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THE PRONATING RADIUS OSTEOTOMY FOR CORRECTING THE SUPINATION DEFORMITY IN BRACHIAL PLEXUS BIRTH PALSY

DOĞUMSAL BRAKİYAL PLEKSUS PARALİZİSİNDE SUPİNASYON DEFORMİTESİNİ DÜZELTMEK İÇİN RADİUS ROTASYON OSTEOTOMİSİ UYGULAMASI

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ABSTRACT

Objective: Severe supination deformity may be seen in brachial plexus birth palsy (BPBP). The aim of this study was to determine the efficacy of pronating radius osteotomy in the management of this deformity.

Material and Methods: BPBP patients with severe supination deformity were included in this study and they were operated between November 2003 and December 2015, by the same operative team. Pronating radius osteotomy was performed and internal fixation was maintained either by Kirschner wires or semitubular plates. In some patients, tendon transfers were performed during the same operation for the restoration of shoulder and thumb abduction and wrist extension.

Results: Forty one patients had supination deformities caused by BPBP. The mean age was 9.2 years (4-22). The mean follow-up was 5 years (1-7). The mean active pronation was -60° before the operation, and the passive one was -10°. The mean active pronation of the patients was 9° after the operation, and the passive one was 45°. The mean active supination of the patients was 75° before the operation, and the passive one was 85°. The mean active supination of the patients was 45° after the operation, and the passive one was 65°. One malunion was detected at the second year after the operation (1/41). Three patients had low pronation degrees during the follow-up (3/41).

Conclusion: Satisfactory postural and functional improvement can be achieved with the use of pronating radius osteotomy for patients with severe supination contractures.

Keywords: Brachial plexus birth palsy, contracture, pronating radius osteotomy, supination deformity, tendon transfer

ÖZET

Amaç: Doğumsal brakiyal pleksus paralizisi (DBPP) şiddetli supinasyon deformitesi ile seyredebilir. Bu çalışmanın amacı, bu deformitenin tedavisinde radius pronasyon osteotomisinin etkinliğini saptamaktır.

Gereç ve Yöntemler: Şiddetli supinasyon deformiteleri olan DBPP hastaları bu çalışmaya eklenmiştir ve bu hastalar Kasım 2003 ila Aralık 2015 tarihleri arasında, aynı ekip tarafından ameliyat edilmiştir. Radius pronasyon osteotomisi yapılmıştır ve kemiksel sabitleme Kirschner telleri veya semitübüler plaklar ile sağlanmıştır. Bazı hastalarda, omuz ve başparmak abdüksiyonu ve el bileği ekstansiyonunun sağlanması için aynı ameliyatta tendon transferleri de yapılmıştır.

Bulgular: Kırk bir hastada DBPP'ye bağlı supinasyon deformiteleri saptanmıştır. Hastaların ortalama yaşı 9,2 yıldır (4-22 yıl). Hastaların ortalama takip süresi 5 yıldır (1-7 yıl). Ortalama ameliyat öncesi etkin pronasyon -60° iken pasif değer -10°'dir. Ortalama ameliyat sonrası etkin pronasyon 9° iken pasif değer 45°'dir. Ortalama ameliyat öncesi etkin supinasyon 75° iken pasif değer 85°'dir. Ortalama ameliyat sonrası etkin supinasyon 45° iken pasif değer 65°'dir. Bir hastada ameliyat sonrası ikinci yılda malünyon saptanmıştır (1/41). Üç hastada ameliyat sonrası dönemde yetersiz pronasyon elde edilmiştir (3/41).

Sonuç: Şiddetli supinasyon kontraktürü olan hastalarda, radius pronasyon osteotomisi ile tatmin edici bir görünüm ve işlevsel düzelme elde edilebilir.

Anahtar Kelimeler: Doğumsal brakiyal pleksus paralizisi, kontraktür, radius pronasyon osteotomisi, supinasyon deformitesi, tendon transferi

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INTRODUCTION

Supination deformity is a challenge in the management of brachial plexus birth palsy. The pronator quadratus and the pronator teres muscles may be affected in the plexus palsies with the involvement of the C5-T1 nerve roots (1). The unopposed supination forces keep the forearm in supination, and with time, rigid deformity develops with the involvement of the interosseous membrane (1). At its earlier stages, the deformity may be corrected passively, but it generally progresses to become fixed over time (2).

The supination deformity affects the patient both functionally and aesthetically. For this reason, many surgical interventions have been described. Although some deformities may be treated with tendon transfers and interosseous membrane releases, more rigid deformities require bone interventions such as osteotomy (2, 3). In fact, the management strategies of the supination deformity vary according to the congruence of the radioulnar joint. Zancolli classified distal radioulnar joint congruence in three types such as type Ia, Ib and II. In type II (fixed deformity), the patients do not have passive pronation and supination in their distal radioulnar joints, and osseous procedures are required in such patients (4). In 1940, Blount suggested osteoclasis of both radius and ulna (5). In 1956, Burman described a method for rotation osteotomy in which the distal fragment of radius is brought to dorsal and ulnar angulation with non-axial torsion (6).

