Pectoralis Major Release to Improve Shoulder Abduction in Children With Cerebral Palsy

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Abstract: The aim of our study was to evaluate the surgical results after pectoralis major muscle release in children with cerebral palsy and to assess a caregiver's satisfaction in patient's care after this procedure.

Twenty-one shoulders in 13 patients were analyzed at least 12 months after surgery. All but 1 patient involved in our study had quadriplegic type of cerebral palsy involvement. In 17 limbs, only pectoralis release was performed; in 4 limbs, latissimus dorsi release was added. After clinical examination, a questionnaire was used to determine the caregiver's assessment.

The passive range of abduction and flexion was maintained at an angle greater than 90 degrees in 10 patients. External rotation was restricted in 6 patients. All caregivers would recommend this surgery to another patient. All but one reported improvement in care of the patients after surgery.

The indication for this surgical procedure is limited only to the selected cerebral palsy cases in which custodial care is impaired by shoulder adduction contracture. The 2 main indications for the procedure are the limitations in the ability to bathe the axilla and the difficulty in dressing.

Key Words: cerebral palsy, pectoralis release, shoulder, upper extremity

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The overall disability of the child with cerebral palsy (CP) represents a wide spectrum of conditions, which changes over time. Therefore, surgical management decisions are complex and should be based on the patient's intelligence, motivation, motor function capability, sensibility, and age.[1–3] Contractures of the upper extremity typically involve shoulder adduction and internal rotation, elbow flexion, pronation of the forearm, wrist ulnar deviation and flexion, and thumb-in-palm with finger flexion. Although the overall function of the upper extremity may be impaired by contractures localized at each level, literature describing contractures of the shoulder is relatively scant.[3,4]

Muscle contractures around the shoulder are commonly found in patients with CP. An adduction internal rotation posture at the shoulder is caused by spasticity and contracture of the pectoralis and subscapularis muscles. Many authors do not consider this deformity severe enough to require operative management. Surgical attention for the upper extremity in CP has been traditionally concentrated on the distal upper limb segment.[1,5,6] Other authors, however, report concerns about possible instability and future arthritic changes in glenohumeral joint caused by the shoulder contractures.[2,4] They advocated different surgical treatments for this condition, such as humeral osteotomy, shoulder fusion, or release of the contracted structures without muscle balance.[2] Shoulder contractures initially present in children with CP and are dynamic and may not cause fixed deformity. Over time, fixed contractures do develop. Although various muscles releases were described in the literature to correct contractures, there are no published reports of the outcomes of this type of the surgery.

The main aim of our study was to evaluate the surgical results after pectoralis major muscle release in children with CP. The second purpose was to assess a caregiver's satisfaction and improvement in patient's care after this procedure.

METHODS

After obtaining institutional review board approval for our study, we reviewed the medical records of consecutive patients treated by means of soft tissue releases of the shoulder at our cerebral palsy clinic between 1994 and 2003. Our inclusion criteria were patients with a primary diagnosis of CP, treatment by means of pectoralis major release with or without additional soft tissue releases around the shoulder area, and at least 12 months of follow-up after surgery. From the group of 18 patients treated at our hospital using the described technique, 2 patients died of causes secondary to the main disease process but not associated with the shoulder surgery before the current study was commenced. Three patients were lost to follow-up. The remaining 13 patients (21 shoulders) were included in the study.

Indications for the pectoralis and latissimus dorsi muscles releases were (1) shoulder spasticity and contractures making routine hygiene and dressing difficult for caretakers to perform and (2) skin breakdown problems in the axilla. Specific degrees of deformity were not considered in the indications (only the caretaker's complaints of difficult

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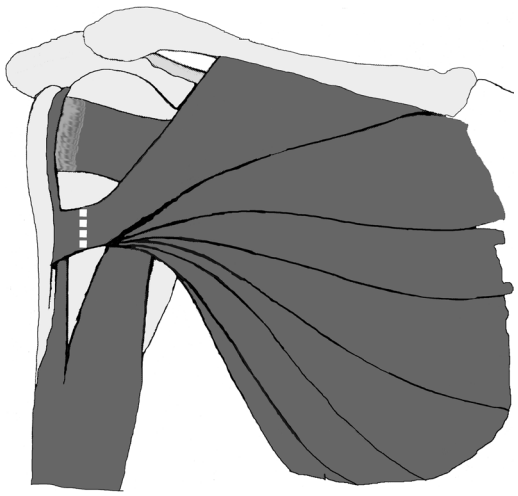

