Anterior Release of Elbow Flexion Contractures in Children With Obstetrical Brachial Plexus Lesions

Antonio García-López, MD, Pablo Sebastian, MD, Francisco Martinez-López, MD

Purpose A flexion contracture of the elbow is common in upper obstetric brachial plexus palsy. One less than 30° involves no major aesthetic or functional abnormalities, whereas for one greater than 30°, conservative treatment with serial splints produces variable results. We evaluated anterior release of the elbow with partial tenotomy of the anterior brachialis muscle and of the biceps, for their effect on elbow flexion contractures.

Methods We performed 10 anterior releases of the elbow with lengthening of the distal tendons of the biceps and the anterior brachialis muscle. All patients had upper obstetric brachial plexus palsies (C5-C6) and elbow flexion contractures of 35° or greater (range, 35° to 60°). The flexion strength of the elbow was 4 or higher on the British Medical Research Council scale, and the patients had no bone abnormalities in the elbow region.

Results After a mean follow-up period of 3 years, the mean gain in extension was 28° (range, 20° to 35°). All patients maintained flexion strength. Elbow extension was 2° less than obtained at surgery and was maintained during follow-up. All patients were satisfied or very satisfied, and none presented major complications, except hypertrophic scarring to a greater or lesser extent at the incision site.

Conclusions Anterior release of the elbow is a useful method for treating elbow flexion contractures of more than 35° and can reduce the deformity to bring it within functional range without compromising flexion. *(J Hand Surg 2012;37A:1660–1664. Copyright © 2012 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Brachial plexus, joint contracture, joint deformities, joint release, nerve injury.

THE INCIDENCE OF obstetric brachial plexus palsy (OBPP) in industrialized countries ranges between 0.4 and 3.0 per 1,000 live births.[1–4] Most patients have a favorable course and achieve good functional recovery. However, the course of the most severe cases is affected by imbalances in the muscles involved and leads to contractures, particularly in the shoulder and elbow joints. One of the major sequelae in upper and middle trunk palsy is a deficit in elbow extension, which normally ranges between 10° and 20°[5] but may reach an extension deficit of 40° to 60°.[6]

The amount of elbow motion adequate to perform the sedentary daily activities is 30° to 130° extension-flexion.[7] However, if the elbow flexion contracture is greater than 30°, functional and aesthetic problems ensue. Elbow flexion deformity with internal rotation contracture of the shoulder gives the appearance of a short arm compared with the contralateral side.[8]

The use of orthoses in initial treatment has been described and has shown satisfactory results in compliant patients with motivated parents.[8–10] Static nighttime extension splints may prevent contracture in younger

From the Upper Limb Unit, Orthopaedic Department, Hospital General Universitario de Alicante, Alicante, Spain.

Received for publication December 3, 2011; accepted in revised form May 2, 2012.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Antonio García-López, MD, Orthopaedic Department, Hospital General Universitario de Alicante, C/Madre Teresa de Calcuta, 4 B4 E2 4I, 03016 Alicante, Spain; e-mail: garcialopez1@hotmail.com.

0363-5023/12/37A08-0022$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2012.05.002

children, and articulated static progressive extension splints and plaster casts have been used in older children.[8]

The only published surgical experience is based on closed techniques with external fixation systems.[11] We propose an anterior approach to the elbow to explore the extra-articular structures that, in our opinion, are responsible for this condition, and release of these structures by means of a modified Manske technique.[12] This technique was initially designed for elbow flexion contractures resulting from spastic palsy and consists of division of the lacertus fibrosus and elimination of the adventitia of the biceps tendon to interrupt afferent nerve fibers without lengthening the tendon. A fractional lengthening is performed on the brachialis muscle by making 1 to 3 transverse incisions across the entire width of the fibrous aponeurosis and passively extending the elbow. We add a lengthening of the biceps with partial transverse tenotomies in the muscle–tendon junction in the most severe cases. We present the results of our experience with modified anterior release of the elbow in OBPP.