In this study, an overview of radius pronation osteotomy technique for supination deformities in brachial plexus birth palsy was made, and postoperative results were reported.

MATERIAL AND METHOD

Brachial plexus birth palsy (BPBP) patients who had pronating radius osteotomy for severe supination deformity of the forearm were included in the study (Figure 1). The patients were operated on between November 2003 and December 2015 by the same operative team. The following were the indications for radius pronating osteotomy: a lack of active and passive pronation of the forearm (fixed supination deformity), intact sensibility and good grasp/release function of the hand. In some patients, tendon transfers were performed during the same operation for shoulder, thumb and wrist function. All goniometric evaluations were made by the same hand therapist. Preoperative and postoperative active/passive pronation and supination degrees of the forearm were assessed by goniometric measurements (Figure 2). A low pronation degree was defined as passive pronation less than 30 degrees because such a range of motion is required in healthy individuals.

Figure 1: The preoperative photograph of a patient with right sided obstetric brachial plexus paralysis with severe supination deformity is shown. The patient can not pronate his forearm actively

Figure 2: The postoperative photograph of the same patient is shown. The patient can actively pronate his right forearm

The Institutional Ethics Committee approved the study (Date: 26.02.2018, No: 279). Informed consent was obtained from the guardian of each patient.

Surgery was performed under general anesthesia and a pneumatic upper arm tourniquet was used. The linear incision was performed on the volar and radial aspect of the forearm. The intersection point between the proximal and the middle one thirds of the radius was reached through this incision (Figure 3). Due to the robust blood supply of this point, rapid bone healing may be ensured. Radial osteotomy was performed distal to the pronator teres enthesis and the forearm was pronated to the maximal limit. Bone fragments were fixated either by Kirschner wires or by semitubular plates (Figure 4).

Following skin closure, a long-arm cast was applied. The elbow was flexed in 90 degrees and the forearm was positioned in maximal pronation. The wrist was extended in 30 degrees. The cast immobilization was continued for six weeks and the cast was changed with a thermoplastic splint after the sixth postoperative week. Simultaneously a rehabilitation program was started. The thermoplastic

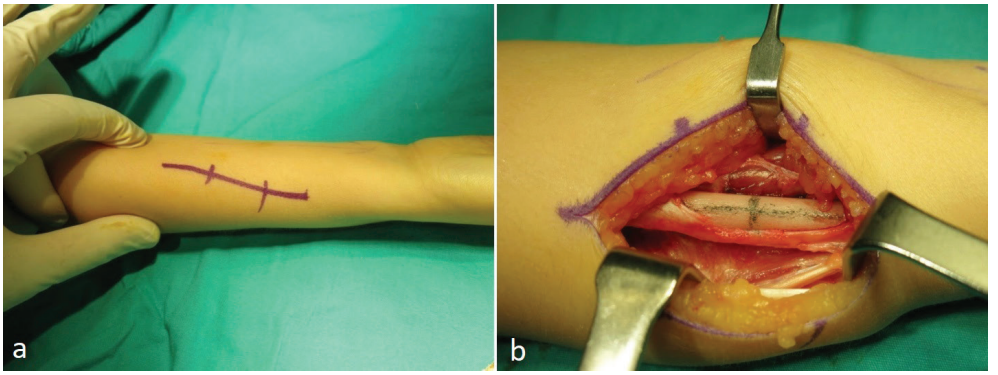

Figure 3: The operative photograph demonstrates our incision of preference (a) and the area of osteotomy on the radius (b)

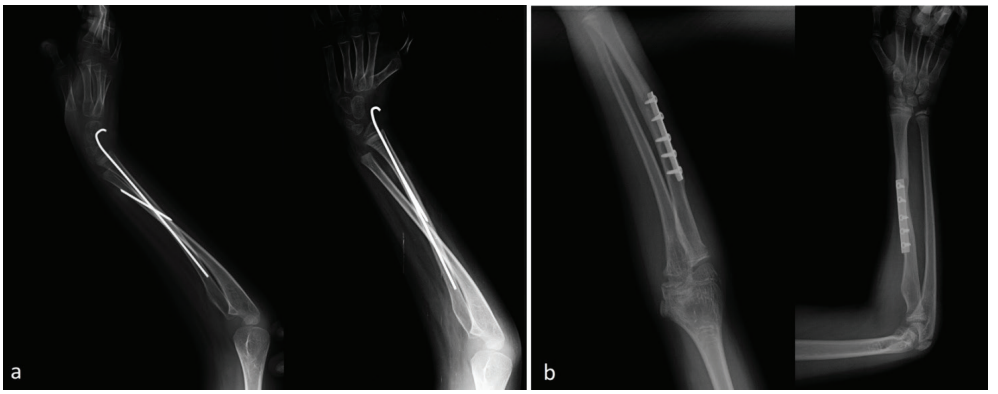

Figure 4: The postoperative radiograph of two patients are shown. (a) Kirschner wire (b) Semitubular plate

