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Floating Shoulder Injury Resulting in Delayed Onset of Infraclavicular Brachial Plexus Palsy

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As the brachial plexus traverses the costoclavicular space, it is susceptible to compression by pathologies affecting the clavicle. Clavicle nonunions with hypertrophic callus may cause a delayed onset of brachial plexus palsy. We present a rare case of a floating shoulder injury causing medial and posterior cord brachial plexus palsy two months after initial injury. After the diagnosis was established, the patient was treated successfully with expeditious brachial plexus decompression, callus excision, and rigid osteosynthesis, with healing of the clavicle nonunion and scapular fracture, and recovery of sensory and motor deficits.

Keywords: *Brachial plexus, Clavicle, Floating shoulder, Bony callus, Clavicle nonunion*

INTRODUCTION

The brachial plexus passes through the interscalene triangle and the costoclavicular space before proceeding into the upper extremity.[1)] By virtue of its proximity, the brachial plexus may be injured by displaced fractures of the clavicle. In rare instances, hypertrophic callus or nonunions of clavicle fractures may impinge upon the infraclavicular brachial plexus in a delayed fashion.[2)]

We present a rare case of a floating shoulder injury causing delayed onset of a brachial plexus palsy of the medial and posterior cords, treated successfully with brachial plexus decompression, callus excision, and rigid osteosynthesis.

CASE REPORT

A 65-year-old male was transferred to our tertiary care center as a polytrauma patient following a motor vehicle accident. Upon arrival, the airway was patent, breathing was spontaneous, and hemodynamic parameters were stable. The patient complained of pain, swelling, and deformity of the left shoulder, left chest wall, right hand, and right foot. Past medical history was significant for diabetes mellitus and hypertension.

Examination showed an open laceration of the right hand and an open wound of the right lateral foot with extensive degloving. Tenderness and crepitus were elicited at the left clavicle, chest, and scapula. Neurovascular examination of the upper extremities was normal at injury presentation. Plain radiographs and computed tomography confirmed open fractures of the right fourth and fifth metatarsals and open fractures of the right ring finger and small finger metacarpals and proximal phalanges. Additionally, the patient had a displaced, comminuted fracture of the left midshaft clavicle (Fig. 1A) and displaced, comminuted fractures of the left scapular surgical neck and body (Fig. 1B), consistent with a floating shoulder injury. The patient had a closed left zygomatic arch fracture, left third through tenth rib fractures, left pneumothorax, and right hemopneumothorax. After trauma resuscitation, the patient was taken to the operating room for debridement and Kirschner wire stabilization of his open fractures. The fifth toe was amputated

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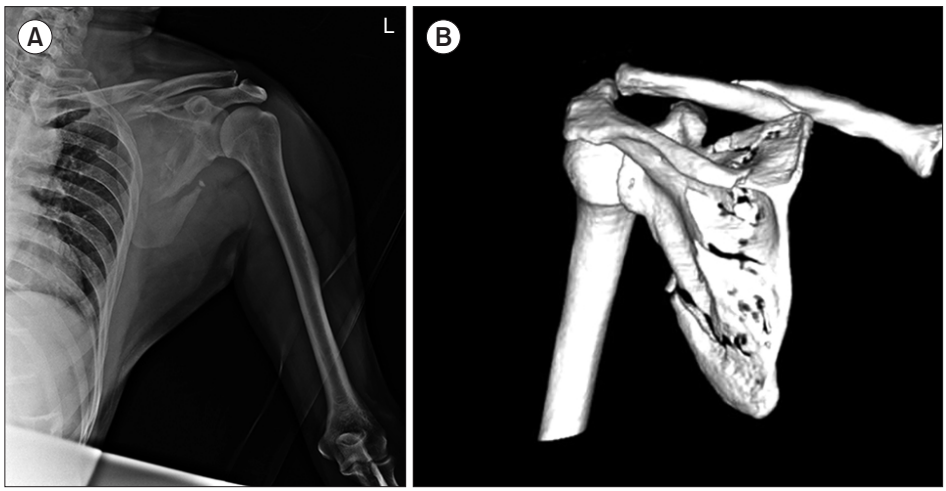

Fig. 1. (A) Left shoulder frontal injury radiograph showing a displaced, comminuted, midshaft clavicle fracture and a displaced scapula fracture. (B) Computed tomography 3D reconstruction showing a midshaft clavicle fracture and fractures of the scapular surgical neck and body, consistent with a floating shoulder injury.

