SCIENTIFIC ARTICLE

Supination Contractures in Brachial Plexus Birth Palsy: Long-Term Upper Limb Function and Recurrence After Forearm Osteotomy or Nonsurgical Treatment

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Purpose Forearm osteotomy for supination deformity in brachial plexus birth palsy (BPBP) may lead to improved function of the upper limb. However, recurrence rates are high and limit satisfactory results.

Methods We reviewed the long-term outcome of the entire upper limb of 22 BPBP patients with a supination contracture who were treated by forearm osteotomy and compared them with an age-matched group that was treated nonsurgically (n = 28). Recurrence was defined as a passive pronation below 30°.

Results The median follow-up was 5.0 years (range, 1.5−14 years). The mean passive pronation after forearm osteotomy, including patients with recurrence at follow-up, improved from −1° (SD, 9°) to 33° (SD, 48°) at final follow-up, mean active wrist extension improved from 23° (SD, 40°) to 41° (SD, 38°). An overall improvement of wrist and hand strength was present. In patients without recurrence, pronation improved to a mean of 66° (SD, 23°) at final follow-up. Recurrence of the supination contracture was present in 9 cases (41%) and was only present in patients with a single bone osteotomy. Recurrence was associated with lower age at surgery (recurrence mean, 4 [SD, 1.2] and no recurrence 8 [SD 4.5]), lower shoulder external rotation (recurrence mean, 28 [SD, 17] and no recurrence 49 [SD, 23]), and overall lower hand function at baseline.

Conclusions Forearm osteotomy improves forearm pronation and hand function. Recurrence should be considered as a potential complication after forearm osteotomy and is associated with young age and lower function of shoulder and hand. Single-bone osteotomy might also be a risk factor for recurrence. *(J Hand Surg Am. 2017;■(■):1.e1-e11.* *Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Natural history, brachial plexus palsy, osteotomy, recurrence, supination.

Online Exclusive

In patients without full recovery from a brachial plexus birth palsy (BPBP), a supination deformity may develop in 7% of the cases.[1] The incidence of supination deformity depends on the number of roots involved and the severity of root involvement.[2] In global plexus palsy, the incidence of supination deformity increases to 23%.[1] A supination contracture has been proposed to be secondary to the muscle

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Received for publication February 5, 2016; accepted in revised form June 1, 2017.

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

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0363-5023/17/■ ■-0001$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2017.06.002

power of the supinator and biceps that is unopposed by the paralyzed pronator muscles.[3,4] Recently, some authors have suggested relative shortening of poorly innervated muscles, owing to growth retardation, as a possible contributing cause.[5,6] Relative growth differences between bone and partially denervated muscles, which have less excursion within the musculotendinous sheath, might have an effect as well, although all these mechanisms remain speculative.

A supination contracture of the forearm can present serious functional disabilities in BPBP patients. The supination contracture, as part of multiple deformities of the entire limb, leads to the classic "begging" position of the hand seen in global BPBP. For hand function in daily life activities (eg, writing and typing), forearm pronation is used more frequently than supination. Surgical intervention to correct the forearm position may lead to improved hand function.[7,8] To this end, the forearm osteotomy was proposed to correct for supination contractures.[9,10] However, high recurrence rates (20%−40%) have been previously reported following forearm osteotomy.[1,11] No previous reports have assessed or quantified the risk factors for these recurrences.

The purpose of this retrospective cohort study was to present the long-term clinical and functional outcome of the entire limb after forearm osteotomy in residual BPBP and to compare these results with a control cohort of age-matched children with a supination contracture who were treated nonsurgically. Possible factors determining recurrence after forearm osteotomy were also studied.

METHODS

Patients

Between December 1999 and December 2012, we identified all patients undergoing a forearm osteotomy for their supination contracture (n = 22) in the specialized brachial plexus unit at the Leiden University Medical Center, Leiden, the Netherlands. These 22 children were retrospectively reviewed for this study. The control group consisted of 28 age-matched children who visited our center in 2012, who had been eligible for forearm surgery but whose parents refused surgery. The main patient characteristics are summarized in Table 1. The mean age at the time of surgery was 6 years (SD, 4.0 years), and in the nonsurgically treated group, the mean age at supination contracture diagnosis was 5 years (SD, 2.4 years). The medical ethics commission at our institution approved the study and patients and/or their parents provided written informed consent.

All patients initially received intensive physical therapy with specific exercises to increase the active and passive range of rotation of the forearm. A functionally compromising supination contracture was defined as passive pronation less than 20°. If passive pronation less than 20° was observed, patients were considered for a forearm osteotomy if a functional hand was present. The presence of active wrist extension was thought to be important before forearm osteotomy was performed, such that wrist extension tendon transfers were performed first for those children with limited active wrist extension, to avoid postosteotomy wrist drop. In patients with limited shoulder external rotation, the shoulder pathology was treated first by tendon transfer or subscapular release. In the forearm osteotomy group, 4 patients had undergone previous surgery related to their plexus palsy. In the nonsurgically treated group, 6 patients had undergone previous surgery.

Surgical procedure

Procedures were carried out with the patient under general anesthesia. All forearm osteotomies were carried out by the senior author (R.G.N.), who is experienced in the operative technique. Patients were in the supine position with the arm on an arm table. Before surgery, the passive pronation and supination were recorded. Ulnar osteotomies were carried out through an incision starting just distal from the lateral epicondyle. The plane between the forearm extensor and the forearm flexor compartment was used to approach the ulna. The location of the osteotomy was at approximately the junction of the proximal and middle thirds of the ulna. A longitudinal marking was carried out to guide an adequate rotation through the osteotomy. A small-fragment, 4-hole locking compression plate (modular handset, 2.0-and 2.7-mm screws; Synthes, West Chester, PA) was placed at the planned osteotomy site and 1 drill hole was made in the proximal end. Then, with protection of the surrounding tissue, a transverse osteotomy was carried out. The plate was first fixed to the proximal end of the ulna with 2 cortical locking screws. Then, the forearm was rotated toward maximum pronation; after which, the distal end of the plate was also fixed to the pronated ulna with 1 compression screw and 1 cortical locking screw. Next, a middistal radius osteotomy was carried out. The radius osteotomy was performed by a direct dorsolateral approach. The osteotomy site was planned at the junction of the middle and distal thirds of the radius. Again, a plate was fixed in the same manner as was done for the ulna (2.0-mm cortical compression screw and

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