

Case Report

Two cases of brachial plexus compression secondary to displaced clavicle fractures

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ARTICLE INFO

Keywords:

Clavicle fracture
Clavicle nonunion
Dual-plating
Brachial plexus compression
Thoracic outlet syndrome

ABSTRACT

Brachial plexus compression is a rare complication of displaced clavicle fractures, with few reports existing in the literature. Neurologic symptoms can present immediately after the injury or in a delayed fashion months later. Following polytrauma, two patients presented with displaced middle-third left clavicle fractures initially treated conservatively at other institutions. Both patients developed neurologic symptoms in the left upper extremity consistent with brachial plexus compression. Magnetic resonance imaging and electrodiagnostic testing were used to help confirm the diagnosis of thoracic outlet syndrome/brachial plexopathy, and both patients underwent open reduction internal fixation with dual plating, local bone grafting and brachial plexus decompression. Both patients experienced successful relief of neurologic symptoms postoperatively. The purpose of this case series is to report on a rare complication of delayed- and non-united clavicle fractures and describe successful treatment with a novel fracture fixation construct.

Introduction

Neurogenic thoracic outlet syndrome (TOS) is a rare complication of clavicle fractures managed conservatively. In the acute setting, displaced clavicle fracture components or bone fragments can compress the brachial plexus, causing neurological symptoms. Alternatively, symptoms can present weeks to months after the initial injury as callus and scar tissue develop and impinge on the brachial plexus [1]. Surgical treatment options for TOS classically include first rib resection, clavicle resection, or scalenectomy [2]. However, in cases of brachial plexus compression caused directly by clavicle fracture components or fracture callus, brachial plexus decompression via anatomic reduction and fixation of the fracture site and callus resection can provide adequate relief as described in case reports and small case series [1–4].

We present two cases of brachial plexus compression following conservatively managed midshaft clavicle fractures ultimately treated successfully by open reduction internal fixation (ORIF) with mini-fragment dual-plating augmented by local bone graft. To the best of our knowledge, this is the first report of brachial plexus compression associated with clavicle fracture treated with this surgical technique. Therefore, the purpose of this case series is to report on a rare complication of a clavicle fractures and describe successful treatment with a novel fracture fixation construct.

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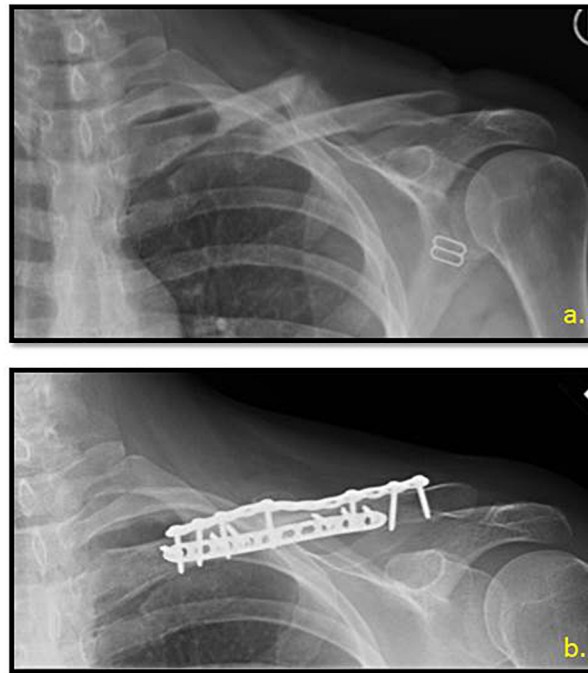


Fig. 1. a.) Case 1 anterior-posterior (AP) radiograph demonstrating a displaced, midshaft clavicle fracture with overriding fracture components and callus formation. b.) Case 1 AP radiograph at 10 weeks postoperatively showing a well-aligned, healing midshaft clavicle fracture.