splint was used until the direct graphs revealed evidence of bone healing. Kirschner wires were usually removed at the postoperative second month according to X-ray follow-ups. Plate and screws were removed after 1-2 years if the patients had complaints such as prominence of the plate under the skin.

RESULTS

Forty one patients had supination deformities caused by BPBP. The mean age was 9.2 years (4-22). Twenty three patients were female whereas 18 patients were male. The mean follow-up was 5 years (1-7). Shoulder, thumb and wrist functions were augmented with tendon transfers in nineteen patients (19/41). There were no patients who underwent tendon transfers for forearm rotation before rotation osteotomy.

The angle 0 was defined as neutral. The negative values stood for supination whereas the positive values stood for pronation (Figure 5). The mean active pronation was - 60° (range - 80° to - 45°) before the operation, and the passive one was - 10° (range - 30° to 5°) (Figure 6). The

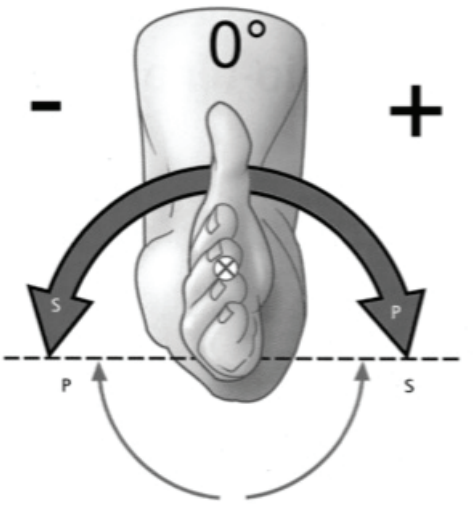

Figure 5: The angle 0 was defined as neutral. The negative values stood for supination whereas the positive values stood for pronation

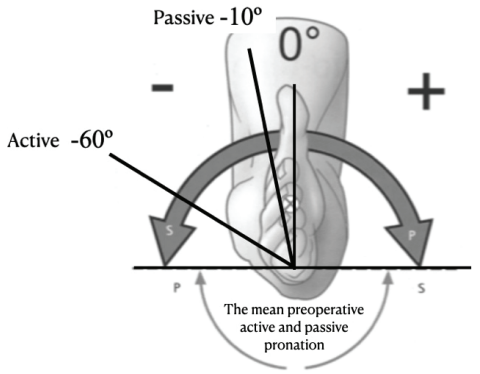

Figure 6: The mean pronation values (active and passive) are presented for the preoperative period

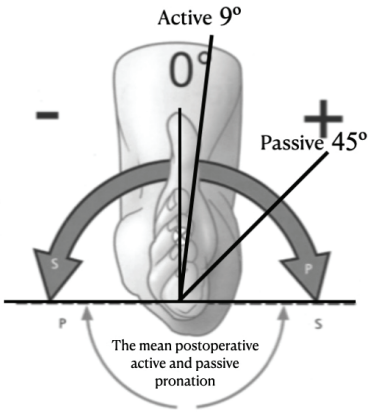

Figure 7: The mean pronation values (active and passive) are presented for the postoperative period

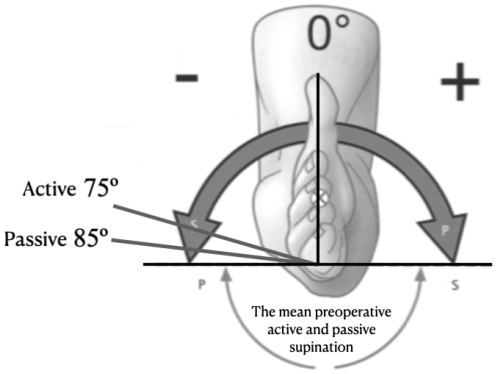

Figure 8: The mean supination values (active and passive) are presented for the preoperative period

mean postoperative active pronation was 9° (range - 10° to 20°), and the passive one was 45° (range 25° to 60°) (Figure 7). The mean active supination was 75° (range 35° to 85°) before the operation, and the passive one was 85° (range 45° to 90°) (Figure 8). The mean active supination was 45° (range 20° to 60°) after the operation, and the

