of 8 with dislocation, and in 5 of 9 cases where preoperative radiographs were not available.

The clinical results were better for patients who had not undergone further hip operations ($p < 0.001$), for patients with bilateral operations in relation to those with unilateral operations ($p = 0.04$), and for patients with good radiographic results ($p < 0.001$). There were no statistically significant differences according to sex, type of CP, age at operation, gait function, radicality of the operation, and preoperative MP.

Postoperative complications occurred in 6 children. Skin ulceration on the heel developed in 4 children because of pressure caused by the plaster bandage. Wound infection occurred in 1 child and 1 child had long-lasting pain after surgery. These complications were relieved by nonoperative treatment.

Table 3. Radiographic results according to preoperative hip status

Radiographic classification	Preoperative hip status	No of patients/hips	Good radiographic results Patients n (rate)	Hips n (rate)
Kalen and Bleck (1985)				
	All hips	53 / 98	39 (0.7)	79 (0.8)
	Subluxation	24 / 30	14 (0.6)	23 (0.8)
Onimus et al. (1991)				
	All hips	53 / 98	13 (0.3)	31 (0.3)
	Subluxation	24 / 30	10 (0.4)	19 (0.6)

Radiographic outcome

The preoperative radiographs were available in 69 children. The radiographs of the remaining 9 children could not be found and the most common reason was that they had been sent to another hospital closer to the home of the patient, where further follow-up was to take place.

The mean preoperative MP (mean of right and left side) was 38% and the maximal preoperative MP (mean of the worst side in all the patients) was 45%, and both were significantly greater in quadriplegia than in diplegia ($p < 0.001$).

According to the radiographic classification of Kalen and Bleck (1985), there were good results in 39 out of 53 patients (Table 3). When using the radiographic classification of Silver et al. (1985) as modified by Turker and Lee (2000), 45 patients had good results ("success") and 14 had poor results ("failure"). There was a good correlation between this classification and that of Kalen and Bleck since 39 patients had good results and 12 had poor results by both classifications. There was discrepancy in 2 patients only (both good by Silver and poor by Kalen and Bleck).

The radiographic results were better when the preoperative MP in the worst hip was less than 50% and better when symmetric operations had been carried out. The group with poor results had higher preoperative MP (worst hip) and higher acetabular index than those with good results (Table 4). The radiographic results were not significantly related to gender, type of CP, age at operation, gait function, clinical indications for operation, unilateral versus bilateral operation, and radicality of the operation.

Using the stricter classification of Onimus et al. (1991), only 13 patients (one quarter) had good

Table 4. Radiographic results according to age and preoperative radiographic measurements

	Radiographic results				
	Good		Poor		P-value [a]
	mean	SD	mean	SD	
Age at operation (years)	8.5	4.5	6.3	3.3	0.07
MP preoperatively, worst hip (%)	34	20	49	19	0.02
Annual MP progression (%) [b]	–0.3	2.8	7.8	8.2	0.003
Acetabular index (degrees)	23	6.5	27	2.7	0.004
Pelvic obliquity (degrees)	1.4	2.7	3.8	4.4	0.07

[a] Independent samples t-test (difference between patients with good and poor radiographic results).
[b] MP: migration percentage.

Table 5. Hip joint status preoperatively and at follow-up, or at reoperation for the worst hip (number of patients)

	Located	Subluxation	Dislocation	Total
Located	25	4	0	29
Subluxation	7	12	6	25
Dislocation		1	6	7
Total	32	17	12	61

radiographic results (Table 3). In the group with preoperative subluxation (24 patients), where the aim was to avoid severe subluxation and dislocation, the outcome was somewhat better, with 42% good results when the worst hip in each patient was used for the evaluation. Considering all 30 hips with preoperative subluxation, the percentage good results increased to 63%. A similar trend towards better results when all the hips were analyzed as opposed to when the worst hip only in each patient was evaluated, was seen when the classification of Kalen and Bleck was used (Table 3).

Both hips were located preoperatively in 29 patients (Table 5). At follow-up, deterioration to subluxation had occurred in 4. Of the 25 patients with preoperative subluxation, 12 still had subluxation at follow-up whereas improvement to located hips had occurred in 7 (Figure 1) and deterioration to dislocation was found in 6 patients. The hips were still dislocated at follow-up in 6 out of 7 patients with dislocation preoperatively.