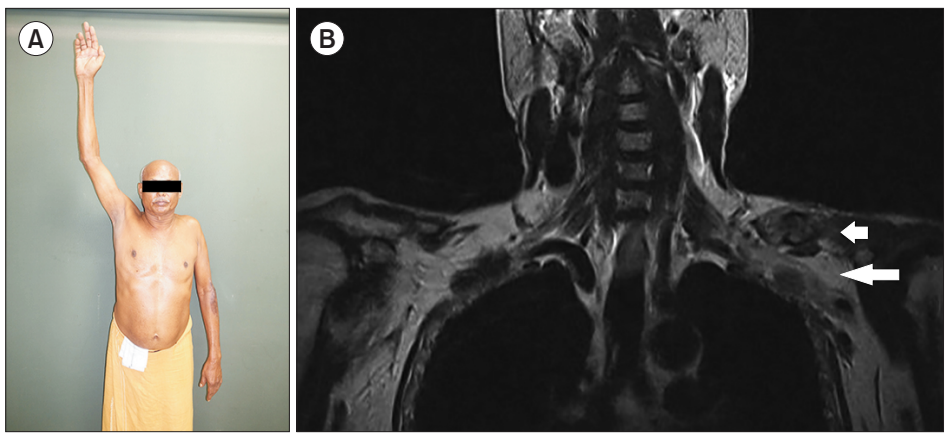

Fig. 2. (A) Clinical photograph of patient preoperatively demonstrating inability to actively abduct the left shoulder. (B) Magnetic resonance imaging of the brachial plexus showing hypertrophic callus at the clavicle nonunion site (short arrow) immediately adjacent to the infraclavicular brachial plexus (long arrow).

to the metatarsophalangeal joint level due to composite tissue loss. The patient returned to the operating room eight days following presentation for microvascular free gracilis muscle flap coverage of his right foot degloving injury. The left floating shoulder injury was initially treated nonoperatively.

At one month following injury, the patient first noticed weakness in the left shoulder and numbness in the left hand; these symptoms worsened at two months, at which time he presented to our clinic with these complaints. At this time, the patient had M0 motor activity in the deltoid, M4 in the biceps, M3 in the triceps, M0 in all wrist and digital extensors, and M3 in all wrist flexors (Fig. 2A). He had weakness in all extrinsic digital flexors and intrinsic hand muscles, with ulnar-innervated muscles being more affected. He had hypoesthesia in all nerve distributions in the left hand. Magnetic resonance imaging of the brachial plexus was performed at this time, showing a nonunited left clavicle fracture with hypertrophic callus causing extrinsic compression on the infraclavicular brachial plexus (Fig. 2B).

In light of these findings consistent with compression of the posterior and medial cords of the brachial plexus, the patient returned to the operating room. Upon exploration, the hypertrophic callus of the fracture nonunion was seen to be compressing the adjacent infraclavicular brachial plexus at the cord level. Brachial plexus neurolysis was performed, and the hypertrophic callus was excised. Intraoperative nerve stimulation following neurolysis confirmed firing of motor potentials across the area of nerve compression. The midshaft clavicle nonunion was reduced and stabilized with precontoured locking compression plating (Fig. 3).

The postoperative course was uncomplicated. On postoperative day two, the patient started to regain active wrist extension to neutral. By four weeks, the patient demonstrated active shoulder abduction, active wrist extension, and active thumb and digital flexion and extension. Clinical and radiographic union of the clavicle fracture was demonstrated at three months (Fig. 4A). At

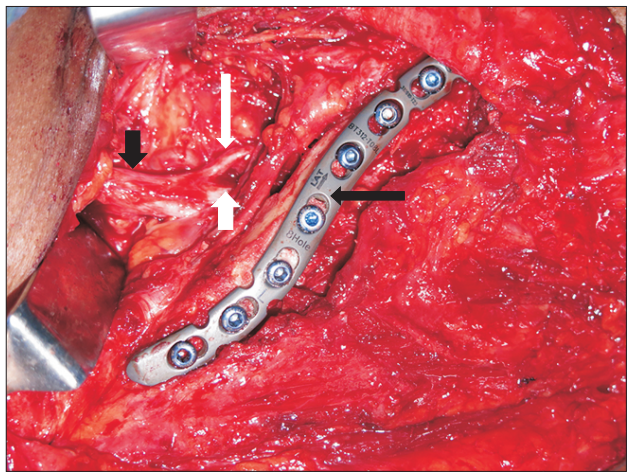

Fig. 3. Intraoperative clinical photograph showing open reduction and internal fixation of the clavicle nonunion after callus excision. The clavicle fracture (long black arrow), upper trunk (short black arrow), suprascapular nerve (long white arrow), and divisions of the upper trunk (short white arrow) are shown.