FIGURE 1. Diagram showing the site of release of the pectoralis major muscle at its tendinous portion.

caregiving were considered). The same surgeon (senior author F.M.) performed the soft tissue releases using the same technique in all cases. The patient was placed supine on the operating room table. After adequate induction of general anesthesia, the involved upper extremity was prepped and draped in the usual sterile fashion. A longitudinal 3- to 4-cm skin incision was made over the deltopectoral region. Dissection was performed down through the subcutaneous tissue, and cephalic vein was identified and retracted safely. The fascial plane between the anterior border of the deltoid and the pectoralis major was identified. Blunt dissection was performed down to the tendon of pectoralis, and the superior and the inferior borders of the tendon were identified. The pectoralis major was elevated in the operative field and then completely transected at pectoralis tendinous unit by means of electrocautery (Fig. 1). The release of the pectoralis usually resulted in increase of passive abduction of the shoulder of approximately 30 to 45 degrees (Fig. 2). In severe cases where the latissimus dorsi muscle was very prominent after pectoralis release, a longitudinal skin incision was performed over the posterior axillary fold directly overlying the latissimus dorsi tendon. Blunt dissection was used to identify the tendon at its superior and inferior borders. The latissimus dorsi tendon was then transected by means of electrocautery. This release typically provides an additional 30-degree shoulder abduction. Postoperatively, the patients were allowed full range of motion. After 1 night in the hospital, the patients were discharged, and a rehabilitation protocol of 6 weeks was started.

The medical chart review included sex, side on which surgery was performed, type of CP involvement, age at surgery, preoperative shoulder status, caregiver complaints, and indications given for the surgery. At subsequent follow-up visits after the procedure, we analyzed the surgical complications, the pain and shoulder function, and the stability.

All but 1 patient involved in our study had a quadriplegic type of CP involvement. Most of these patients with quadriplegia were persons with either severe mental

FIGURE 2. A, Preoperative shoulder position shows restricted abduction with a very prominent pectoralis tendon. The image was taken under general anesthesia in maximum abduction. B, Postoperative image made 1 week after the release shows improved abduction without discomfort.

Question		Points
1. Does your child currently experience any pain?		
a.	No	10
b.	Yes, during the night	5
c.	Yes, during daily activities	0
2. Did the ability to bathe and keep the axilla clear change after surgery?		
a.	Improved	10
b.	No change	5
c.	Worse	0
3. Did the ability to dress change after surgery?		
a.	Improved	10
b.	No change	5
c.	Worse	0
4. Does your child have currently any skin problems in the axilla?		
a.	Yes	0
b.	No	10
5. Does your child have any discomfort in the shoulder area?		
a.	Yes	0
b.	No	10
6. Does your child's arm stay in a safe comfortable position at the side of the body?		
a.	Yes	10
b.	No, there is spasticity	0
7. Would you recommend this type of surgery to another parent?		
a.	Yes	10
b.	No	0
8. Range of shoulder abduction		
a.	less than 45 degrees	0
b.	between 45 and 90 degrees	5
c.	more than 90 degrees	10
9. Range of shoulder anterior flexion		
a.	less than 45 degrees	0
b.	between 45 and 90 degrees	5
c.	more than 90 degrees	10
10. Range of shoulder external rotation		
a.	less than 45 degrees	0
b.	between 45 and 90 degrees	5
c.	more than 90 degrees	10
Overall		0-100

FIGURE 3. Questionnaire for the assessment of function of the shoulder after surgery in children with CP.

retardation or had speech impairment, making it difficult to assess patient satisfaction after surgery. Therefore, after the completion of the medical chart review, we decided to contact the caregivers of patients involved in the study to conduct a telephone survey about the current status of the shoulder(s). We designed the questionnaire evaluating both shoulder function and caregiver assessment (Fig. 3). During this second phase of our study, we were able to contact 8 families; all of them agreed to participate in the survey. After an explanation of the purpose of the study and a detailed description of each question, the caregivers completed the questionnaire.