The annual change in MP was calculated for patients with radiographs that were available both preoperatively and at follow-up. For those who underwent further hip operations, the change was calculated from the preoperative MP and the last radiograph before reoperation. For patients who had not been reoperated, the annual change in MP was calculated from the preoperative radiograph and the radiograph at the follow-up examination. The latter radiograph was considered to represent the status of the hips at 16 years of age, since it was assumed that the hips had not changed substantially after this age. Thus, patients who were 16–18 years at operation were not included in this calculation. The progression per year in the worst

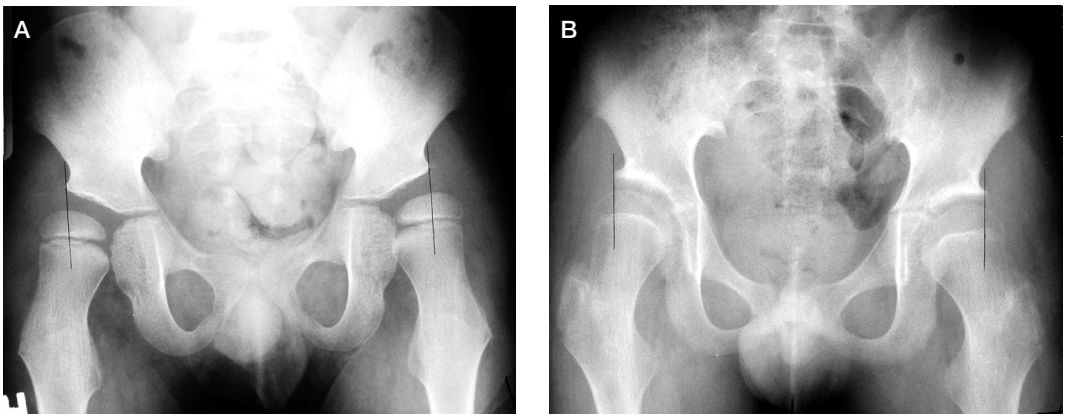

Figure 1. A 4-year-old boy with spastic diplegia and bilateral hip subluxation preoperatively (A). At age 13 years (B), showing located hips (MP 29% on the right side and 26% on the left).

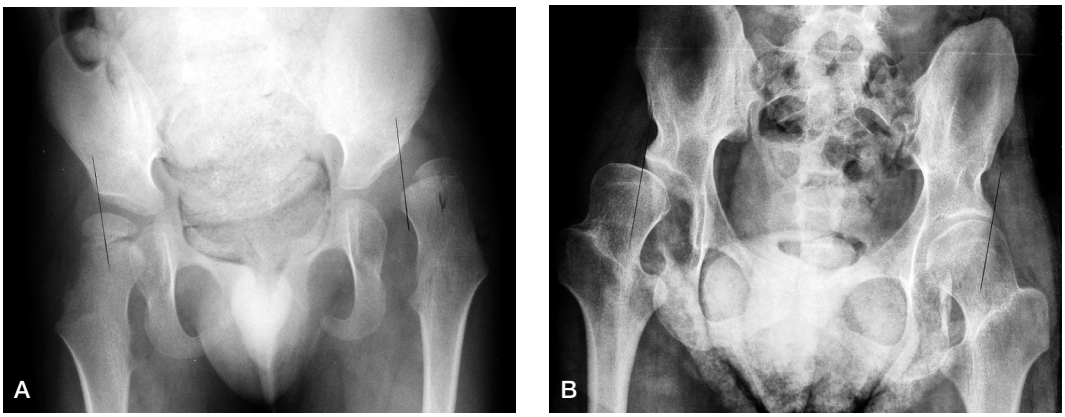

Figure 2. Preoperative dislocation (A) of the left hip in a 4-year-old boy with spastic quadriplegia. An asymmetric adductor tenotomy, more radical on the left side, was performed. At age 18 years (B), the left hip has become normal whereas the right hip is markedly subluxated.

