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Original article

Soft-tissue release for hip subluxation and dislocation in cerebral palsy

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Abstract

Objective: This study aimed to evaluate the effectiveness of soft-tissue release on hip subluxation and dislocation in cerebral palsy as well as activities of daily living after surgery.

Patients and Methods: Soft-tissue release was performed in 13 patients (19 hips) with cerebral palsy. Of them, 10 had spastic quadriplegia and three had spastic diplegia. Mean ages were 8.6 years at surgery and 13.8 years at the last investigation. The mean follow-up period was 5.2 years. Hip subluxation and dislocation severities were analyzed before and after surgery and at the final investigation as migration percentage on radiographs. Postoperative activities of daily living were also evaluated in 12 patients.

Results: Seven hips classified as mild and moderate preoperatively were classified as good, mild, and moderate at the last investigation. Nine of 12 hips classified as severe preoperatively continued to be severe at the last investigation. However, three of 12 hips classified as severe preoperatively improved at the last investigation. There was a positive correlation between preoperative migration percentage and that at the last investigation. Daily activities improved postoperatively in 12 patients.

Conclusions: Early treatment is necessary to prevent hip dislocation and improve hip subluxation. However, several patients with severe subluxation might experience improvement with soft-tissue release alone. Soft-tissue release is effective for treating hip dislocation and subluxation in cerebral palsy and improving daily activities.

Key words: soft-tissue release, cerebral palsy, spastic hip subluxation and dislocation

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Introduction

Spastic subluxation and dislocation of the hip are common in children with cerebral palsy. These conditions are related to spasticity severity and often progress to quadriplegic cerebral palsy. The reported prevalence of hip dysplasia in children with cerebral palsy varies. Howard *et al*.[1] reported that the incidence of dislocation was 59% in patients with bilateral hemiplegia and severe involvement of the upper limbs versus 6.5% in those with diplegia and little involvement of the upper limbs. Lonstein and Beck[2] reported hip subluxation or dislocation in only 7% of those capable of independent ambulation versus 60% of those who were non-ambulatory. Terjesen[3] reported that hip displacement (migration percentage [MP] > 33%) occurred in 26% of those with a Gross Motor Functional Classification System (GMFCS) level IV and in 63% of those with a GMFCS level V.

Hip dislocation leads to limited hip movements, causing difficulty in activities of daily living (ADL), such as the inability to walk, pain, difficulty maintaining sitting balance, decubitus ulcer development, and interference with perineal care[4–6].

Soft-tissue release has been proven beneficial in the prevention of spastic hip subluxation and dislocation. Miller *et al*.[7] reported that 80% of children with spastic hip disease have a good or fair outcome after open adductor and iliopsoas lengthening. However, there is no consensus about procedure, patient age, and dislocation degree as indicators of surgery. In addition, a postoperative evaluation is often performed based on radiographic views using MP as the evaluation parameter; however, ADL function is rarely reported.

In the present study, tenotomy of the adductor for hip subluxation and dislocation was performed in patients with cerebral palsy, and the chosen method used to lengthen the hamstrings, iliopsoas, and rectus femoralis was selected on a patient-by-patient basis. The purpose of this study was

to retrospectively evaluate the effectiveness of soft-tissue release on hip subluxation and dislocation, and ADL after surgery.

Patients and Methods

Thirteen patients (19 hips) underwent soft-tissue release. Of them, 10 had spastic quadriplegia and three had spastic diplegia. Mean ages were 8.6 years at surgery and 13.8 years at the last investigation, and the mean follow-up period was 5.2 years. Numbers of patients with GMFCS levels III, IV, and V were one, three, and nine, respectively. Five patients had right hip subluxation, two had left hip subluxation, and six had bilateral hip subluxation or dislocation (12 hips) (Table 1).