MATERIALS AND METHODS

Between May 2005 and November 2008, we performed anterior release of the elbow in flexion contractures greater than 35° in 10 patients (Table 1). There were 9 boys and 1 girl, and ages ranged between 10 and 13 years. All cases were the result of upper OBPP (C5 and C6), and 3 patients had undergone prior surgery (1 derotational humeral osteotomy and 2 latissimus dorsi muscle transposition). The same surgeon always measured elbow flexion-extension with a goniometer. The flexion strength of the elbow, evaluated using the criteria of the British Medical Research Council, was 4 or higher, and no patients had radiographic evidence of bone abnormalities in the elbow region. We used a satisfaction scale based on a visual analog score of 0 to 10: very satisfied (7.5–10), satisfied (5–7.4), somewhat dissatisfied (2.5–4.9), and completely dissatisfied (0–2.4).

All patients had received treatment at the rehabilitation department by stretching and night splinting. The indication for surgery was a flexion greater than 35°, with difficulty performing day-to-day activities and major aesthetic abnormalities. All parents of the children gave written informed consent.

Surgical technique

The operation begins with an incision in the anterior surface of the elbow, starting at the fold between the biceps brachii and the brachioradialis muscle in the

TABLE 1. Data From Case Series Study With Elbow Extension Deficit Preoperatively, Postoperatively, and at Follow-up

Patient	Age	Sex	Preoperative Strength	Preoperative Flexion	Preoperative Extension Deficit	Biceps Brachii Lengthening	Capsulotomy	Postoperative Extension Deficit	Final Flexion	Final Extension Deficit	Final Strength	Follow-up (y)
1	13	F	4+	145°	60°	Yes	Yes	25°	145°	25°	4+	2
2	12	M	4	135°	60°	Yes	Yes	20°	135°	25°	4	4
3	12	M	4+	140°	50°	Yes		15°	140°	20°	4+	3
4	11	M	4	140°	45°			20°	140°	20°	4	2
5	12	M	4+	145°	45°	Yes	Yes	15°	150°	15°	4+	3
6	11	M	4	140°	45°			10°	140°	15°	4	3
7	10	M	4	135°	40°			15°	135°	15°	4	3
8	10	M	4	135°	35°			15°	135°	15°	4	2
9	10	M	4+	150°	35°			10°	150°	10°	4+	5
10	10	M	4+	145°	35°			5°	145°	10°	4+	3

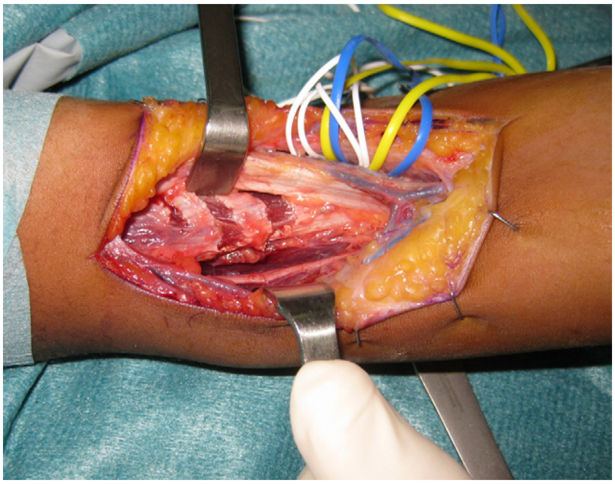

FIGURE 1: Intraoperative photograph showing fractional lengthening of the anterior brachialis muscle by means of several transverse cuts through the entire thickness and width of the aponeurosis of the brachialis muscle.