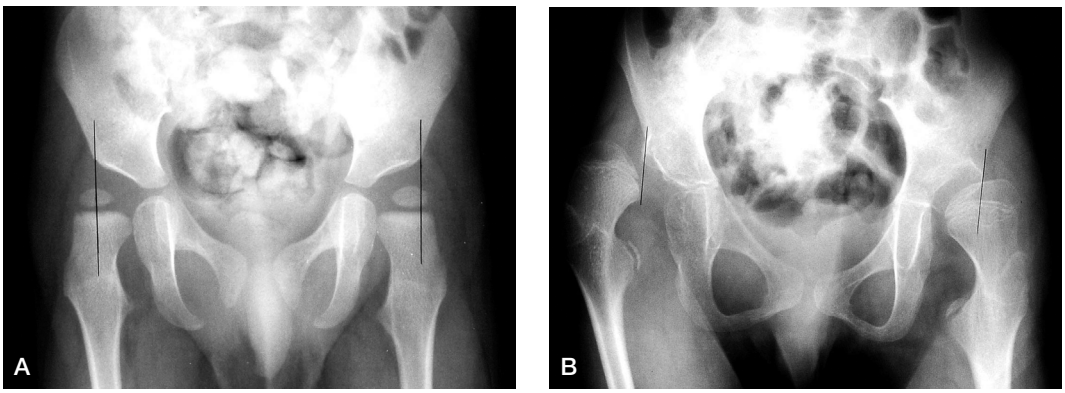

Figure 3. A 2-year-old quadriplegic boy (A) with subluxation of the right hip preoperatively. At 12 years of age (B), he had dislocation of the right hip and subluxation of the left.

hip of 48 patients was 1.9%. The progression was larger ($p = 0.04$) in patients with QP (4.0%) than with DP (0.5%). There was no significant correlation between annual MP progression and either preoperative MP, or age at surgery.

Asymmetric operations

14 children underwent unilateral adductor tenotomy at the age of 9.7 (4–16) years. The radiographic results were known for 7 of these children (2 below and 5 above 10 years of age). MP on the operated side was 48% (13–91) preoperatively and 14% (-4–52) at follow-up. The hip dysplasia did not change side in any of the children.

The operation was bilateral but asymmetric (more radical on one side) in 16 children. In 5 of these cases, the hip dysplasia changed side because the worst hip improved whereas the originally best hip deteriorated (Figure 2). These 5 children were aged 5.5 (3–8) years at adductor tenotomy. The MP on the worst side was 68% (43–100) preoperatively. The originally worst hips (4 subluxation and 1 dislocation) became located, whereas the opposite side deteriorated to subluxation in 4 cases and dislocation in 1 case. The MP of the worst hips at follow-up was 61% (34–100).

Reoperation

27 patients had undergone further hip surgery during the follow-up period. The reason was increasing lateral migration on the worst side in 11 cases (Figure 3), increasing migration on the opposite side in 3, and various clinical reasons in 13 patients (to improve gait or to improve range

of motion or symmetry). Most patients reoperated for clinical causes had diplegia. Their hips had not deteriorated during follow-up since the MP on the worst side was reduced by a mean of 2.9%.

Increasing MP was the reason for reoperation in 14 patients (6 with DP and 8 with QP). The adductor release had been symmetric in 5 cases and asymmetric in 9. The preoperative MP was 47% (17–80). The follow-up period between the first and second hip operation was 6.2 (1.6–10.9) years and the MP increased during this time by 6.9% (2–33) per year (4.2% in DP and 8.9% in QP).

Long-term follow-up examination

33 patients who had not been reoperated attended the long-term follow-up examination. There were 20 men and 13 women, of which 18 had DP and 15 had QP. The follow-up period was 14 (8–16) years and age at follow-up was 23 (14–34) years. The clinical results were good in 28 patients. At follow-up, 8 patients complained of pain in their lower extremities, but no one had constant or strong pain. 7 patients walked without support, 16 could walk with support (crutches or rollator), and 10 could not walk. The range of hip motion was considerably reduced, with the following mean (range) values: flexion 101° (80–140), extension –10° (-35– 0), and abduction 26° (-5–50).