Adductor longus tenotomy was performed, partial myotomy of the adductor brevis and magnus was conducted, and a gracilis tenotomy was also performed when the tension of the muscles was strong[8]. Furthermore, tenotomy of muscles such as the hamstrings and iliopsoas and lengthening of the rectus femoralis were performed as required. Tenotomy of the hamstrings was performed proximally, distally, or both. Tenotomy of the proximal hamstring was performed in conjunction with tenotomy of the adductor, whereas the semimembranosus, semitendinosus, and biceps were released from the ischium[8] The distal hamstrings release means tenotomy of the semimembranosus and semitendinosus at popliteal region. The iliopsoas tendon was resected, leaving the muscle fibers intact[9], and the rectus femoralis underwent Z-lengthening.

Eleven hips were subjected to tenotomy of the adductor only, whereas two hips were subjected to tenotomy of the adductor and proximal hamstrings and three hips were subjected to tenotomy of the adductor and distal hamstrings. Tenotomy of the adductor, distal hamstrings, and iliopsoas was performed in two hips. Tenotomy of the adductor and proximal hamstrings and lengthening of the rectus femoralis was performed in one hip, whereas resection of the distal hamstring was performed to treat severely restricted knee extension (Table 2).

Hip MP values on radiographs were measured before surgery, after surgery (< 1 year after surgery), and at the last investigation. The MP was used to determine the degree of hip subluxation on radiographs as described by Reimers[10] (Figure 1).

Preoperatively, cases were classified as mild, 25% ≤ MP < 40%; moderate, 40% ≤ MP <60%; and severe, MP ≥ 60%. After surgery, they were classified as good, MP < 25%; mild, 25% ≤ MP < 40%; moderate, 40% ≤ MP < 60%; and severe MP ≥ 60%.

The mean MP was calculated before and after surgery and at the last investigation. The Spearman rank correlation coefficient was used to determine the correlation between the preoperative MP and that at the last investigation.

In addition, we investigated the change in ADL (care and rehabilitation) before versus after surgery from the patients' medical records.

The ethics committee of Ibaraki Prefectural University of Health Sciences reviewed and approved this retrospective study (approval number: e88).

Table 1 Patient characteristics

Diagnosis, n	Spastic quadriplegia, 10 Spastic diplegia, 3
Right : left : bilaterally, n	5 : 2 : 6
Mean age at surgery	8.6 (3.3–16.7) years
Mean age at last investigation	13.8 (6.0–25.0) years
Mean follow-up period	5.2 (1.1–14.2) years
GMFCS stage, n	III: 1; IV: 3; V: 9

GMFCS, Gross Motor Function Classification System.

Results

The mean preoperative MP was 67.5 ± 22.9%, whereas those after surgery and at the last investigation were 58.9 ± 25.8% and 57.0 ± 30.9%, respectively. Changes in MP from

Table 2 Surgical methods

Method	GMFCS, n	Hips, n
Adductor tenotomy	IV: 2 V: 6	11
Adductor and proximal hamstrings tenotomy	III: 1	2
Adductor and distal hamstrings tenotomy	IV: 1 V: 1	1 2
Adductor, distal hamstrings and iliopsoas tenotomy	V: 1	2
Adductor, proximal and distal hamstrings tenotomy and rectus femoralis lengthening	V: 1	1

GMFCS, Gross Motor Function Classification System.