four months after surgery, patient had M4 motor activity in the deltoid, M4 in the biceps, M4 in the triceps, M4 in all wrist and digital extensors, and M4 in all wrist flexors (Fig. 4B). His grip strength was 10 kg and his pinch strength was 5 kg, equal to the contralateral hand, although the low values may be effort-dependent. His paresthesias were resolved. Static two-point discrimination measured 7 mm and moving two-point discrimination measured 6 mm. He reported no difficulty or mild difficulty with all functional tasks, and the Disabilities of the Arm, Shoulder and Hand (DASH) score at final follow-up was 15.

DISCUSSION

The brachial plexus passes through the interscalene triangle, the costoclavicular space, and the retropectoralis minor space before proceeding to the upper extremity.[1,2] Midshaft clavicle fractures that are displaced or healing

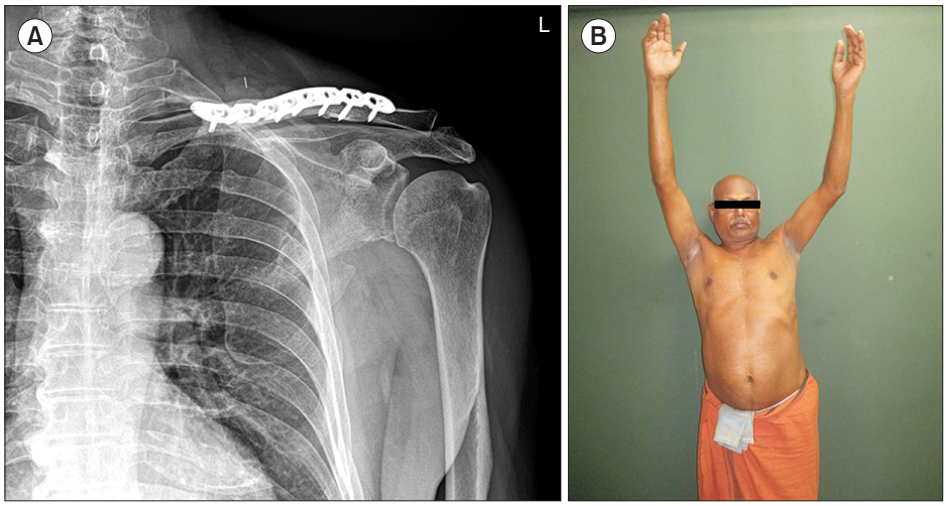

Fig. 4. (A) Left shoulder frontal radiograph at three months postoperatively demonstrating healed clavicle and scapula fractures. (B) Clinical photograph of patient at four months postoperatively demonstrating restoration of active left shoulder abduction.

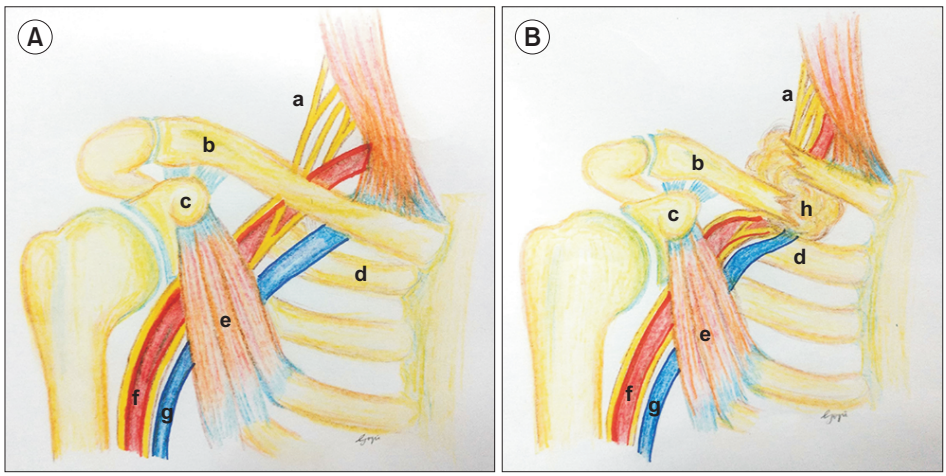

Fig. 5. (A) Normal anatomy of the thoracic outlet. (B) Clavicle fracture with hypertrophic callus formation causing compression in the costoclavicular space. Labeled structures are the (a) brachial plexus, (b) clavicle, (c) coracoid process, (d) first rib, (e) pectoralis minor, (f) subclavian artery, (g) subclavian vein, and (h) hypertrophic callus.