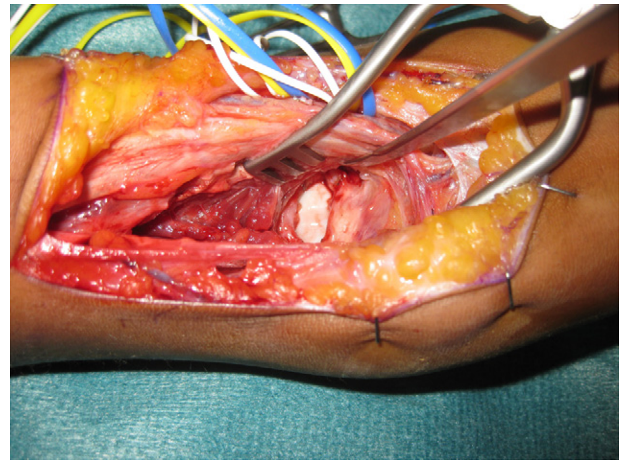

FIGURE 2: A periosteal elevator exposes the joint capsule deep in the surgical field.

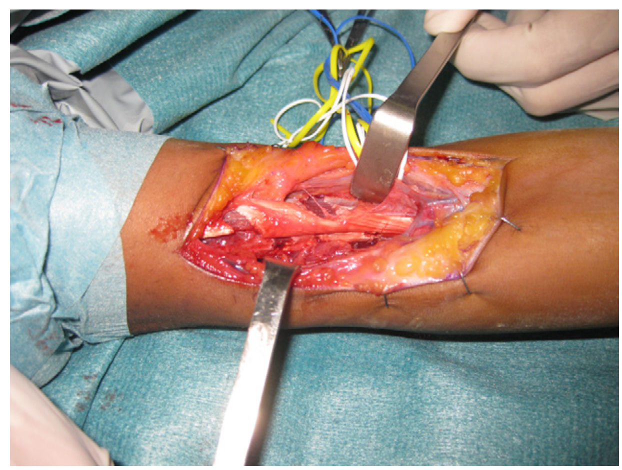

FIGURE 3: Performing partial tenotomies of the biceps tendon while gently extending the elbow gain tendon length.

arm, and extends somewhat distally to the flexion fold of the elbow along the medial surface of the forearm. The lacertus fibrosus, which is always tense, is cut, which gains a few degrees of extension. The biceps tendon is retracted medially and the anterior brachialis muscle is identified. To gain extension, a fractional lengthening of the anterior brachialis muscle is performed by means of several transversal cuts through the entire thickness and width of the aponeurosis of the brachialis muscle (Fig. 1). Passive extension of the elbow is then forced, and the edges of the aponeurosis are seen to separate, exposing the muscle fibers, which must remain intact. The muscle and the tendon of the anterior brachialis muscle are then retracted medially, and the radial nerve and the brachioradialis muscle are retracted laterally to expose the joint capsule, which is dissected using a periosteal elevator. An anterior transverse capsulotomy may be performed to gain further extension in the most severe cases (Fig. 2). Typically, however, the capsule is not a major contributor to contracture and its release produces only modest additional gains. We return to the biceps tendon, and if necessary, several partial tenotomies of this tendon are performed (Fig. 3) as we gently extend the elbow to gain length and take care to avoid complete division of the tendon. We do not perform a release of the ligamentous complex or completely section the brachialis muscle or the biceps. We stretch the elbow to verify the extension obtained compared with the preoperative state. Full extension was not achieved in any case.

The tourniquet is released and the bleeding vessels are coagulated; a suction drain is inserted, and a long-arm cylindrical plaster cast is placed on the elbow at maximum extension. The patient is kept in hospital to monitor pain or the appearance of vascular or nerve complications. On the following day, the drain is removed, and the patient is discharged and scheduled for outpatient consultation in 1 week. At that point, the wound is treated and the elbow is allowed freedom of movement. The patient and parents are shown how to perform flexion-extension movements, and a dynamic extension splint is used at night for 10 to 12 weeks. Strengthening exercises are started 3 months after surgery.

RESULTS

The mean follow-up period was 3 years (range, 2–5 y). All patients increased elbow extension by a mean of 28° (range, 35° to 20°) at final follow-up. The patients who showed the greatest improvement were those with greater flexion, although the residual contracture in the final result was also greater.