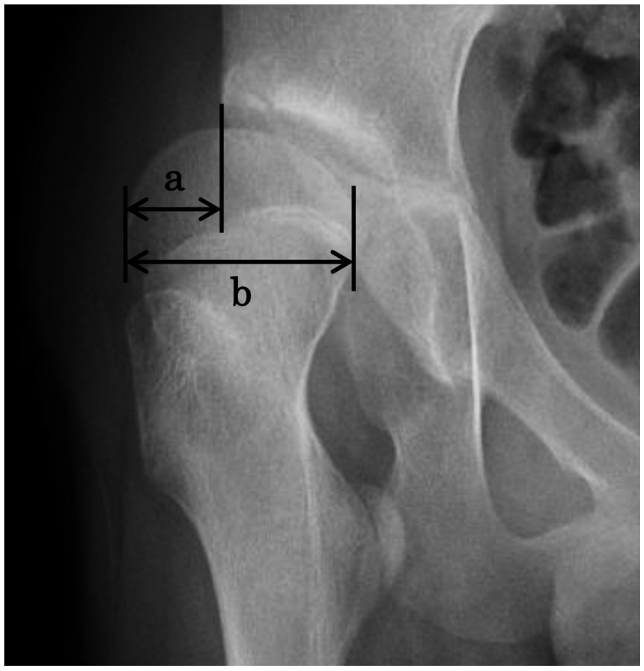

Figure 1 Migration percentage (MP). The portion of the femoral head lateral to the Perkins line is measured (a) and expressed as a percentage of the entire width of the femoral head (b). MP = a/b × 100 (%).

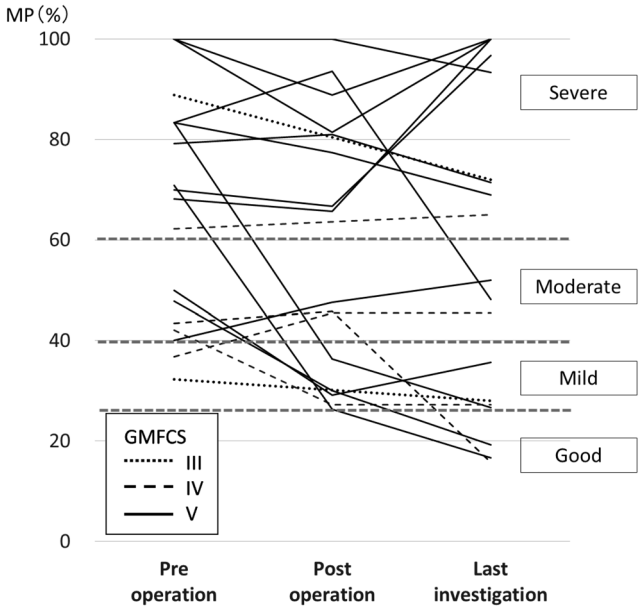

Figure 2 Comparison of preoperative MP, postoperative MP, and MP at the last investigation. All seven hips classified as mild and moderate preoperatively, were good, mild, or moderate at the last investigation. Nine of 12 hips classified as severe preoperatively remained severe at last investigation. However, three of 12 hips classified as severe preoperatively were improved at the last investigation. MP, migration percentage; GMFCS, Gross Motor Function Classification System

before surgery to after surgery and at the last investigation are shown in Figure 2. Preoperatively, two hips were classified as mild, five as moderate, and 12 as severe. Of the two mild cases preoperatively, one remained mild at the last investigation, whereas the other became moderate. Among the five cases that were in the moderate category preoperatively, two became good, two became mild, and the remaining case became moderate at the last investigation. Among the severe cases (12 hips), one was good, one was mild, one was moderate, and nine were severe at the last investigation (Table 3). The contribution ratio of the Spearman rank coefficient of correlation was r = 0.581 (p = 0.009) for the MP preoperatively and at the last investigation. This shows that there was a positive correlation between the MP preoperatively and that at the last investigation.

Improvement in postoperative ADL was confirmed in 12 of 13 patients. Regarding the remaining one patient, the medical record did not mention a change in ADL. Reported improvements in ADL were as follows: ease of diaper change in four patients, improvement in sitting balance in four, ability to perform standing training in two, ease of holding the patient in the caregiver's arm in one, improvement in standing position in two, and improvement in walking position in one (Table 4).

Table 3 Comparison of MP preoperatively versus at the last investigation

MP preoperatively	GMFCS stage, n	MP at the last investigation
Mild 2	III: 1	Mild, 1
	IV: 1	Moderate, 1
Moderate 5	IV: 2	Good, 1
		Mild, 1
	V: 3	Good, 1
		Mild, 1
		Moderate, 1
Severe 12	III: 1	Severe, 1
	IV: 1	Severe, 1
	V: 10	Good, 1
		Mild, 1
		Moderate, 1
		Severe, 7

MP, migration percentage; GMFCS, Gross Motor Function Classification System.