Preoperatively, 19 patients had had both hips located, 9 had subluxation, and 2 had dislocation (3 individuals lacked preoperative radiographs). At the follow-up examination, the corresponding numbers were 24, 6, and 3. Out of 28 patients, 25 had good radiographic results with reduction or less than 10% increase in MP. The mean preoperative MP of the worst hip was 36% (11–100). The MP progression per year (calculated from the preoperative value to age 16 years) was 1.2% (-5–11).

Discussion

Clinical results

Approximately two-thirds of the patients had a good clinical result, defined as satisfied patients and caregivers and by the fact that the aim of the operation had been achieved. These results seem to be in accordance with those of previous studies, but the clinical grading of functional results is difficult because many patients have mental retardation and other types of handicap (Tachdjian and Minear 1956). Banks and Green (1960) used two classifications; one was based on improvement related to the preoperative status of the patient and the other was functional performance, but the grading in both systems was rather subjective. They found improvement and good to excellent function in more than half of the patients. Sharrard et al. (1975) used no grading of the results but reported a striking improvement in function in almost all children.

Radiographic results

There is no agreement with regard to grading of radiographic results after soft tissue release of the hips in CP. This was the reason why we used 3 different classification systems. The classification of Kalen and Bleck (1985) is based on increase in MP and the classification of Silver et al. (1985) uses the need for additional surgery to obtain a stable, located hip. There was a very good accordance between these gradings, with discrepancy in only 2 of 53 patients.

The grading of Onimus et al. (1991) is more strict and is less suitable in patients with located hips, because the aim of soft tissue release in such cases is prophylaxis against subluxation and dislocation, not reduction in MP. Thus, the Onimus classification should be used in subluxated hips only. In a study like the present one, consisting of patients with normal hips, hips at risk, and subluxated hips, the grading of Kalen and Bleck (1985) seems to be the most adequate.

In most previous studies, the result of each hip has been reported separately (Kalen and Bleck 1985, Silver et al. 1985, Onimus et al. 1991). In 2 studies from recent years, however, the outcome for a child has been reported by the result for the worst hip only (Miller et al. 1997, Turker and Lee 2000). Better results will be obtained, however, if both hips are evaluated as separate entities. This is shown in Table 3, where the rate of good radiographic results (Kalen and Bleck classification) in patients with preoperative subluxation was 0.6 when only the worst hip was analyzed and 0.8 when both hips were evaluated separately. A similar difference was reported by Turker and Lee (2000), with a success rate of 42% when only the worst hip was analyzed

and 65% when all hips were included. However, it is of no help to the patient that one hip improves if the other deteriorates to subluxation or dislocation. Therefore, we agree with Turker and Lee (2000) that a unilateral failure should be considered to be a complete failure for that patient.

Because of different classifications and the consideration of whether the worst hip or both hips are included, it is difficult to compare the results of different studies with each other. Sharrard et al. (1975), who used subjective evaluation only of radiographs, reported that one operative procedure—usually an adductor release—succeeded in obtaining and maintaining hip stability in 75% of the hips. Good results were reported by Miller et al. (1997) and Houkom et al. (1986), but they used radiographic gradings other than those mentioned above. Banks and Green (1960) had 34 hips with subluxation, of which 27 were available for follow-up. 17 hips became located and 2 were unchanged; thus, good results were achieved in 70%. Kalen and Bleck (1985) found that 80% of the hips had good results and the same percentage of good results was reported by Silver et al. (1985). Thus, most studies have found good results in 70–80% of hips, which is in keeping with the results of our study. A lower success rate of 42% was found by Turker and Lee (2000), but only the worst hip in each patient was included in their analysis.

Another way of evaluating the radiographic outcome is to compare the yearly progression in MP between operated and nonoperated patients. In a recent study on the natural history of hip development in CP, the MP increase per year in patients above 5 years of age was 2.5% in DP and 7.3% in QP (Terjesen 2001), which is considerably more than the 0.5% and 4.0%, respectively, in our patients after adductor tenotomy.