with exuberant callus formation may impinge upon the costoclavicular space.[3] The inferior and posterior displacement of the distal fragment of diaphyseal clavicle fractures can cause external compression of the brachial plexus and subclavian vessels, and hypertrophic callus or motion at a nonunion site further compromises the costoclavicular space (Fig. 5). Delayed onset of a brachial plexus palsy in a patient initially free of symptoms is rare. In 1949, Campbell et al. first described a case of delayed brachial plexus palsy in a nonunited clavicle fracture in a World War II soldier who had reproducible upper extremity paresthesias while wearing his army pack on his affected shoulder.[4] In a study of 690 clavicle fractures, Rowe found that only two fractures were complicated by delayed neurovascular symptoms.[5] Though rare, delayed brachial plexus palsy has been described weeks, months, or years following clavicle fractures.[6-8] Clavicle nonunions with hypertrophic callus most commonly compress the medial cord of the brachial plexus and manifest as weakness or paralysis of the intrinsic hand muscles and paresthesias in the hand; however, compression of the posterior cord has been described as well.[7]

We have presented a case of delayed brachial plexus palsy following a floating shoulder injury. Floating shoulder injuries are comprised of a fracture of the clavicle and a fracture of the scapular neck, resulting in a two-part disruption of the superior shoulder suspensory complex.[9] Whether floating shoulder injuries are best treated nonoperatively or with surgical stabilization remains unclear, and available evidence is limited to retrospective studies.[10-13] While some authors recommend surgical fixation of all displaced floating shoulder injuries, significant functional differences have not been demonstrated between surgical fixation and nonoperative treatment of floating shoulder injuries in prior comparative studies.[10,12] Moreover, when surgical fixation is performed, there is insufficient evidence to conclude whether open reduction and internal fixation of both the clavicle and scapular neck is necessary or whether open reduction and internal fixation of the clavicle alone is adequate.[13] In our case, the added instability from a double disruption of the superior shoulder suspensory complex may have contributed to an exuberant callus forming response in the process of secondary bone healing. In retrospect, our patient may have benefited from clavicle fixation at initial presentation to stabilize the shoulder girdle. In keeping with previous reports, in our case, the brachial plexus was compressed at the infraclavicular cord level. Symptoms were mainly manifest in the medial cord, as evidenced by weakness of the wrist flexors, digital flexors, and hand intrinsics, and posterior cord, as evidenced by weakness of the deltoid, triceps, wrist extensors, and digital extensors. Clinical neurologic recovery was evident as early as postoperative day two, and a full functional recovery was seen at four months.

Delayed onset brachial plexus palsy following an initially normal neurological presentation warrants prompt work-up. A high index of suspicion should be kept for external compression by fracture callus when a delayed brachial plexus palsy is seen in the setting of a prior ipsilateral clavicle fracture or floating shoulder injury. Unlike the traction-type injuries seen in acute traumatic brachial plexus injuries, delayed brachial plexus palsies caused by external compression are neuropraxias. Therefore, when such a diagnosis is made, surgical decompression of the brachial plexus should be performed expeditiously. Previous recommended treatments of the bony nonunion in the setting of delayed brachial plexus palsies have ranged from callus excision alone, to osteosynthesis of the nonunion, to partial cleidectomy.[4-8] Proponents of partial cleidectomy argue that osteosynthesis of the clavicle nonunion may again result in hypertrophic callus and recurrent brachial plexus compression.[7] We do not advocate partial cleidectomy in the setting of a floating shoulder injury, as this may further destabilize the superior shoulder suspensory complex. Brachial plexus impingement has been reported following excision of the mid-diaphysis of the clavicle by the remaining lateral stump.[6]

Delayed brachial plexus palsy due to compression by hypertrophic callus from a clavicle fracture is a rare occurrence. When diagnosed, excision of the offending callus should be performed expeditiously to prevent ongoing compression of the brachial plexus. In the setting of a floating shoulder injury, rigid osteosynthesis of the clavicle nonunion imparts stability to the superior shoulder suspensory complex. Early diagnosis and treatment of this neuropraxia-type injury can result in a good functional recovery.

CONFLICT OF INTEREST

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