Table 4 Improvements in activities of daily living after surgery

Care	Diaper change, n	4
	Holding patient's in caregiver's arm, n	1
Rehabilitation	Sitting balance, n	4
	Enabled of standing training, n	2
	Standing position, n	2
	Walking position, n	1

Case Report

A woman with a GMFCS level V and bilateral hip subluxation underwent tenotomy of the adductor and lengthening of the distal hamstrings at 7 years of age. MP values before surgery were 47.8% on the right side and 70.8% on the left side; the patient's right and left hips were categorized in the moderate and severe category, respectively. MP values at the last investigation at 11 years of age were 19.2% on the right side and 16.7% on the left side, and both hips were categorized as good (Figures 3-A, B). Ease changing the diaper and holding the patient in the caregiver's arm improved postoperatively.

Discussion

As the preoperative and postoperative MP values were positively correlated, early treatment with soft-tissue release is important to prevent hip dislocation and improve hip subluxation. However, patients with severe subluxation might experience improvement of the MP to < 60% and improvement in ADL function with soft-tissue release. In this study, 10 of 19 hips (52.6%) were categorized as good, mild, or moderate at the last investigation. Seven hips classified as mild and moderate preoperatively were classified as good, mild, or moderate at the last investigation. Although nine of 12 hips classified as severe preoperatively remained severe at the last investigation, three with a GMFCS level V improved at the last investigation.

Previous reports on the outcomes of soft-tissue release for subluxation and hip dislocation in cerebral palsy are varied, and the rates of good outcomes with soft-tissue release for spastic hip subluxation are reportedly 33–90%[10, 11]. Shore *et al*.[12] performed tenotomy of the adductor in 330 children with an average MP of 43% and reported that the success rate (MP <50%) was 94% at GMFCS level II, 49% at GMFCS level III, 27% at GMFCS level IV, and 14% at GMFCS level V. Onimus *et al*.[11] reported successful results in 90% of patients < 4 years of age with an MP < 33%. Miller *et al*.[10] reported performing tenotomy of the adductor and lengthening of the iliopsoas for 74 children (147 hips), 88% of whom were categorized as good (MP < 25%) and fair (MP 25–39%). On the other hand, Silver *et al*.[13] reported that patients with lack of preoperative coverage > 50% were at risk for femoral head coverage deterioration despite adductor release. Bowen and Kehl[14] also reported that hips with a preoperative MP of 30–49% had a normal MP (< 15%) in 18 of 21 cases (81%) postoperatively, whereas those with a preoperative MP > 50% had a normal MP in three of seven (43%) cases postoperatively. They reported that soft-tissue release surgery alone, even in cases of moderate hip subluxation, could result in long-term radiographic hip stability. Presedo