The loss of extension between the immediate postoperative period and the final follow-up visit was 2°, with a range of 0° to 10° (Table 1). Flexion strength was unchanged from before surgery, and no patients developed flexion or supination deficits. No patients developed major complications, although all had hypertrophic scarring to a greater or lesser extent.

Eight patients were very satisfied and 2 were satisfied. All patients stated that they would undergo the operation again.

DISCUSSION

The etiology of contractures of the elbow in upper OBPP is not fully understood. Ballinger and Hoffer[5] evaluated flexion contractures of the elbow in a cohort of children with upper OBPP (C5/C6). They found that 29 of 34 children presented with a flexion contracture and with extension strength of at least grade 1 on the BMRC scale. According to those authors, several theories explain the contractures in the elbow: earlier reinnervation of the flexors than of the extensors, persistence of intrauterine flexion, and presence of an adaptive flexion. Moreover, the authors indicated the possibility of bone necrosis[13] and the possible evolution of co-contraction, as happens in the shoulder.[14] A recent experimental study in mice concluded that flexion of the elbow in upper OBPP resulted from a reduction in the growth of the denervated muscles, the anterior brachialis, and the biceps brachii during the neonatal period and in rapid-growth stages.[15]

Nevertheless, a magnetic resonance imaging study of the elbow suggested that flexion contracture in brachial plexus palsy was caused essentially by atrophy of the anterior brachialis muscle.[6] Our observations in the operating room showed shortening of the biceps muscle and tendon and the bicipital aponeurosis. Although some degree of extension is gained by lengthening the anterior brachialis muscle, division of the lacertus fibrosus is necessary, and some lengthening of the biceps brachii in continuity is required by means of partial tenotomies in the most severe cases. This suggests that the contracture occurred because of inadequate growth or a shortening of these 2 muscles, although with greater contribution of the biceps brachii, because it has greater leverage.

Several types of treatment have been carried out using physiotherapy and splints. These treatments include passive range of motion stretches and either serial casting (in severe cases) or splinting. The treatment period varies according to severity (between 2 and 5 weeks), but continues with a long-term treatment using a thermoplastic orthosis for use at night. Although good results have been published, this is a procedure that requires considerable compliance on the part of the patient and family.[8] Long-term results merely maintain the initial extension gain and do not improve it. Treatment by means of arthrodiastasis appears to provide some hope, but the procedure requires placement of an external fixation system and progressive correction of the flexion contracture after several weeks.[11]

The series of posttraumatic pediatric elbow arthrolysis cannot be extrapolated to OBPP owing to the difference in pathogenesis. In the posttrauma situation, the problem is essentially with the joint and bone, and treatment is therefore aimed at the capsule, ligaments, and bone. In OBPP, the surgical technique consists of partial lengthening of muscle and tendon in a muscle with lower growth. Because the technique does not act on the components that provide the elbow with static stability, a minimal period of immobilization is required, and the patients can begin rehabilitation immediately. In our view, Z-lengthening of the biceps, as proposed by Mital[16] in cerebral palsy, does not allow immediate active rehabilitation in OBPP. We believe that Z-lengthening may also risk further diminishing elbow flexion strength.

In principle, the technique affects the elbow flexors, which have been partially denervated and are therefore deficient. Thus, lengthening carries the risk of loss of elbow flexion. It is therefore important to select patients with elbow muscle flexion strength of grade 4 or higher, never to perform complete myotenotomies, and not to attempt complete extension. These 3 measures prevent loss of active elbow flexion or forearm supination.

The ideal age for performing this surgery is between 10 and 14 years. We believe that in older children, the flexion contracture of the elbow is more established, with major ligament retractions, where simple lengthening of the muscle and tendon may not achieve the desired extension of the elbow. Furthermore, in younger children, the flexion may recur during later growth, and they may not cooperate as actively with the postoperative rehabilitation. Extension loss from the immediate postoperative period to the final follow-up visit was only 2°, probably because the child's motivation after surgery is increased by the aesthetic and functional benefit obtained.

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