RESULTS

There were 7 girls and 6 boys in our study. Surgery was performed bilaterally in 8 cases, on the left side in 3, and on the right in 2 cases. The average age at the time of the procedure was 14.3 years (SD, 3.7 years; range, 8–20 years). In 17 limbs, only pectoralis release was performed; in 4 limbs, latissimus dorsi release was added. The average clinical follow-up interval was 38 months (SD, 16 months; range, 14–79 months) (Table 1).

At the last clinical follow-up examination, all patients were pain-free and without any other concerns regarding the shoulder region. No skin problems in the axilla were reported. The passive range of abduction was maintained at greater than 90 degrees in 10 patients (cases 1–4, 6, 8–10, 12, and 13). In 2 patients (cases 5 and 7), more limitation in abduction was noted, but the range of motion was still greater than 45-degree abduction. In 1 case (case 11), abduction was possible for only up to 45 degrees. According to the caregiver, the

TABLE 1. Data of Patients Included in the Study

Patient	Sex	Side	Age at Surgery (y)	Type of Involvement	Type of Release	Clinical Follow-up (mo)
1	Female	Right	13.6	Quadriplegic	Pectoralis muscles	52
		Left	13.6	Quadriplegic	Pectoralis muscles	52
2	Female	Left	14.4	Quadriplegic	Pectoralis muscles	24
3	Male	Right	17.8	Quadriplegic	Pectoralis muscles	31
		Left	17.8	Quadriplegic	Pectoralis muscles	31
4	Male	Right	12.9	Quadriplegic	Pectoralis muscles	40
		Left	12.9	Quadriplegic	Pectoralis muscles	40
5	Female	Right	11.9	Quadriplegic	Pectoralis muscles	38
		Left	11.9	Quadriplegic	Pectoralis muscles	38
6	Male	Left	18.6	Hemiplegic	Pectoralis muscles + latissimus dorsi muscle	37
7	Male	Right	20.2	Quadriplegic	Pectoralis muscles	14
8	Female	Right	19.6	Quadriplegic	Pectoralis muscles + latissimus dorsi muscle	14
		Left	20.3	Quadriplegic	Pectoralis muscles + latissimus dorsi muscle	22
9	Female	Right	10.3	Quadriplegic	Pectoralis muscles	36
		Left	10.3	Quadriplegic	Pectoralis muscles	36
10	Female	Right	12.8	Quadriplegic	Pectoralis muscles	24
11	Male	Left	15.1	Quadriplegic	Pectoralis muscles	38
		Right	15.1	Quadriplegic	Pectoralis muscles	38
12	Male	Right	8	Quadriplegic	Pectoralis muscles	78
		Left	8	Quadriplegic	Pectoralis muscles	78
13	Female	Left	14.3	Quadriplegic	Pectoralis muscles	39

TABLE 2. List of Patients and Results From Phone Questionnaire

Patient	Side	Follow-up (mo)	Phone Questionnaire Score	Shoulder Range of Motion Interval (degrees)		
				Abduction	Flexion	External Rotation
1	Right	60	90	>90	45–90	−45 to 0
	Left		90	>90	45–90	−45 to 0
3	Right	42	95	>90	>90	−45 to 0
	Left		90	>90	>90	−45 to 0
4	Right	43	95	>90	>90	−45 to 0
	Left		95	>90	>90	−45 to 0
7	Right	23	95	45–90	>90	0–45
9	Right	42	100	>90	>90	0–45
	Left		100	>90	>90	0–45
10	Right	27	95	>90	>90	−45 to 0
11	Right	44	60	0–45	0–45	−90 to −45
	Left		60	0–45	0–45	−90 to −45
12	Right	85	100	>90	>90	0–45
	Left		100	>90	>90	0–45

range of motion deteriorated 2 years after surgery. Flexion range of motion of the shoulder was similar to abduction in our study. External rotation was not restricted in 7 patients. In 5 patients (cases 1, 3, 4, 5, and 7), up to 45-degree internal rotation contracture was noted. In 1 patient (case 11), the internal rotation contracture was 60 degrees bilaterally.