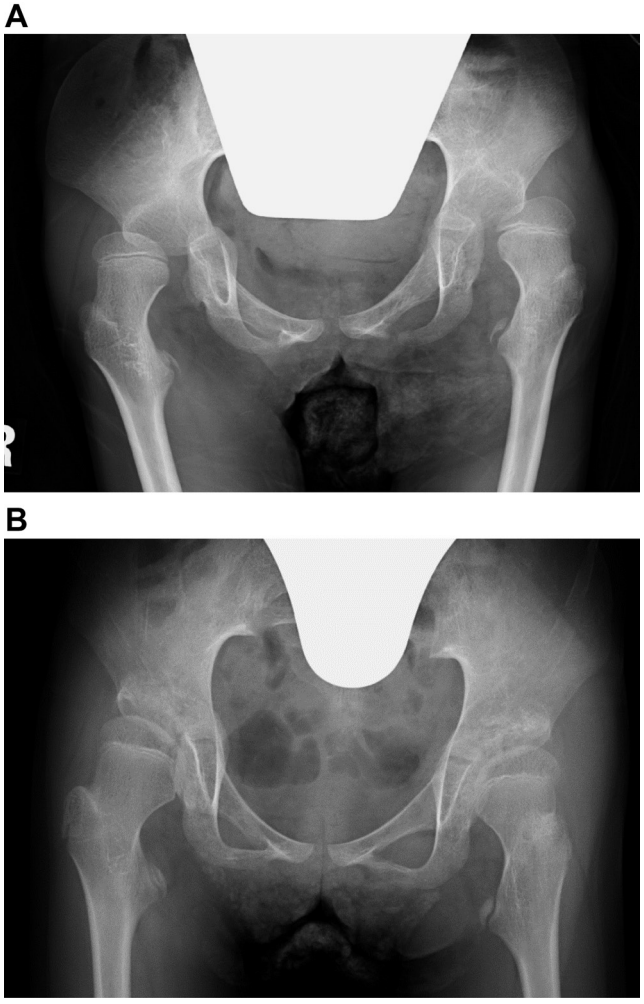

Figure 3 A: Radiograph of a 7-year-old girl with spastic quadriplegia and GMFCS level V, migration percentage before surgery was 47.8% on the right side and 70.8% on the left side. Surgery for adductor tenotomy and hamstring lengthening to treat bilateral hip subluxation were performed. B: When the patient was 11 years of age, migration percentage was 19.2% on the right side and 16.7% on the left side. Changing the diaper and holding the patient in the caregiver's arms were easier postoperatively.

et al.[6] reported that muscle release is seldom indicated in cases of severe subluxation or dislocation (MP ≥ 60%). They also mentioned that the wide difference in success rates was due to differences in the degree of neurological involvement, age at surgery, hip MP, surgical method, postoperative care, definitions of success and failure, and duration of follow-up. Compared to previous reports, the proportion of severe cases of MP preoperatively was high in this series. As mentioned in previous reports, early treatment with soft-tissue release is important to prevent hip dislocation and improve hip subluxation. However, it is necessary to consider that several cases of severe subluxation might be improved with soft-tissue release alone.

In this study, postoperative improvement in functional parameters was obtained in all cases irrespective of MP or GMFCS level. There are few reports regarding functional improvement after soft-tissue surgery for hip subluxation and dislocation in patients with cerebral palsy. Samilson *et al*.[4] analyzed the outcomes of indications (perineal care, gait improvement, hip dislocation prevention, hip relocation, sitting balance, pain relief, release fracture force, and repair incarcerated hernia) for adductor tenotomy. Their results were graded satisfactory in 60% of patients when the surgical objective was achieved. Root and Spero[15] reported that 37% of patients showed improved sitting balance, whereas 56% of patients had improved standing balance with tenotomy of the adductor for various conditions of hip stability. Moreau *et al*.[16] also reported that general functional improvement was seen in 18 of 22 patients after muscle release as evidenced through improvements in ambulation, sitting, and perineal care. Femoral osteotomy is considered in patients who have developed progressive subluxation or dislocation. However, such patients can be at a high risk for surgery because of a poor general condition. As soft-tissue release is minimally invasive, it can be considered a treatment method for such patients.

This study has several limitations. First, only 19 hips in 13 cerebral palsy patients with subluxation and dislocation were retrospectively evaluated. A prospective evaluation with a larger sample size is necessary. Second, the mean follow-up period was 5.2 years (range, 1.1–14.2 years); thus, a future study with long-term postoperative follow-up is necessary. Third, a quantitative evaluation of functional improvement in ADL, such as care and rehabilitation, including sitting and standing balance is necessary.

Conclusions

1. Because the preoperative and postoperative MP values were positively correlated, early treatment is necessary to prevent hip dislocation and improve hip subluxation. However, three of 12 hips classified as severe preoperatively improved by the last investigation. Therefore, it is necessary to consider that several patients with severe subluxation might experience improvement with soft-tissue release alone.
2. Functional improvement occurred in care and rehabilitation, even in patients with severe hip dislocation.
3. Soft-tissue release was an effective treatment method for hip dislocation and subluxation in children with cerebral palsy and improved ADL function, even in patients with severe hip dislocation.

Conflict of interest: The authors declare no conflicts of interest.

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