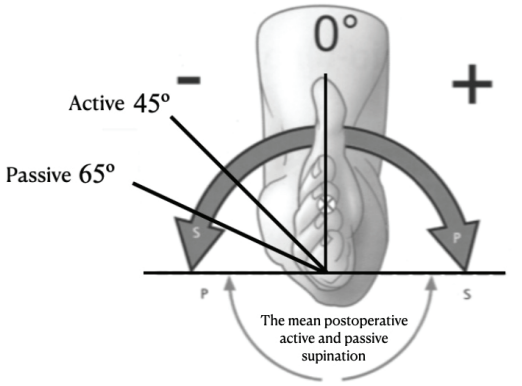

Figure 9: The mean supination values (active and passive) are presented for the postoperative period

passive supination was 65° (range 40° to 80°) (Figure 9). On the other hand, three patients had low pronation degrees (3/41).

One malunion was detected at the second post-operative year (1/41). This patient was treated with open reduction and internal fixation. One patient had a non-union following radius osteotomy due to insufficient plate fixation and the patient was treated by changing the semitubular plate with a strong locking compression plate. The osteosynthesis was performed with plates and screws in 30 patients and removal surgery was performed on 12 patients.

DISCUSSION

Tendon transfers, soft tissue releases and corrective osteotomies may be performed for supination deformities (1-5). The Zancolli procedure is one of the tendon transfers that enhance pronation. After incising the cubital area, the soft tissue contractures are released and the biceps insertion is detached from the ulnar aspect of the radius. The tendon is passed over the radial aspect of the radius to be inserted to the radial side of the radial head (2). This transfer turns the supinatory effect of the biceps muscle to a pronatory one. Although this technique is widely accepted, it was not useful for this study because all the patients had fixed supination deformities refractory to soft tissue reconstruction.

In 2004, Ozkan et al. suggested a new technique of active pronation maintenance (3). The rigid supination was overcome with interosseous membrane section and the brachioradialis tendon was transferred from the dorsal forearm to the volar side of the distal radius (3). However, the deformity was too rigid in this study's population and such soft tissue procedures were not enough to restore the pronation. Thus, tendon transfers, interosseous membrane releases and tendon lengthening procedures

were performed in conjunction with the rotational osteotomy in order to optimize the results of this study.

The rotational osteotomy is an important part of the reconstructive armamentarium and the benefits of the rotational osteotomies were accepted by the reconstructive community. Zaoussis performed radius rotation osteotomies on six patients with forearm supination deformities caused by BPBP (7). Zaoussis designed the radius rotation osteotomies according to malunion correction principles and his technique was different than Blount osteoclasis technique that preferred a closed approach (5, 7). Zaoussis performed open radius osteotomy distal to the radial tuberosity; however, in this study, osteotomies were performed just distal to the enthesis of pronator teres. Also, some authors combined the distal radial osteotomies with proximal humeral osteotomies in severe cases. Goddard et al. performed humerus rotational osteotomies in 10 BPBP patients and their findings supported the need for osteotomy procedures in severely disabled patients who were not good candidates for only soft tissue procedures (8).

Metsaars et al. compared the results of osteotomy with biceps rerouting procedure and they evaluated their results according to the severity of the contractures. Both techniques increased the pronation and the gain was proportionate to the severity of the deformity. The patients with more severe supination deformities benefited more from the rotational osteotomy. Although the recurrence rate was 20-40% in the osteotomy group and hardware complications were observed by Metsaars et al., such a high recurrence and complication rate were not seen in this study (9).

Bahm et al. operated on 40 patients with severe supination deformities and 23 of their patients were operated on either with Blount osteoclasis or open radial osteotomy (10). At a mean follow up of four years, their final postoperative pronation was 17 degrees. However, they had five recurrences in the osteotomy group. According to Bahm et al., age at the time of operation was significant because it affected the compliance of the patients with physiotherapy (10). In 2004, Allende et al. published their results on 66 patients with supination deformities caused by BPBP. Forty four of their patients were operated on with rotation osteotomies whereas 22 of them only had soft tissue procedures. In a mean follow up of 64.3 months, they obtained a postoperative passive pronation of 92 degrees. They had nine recurrences, two delayed unions and one malunion in the osteotomy group (11). In this study, the mean postoperative active pronation was 9 degrees and the mean postoperative passive pronation was 45 degrees. Also, low pronation degrees and recurrence were seen in three patients and malunion was seen in only one patient. The results of this study were comparable with recent literature.

CONCLUSION

Interosseous membrane releases and tendon transfers are preferred treatments in flexible supination deformities. Rotational osteotomies may be preferred in fixed deformities, and the complication rate is relatively low with this technique.

Ethics Committee Approval: This study was approved by the Clinical Research Ethical Committee of the Istanbul University, Istanbul Faculty of Medicine (Date: 26.02.2018, No: 279).

Informed Consent: Written consent was obtained from the participants.

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