Factors influencing outcome

There is no consensus regarding the factors that influence the outcome after soft tissue release. According to Cottalorda et al. (1998) and Silver et al. (1985), the preoperative MP was the only predictor of outcome. Silver et al. (1985) found that the preoperative MP in failures was 59% and in successes it was 39%, which is quite similar to our findings and to the figures of 43% and 33%, respectively, reported in the study of Turker and Lee (2000). Houkom et al. (1986) reported that no child with severe subluxation who was above 6 years of age regained concentric reduction. In accordance with the results of Turker and Lee (2000), we could find no definite cut-off value for preoperative MP. However, based on the pronounced trend towards deterioration in nonoperated hips, especially in quadriplegics and non-walkers, it seems reasonable to perform adductor tenotomy before the MP reaches 50%, or earlier if there are strong clinical indications. Our findings indicate that the outcome will be better if the preoperative acetabular slope (AI) is not too high, but this variable has not been evaluated in previous studies.

With regard to patient age, Kalen and Bleck (1985) found better results in younger patients and recommended that generally soft tissue release should be performed before the age of 5 years. Sharrard et al. (1975) also found better results in younger patients, as did Onimus et al. (1991), who considered that preventive surgery should be performed already at 2–3 years of life. On the other hand, we found no influence of age, which is in keeping with several other reports (Silver et al. 1985, Cottalorda et al. 1998, Turker and Lee 2000).

Concerning type of CP and gait function, we found no significant effects on radiographic outcome, in agreement with Silver et al. (1985) and Cottalorda et al. (1998). Others have found less satisfactory results in severely retarded patients than in those with higher mental status (Banks and Green 1960), and better results in patients who were ambulatory or with walking potential (Kalen and Bleck 1985).

In some studies, type and radicality of the operative procedure had no effect on the outcome (Reimers 1980, Silver et al. 1985, Turker and Lee 2000). Others have reported better results after more radical procedures, including the iliopsoas and other hip muscles (Kalen and Bleck 1985, Cobeljic et al. 1994). In our study radicality of the operation did not significantly affect the outcome, but the results were better when symmetric procedures were performed.

Unilateral adductor release appears to be undesirable because of the deleterious effect on the nonoperated hip (Samilson et al. 1967, Reimers 1980 Silver et al. 1985, Carr and Gage 1987). Noonan

et al. (2000) reported 37 patients with unilateral adductor tenotomy and additional ipsilateral femoral osteotomy in 19 hips. At follow-up, 10 of the nonoperated hips were dislocated and 16 were subluxated, confirming an untoward effect on the nonoperated hip. It is therefore somewhat surprising that none of the patients with unilateral operation in our study developed subluxation of the contralateral hip. However, when an asymmetric operation had been carried out (which was more radical on the side with the highest MP), the hip dysplasia changed side in 5 cases. The reason for the dysplasia changing side in those with asymmetric operations, but not in those with unilateral operations, might be that the latter group were considerably older (mean age 10 years, as opposed to 5 years). Thus, we agree with Noonan et al. (2000) that unilateral operation should be avoided in patients under 6 years of age.

Additional hip surgery to obtain better femoral head coverage was performed in one-fifth of the patients in this study. More frequent reoperations (one-third) were performed by Turker and Lee (2000). They stressed the importance of the length of the follow-up period, which was only 3 years in some previous studies (Reimers 1980, Onimus et al. 1991) and 4–5 years in other reports (Sharrard et al. 1975, Kalen and Bleck 1985, Silver et al. 1985, Miller et al. 1997). Sharrard et al. (1975) maintained that radiographic deterioration became apparent within 2 years and Kalen and Bleck (1985) considered that the long-term stability of the hip can be assessed with a follow-up time of only 2 years. Turker and Lee (2000) felt, however, that the excellent results from previous studies might deteriorate as the children got older, which was the reason for having a longer follow-up period (8 years on average). Since the period of follow-up was longer in our study than in any of the earlier studies, this variable could be evaluated adequately. Since the mean time between operation and reoperation was 6 years, it is obvious that 2 years of follow-up is too short. On the other hand, in the group with long-term follow-up (mean 14 years), the radiographic results were good in nine-tenths of the patients, which indicates that the outcome will not necessarily become worse as the length of follow-up increases. However, the hips with the greatest trend towards deterioration had been reoperated already and thus were not included in the group with long-term follow-up. The patients with long-term follow-up might therefore represent a subgroup with better prognosis. Because of the general trend toward deterioration of the hips with time, it seems reasonable to recommend at least 6 years of follow-up after prophylactic soft tissue release.

No competing interests declared.

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