

CASE REPORT

Simultaneous correction of hyper-supination deformity of forearm and flail wrist in patients with traumatic brachial plexus injuries

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Successful restoration of elbow flexion with nerve surgery in adults with complete brachial plexus injuries commonly develops a hyper-supination deformity of the forearm added to the flail wrist. While the latter is commonly addressed by arthrodesis of the wrist, the hyper-supination deformity would require a pronation osteotomy later. We propose a technique wherein both the procedures are carried out simultaneously. The technique shortens the “wait” of the patient to use their hand in a cosmetically better position and with a stable wrist. An additional surgery is avoided, and earlier rehabilitation is possible.

Keywords: brachial plexus injury, hyper-supination deformity, pronation osteotomy, wrist arthrodesis, flail wrist

Introduction

Postural hyper-supination deformity of the forearm is commonly observed in patients with complete brachial plexus injuries once the elbow flexion has been restored by primary nerve surgery. Following the successful index surgery, the biceps, a strong supinator and elbow flexor, being the only functioning muscle, causes severe hyper-supination posture of the forearm in the absence of the antagonists (**Figure 1**). Supination deformity of the forearm is commonly encountered in patients with birth brachial plexus palsy, and its management has been dealt with in detail in the literature (1, 2). In the children, it has been even referred to as “Beggars’ hand” or “Unshakable hand,” which is aesthetically annoying and functionally deranging (3). However, in adult brachial plexus injuries, it has not been discussed much, and pronation osteotomy remains the sole treatment option.

We identified such deformity in nine patients who have recovered elbow flexion and are waiting for further procedures. Two of these patients underwent pronation osteotomy of the radius as a separate procedure following wrist arthrodesis to alleviate the deformity, which not only



FIGURE 1 | Patient with complete brachial plexus palsy demonstrating hyper-supination deformity of forearm following recovery of elbow flexion.

prolonged the patients’ precious “wait” to experience the restored finger flexion but also remains a technical challenge as the radius already bears an implant (**Figure 2**). Therefore, we devised a novel treatment strategy of correcting the flail wrist and the hyper-supination deformity of the forearm simultaneously.

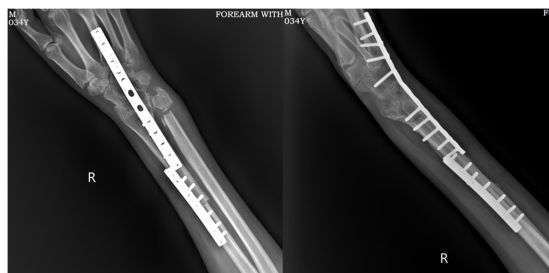


FIGURE 2 | Pronation osteotomy pose a technical challenge where the radius already bears an implant as shown.

Surgical technique

The wrist joint is approached through the universal standard approach, and the proximal exposure is extended to include the distal third of the radius as well. Once the radiocarpal and midcarpal joints have been prepared for the arthrodesis, a simple non-locking dynamic compression plate (12-holed) is chosen, and the distal end is secured to the third metacarpal with three screws. The proximal end is centered along the metaphysis and diaphysis of the radius. An osteotomy of the radius is then planned at a site so as to have a minimum of two screws distal and three screws proximal to the osteotomy site. A few holes are made with a 2.5 mm drill bit, but the osteotomy is not completed. The screws distal to the planned osteotomy site are placed, and the plate is stabilized to the radius. Now the radius osteotomy is completed with sharp osteotomes. The distal segment of the forearm with the plate in place across the wrist is pronated so that the forearm comes to lie in 30° pronation. The proximal screws are then placed, completing the procedure. The limb was then immobilized in an above-elbow plaster cast for 1 month, followed by rehabilitation. Elbow flexion strengthening exercises could be started 3 months following the surgery.

Discussion

Simultaneous correction of supination posture and flail wrist with a single implant is technically possible and saves the patient one extra stage of surgery and is cost-effective. In our institute patients with global brachial plexus palsy undergo staged reconstructive procedures in order to reanimate the injured limb starting with nerve transfer to restore elbow flexion, shoulder stabilization with trapezius transfer, wrist arthrodesis, and tendon transfer/free functioning muscle transfer for finger flexion. Postural hyper-supination deformity of the forearm is commonly observed in patients with complete brachial plexus injuries once the elbow flexion has been restored by primary nerve surgery because of the unresisted supination by the recovered biceps muscle. A flail wrist also needs fusion because of the lack of donors to stabilize or move it. It did appear very logical that this additional surgery could be easily



FIGURE 3 | Pronation osteotomy and wrist arthrodesis encompassed with a single implant.



FIGURE 4 | Pre(A) and post-operative(B&C) results of single stage pronation osteotomy of forearm and wrist arthrodesis.

avoided by adding a pronation osteotomy of the radius at the time of wrist arthrodesis (**Figure 3**). It is a simple technical additive that could effectively reduce the cost and the precious time of a patient with this devastating injury needing multiple procedures.

In our clinical practice, the choice of implant for wrist arthrodesis in these patients had been a non-locking dynamic compression plate unless the patient had poor bone quality where specific wrist fusion plates were used. We have been using the former implant in more than 200 patients with complete brachial plexus injuries and have not encountered any incidence of non-union.

The position of the forearm following pronation osteotomy is determined by the patient's expectation. A neutral or mid-prone position can be provided for those who are in want of improvement in posture only. For patients preoccupied with table-top activities or riding two-wheelers, 30–45 degrees of pronation can be provided. The former position also aids in bimanual activities once the finger flexion is restored (**Figure 4**). Other techniques described for correcting fixed supination deformity in pediatric patients

include surgical synostosis of the distal radio-ulnar joint and one-bone forearm fusion (4). These techniques seem to be readily applicable for adults; however, they carry the disadvantages of sacrificing the forearm rotation and the irreversible nature of the procedure. With our technique, the passive forearm rotation is preserved beyond the position achieved with the osteotomy.

Performing both procedures together carries the advantage of avoiding an additional procedure and separate implant, early rehabilitation, and more coordinated function of the hand along with a cosmetically better-looking hand.

Ethical approval

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Informed consent declaration

Written informed consent was obtained from all subjects before the study. There is no information (names, initials,

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None.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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