The average follow-up interval in the second part of our study was 45 months (SD, 19 months; range, 23–85 months). There were 6 bilateral and 2 unilateral releases. An average score obtained from our questionnaire was 90 points (SD, 13; range, 60–100 points) (Table 2). One caregiver reported mild discomfort of the patient associated with surgical wound paresthesia (case 3, left shoulder). One caregiver (case 11) assessed that her ability to clean the axilla and to dress the patient decreased in the last 18 months; now, she does not see a difference compared with the period before surgery. She was pleased, however, with the improvement after the surgery, and she would recommend this type of surgery to another family.

DISCUSSION

Contractures of the shoulder are common in patients with CP; sometimes, they can represent significant problems in the positioning of the extremity in space and they may impair the routine care of severely involved patients. The posture of glenohumeral joint in CP is determined by the activation of the pectoralis major, latissimus dorsi, and teres major muscles.[4] Over time, dynamic contractures become fixed muscle contractures and may cause secondary, fixed deformities of the shoulder joint. Concerns about shoulder instability and subluxation are widely expressed in the literature with regard to acquired spasticity, but the natural history of the typical shoulder deformities in CP has received little focus.[4,7]

In our study, the average age of the patients at the time of surgical procedure was 14 years. At this age, the contractures of the muscle around the shoulder still have not caused secondary bony changes or severe fixed joint contractures. Several authors recommended muscle releases to improve shoulder function.[1,2,4] To improve the range of abduction, a release or z-lengthening of the pectoralis major or subscapularis muscles anteriorly was described. In addition, latissimus dorsi and teres major muscle posterior transfers were reported to strengthen external rotation.[2] All but 1 patient in our study had a quadriplegic pattern of CP, the most severe type of CP. The common concern in this group of patients is adduction contracture, which impaired routine hygiene and dressing and causes skin problems in the axilla. The standard procedure in our group was pectoralis major release. Because the main indication for the surgical treatment was to decrease the adduction contracture, 3 cases of inadequate improvement after pectoralis major release required the addition of a latissimus dorsi release. At the latest follow-up, the amount of abduction was adequate for the goal of improved axillary care and dressing in 12 of 13 patients. The forward flexion movement's limitations and course after surgery were correlated with abduction in our study. Although forward flexion is more important for reach ability, we think it may also impair hygiene and dressing in some patients. Internal rotation contracture may also compromise the functional ability of the limb. In our series, the amount of external rotation increased after surgery in all patients; however, at follow-up, recurrent contractures were noted in 6 patients. Latissimus dorsi and teres major muscle transfers to the rotator cuff were described to address this problem.[2] In our population, however, latissimus dorsi release was used to improve abduction. We think that latissimus dorsi muscle transfer to the rotator cuff may limit the abduction of the shoulder, and it is rational in patients with quadriplegia to sacrifice active external rotation to achieve good passive range of abduction and forward flexion. We think that the amount of external motion at follow-up was satisfactory enough to leave the subscapularis muscle intact. The role of the subscapularis, a strong internal rotator for the stabilization of the shoulder joint in CP, is unclear. In patients

with hemiplegia, a subscapularis nerve block and botulinum toxin A injections were used to prevent posterior subluxation and to relieve pain.[7,8] In rare cases of abduction external rotation contractures of the shoulder, the scapularis muscle plays an important role as an anterior stabilizer.[2,3] After pectoralis release in our study, we did not find cases of shoulder instability during follow-up examinations.

Telephone questionnaire results concerning shoulder function revealed very high caregiver satisfaction rate (mean score, 90 points) after surgery. All caregivers would recommend this type of surgery to another patient. All but one reported that their ability to provide care and hygiene and to dress the patients improved after surgery. In only 1 case did the ability to provide care deteriorate 18 months after surgery.

In conclusion, our data supports the hypothesis that pectoralis major release is sufficient to maintain adequate abduction and forward flexion in patients with severe forms of CP. For caregivers, the satisfaction rate is very high, with reported improvement in care. However, the indication for this simple surgical procedure is limited only to the selected CP cases in which hygiene and routine care is impaired by shoulder adduction contracture. Other forms of soft tissue procedures may be used to improve active functional abilities when it is possible.

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