Case 1

Presentation

A 51 year-old female involved in a motor vehicle accident sustained polytrauma including a middle-third left clavicle fracture initially treated conservatively at another institution. She presented to our institution 4 months later with left shoulder discomfort and pain. Physical exam revealed intact motor and sensory function throughout C5-T1 nerve distribution. Electromyography (EMG) and nerve conduction velocity (NCV) testing at that time was negative. Radiographs showed an unhealed, displaced, shortened clavicle fracture with abundant callus (Fig. 1). Seven weeks later, the patient reported progressive discomfort and numbness radiating down the left upper extremity, especially with overhead activity. Interval computed-tomography (CT) scan demonstrated a chronic, significantly displaced fracture with overriding fracture components and areas of bridging callus present but with no osseous union of the majority of the fracture site. The workup for TOS was initiated.

Workup

Magnetic resonance imaging (MRI) with the arm in abduction external rotation (ABER) demonstrated osseous impingement on the anterior plexus (Fig. 2). Electrodiagnostic studies were repeated, this time showing a pattern consistent with TOS.

Treatment

Ten months from injury, the patient underwent ORIF of clavicle nonunion through an anterosuperior approach. Bulky callus around the fracture nonunion site was noted to be compressing the brachial plexus. After callus resection and fracture reduction, a 2.4 mm locking compression plate (LCP) was placed anteriorly, followed by a 2.7 mm reconstruction plate placed superiorly. Morcellized graft from the resected callus was packed into the fracture site.

Follow-up

On postoperative day 1, the patient reported resolution of her neurological symptoms. Physical exam at 10 weeks postoperatively revealed intact sensory and motor function and painless near full range of motion (ROM) of the left shoulder. Radiographs (Fig. 1) demonstrated maintenance of fracture alignment and healing.

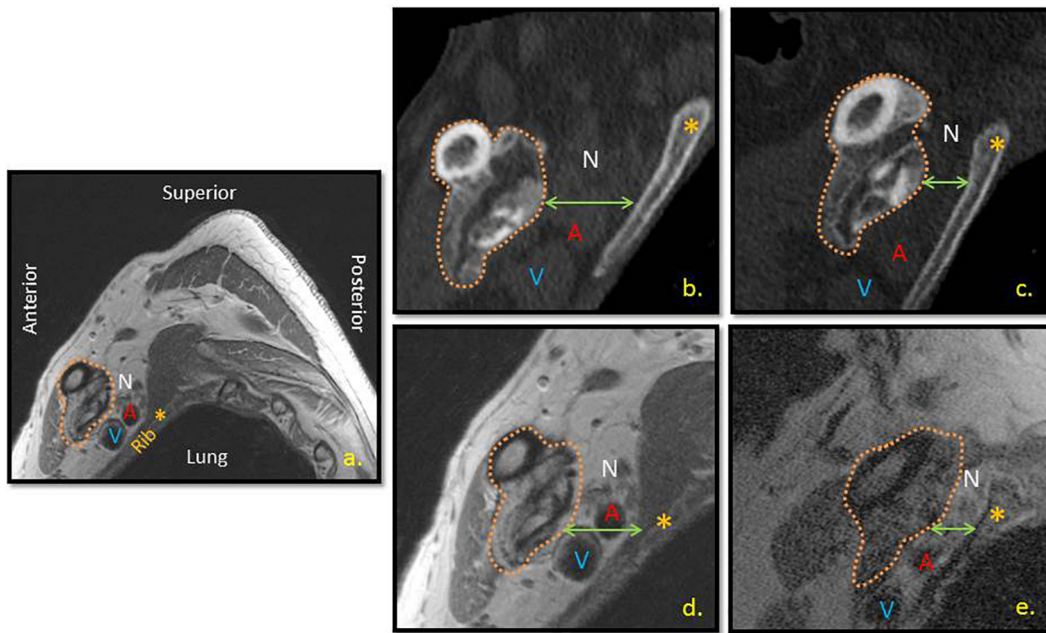


Fig. 2. Case 1 preoperative oblique sagittal proton density weighted MRI and reconstructed sagittal CT imaging of the left brachial plexus. a.) MRI with anatomical structures labeled for reference. Blue “V” represents vein, red “A” represents artery, white “N” represents nerves. b.) Non-positional CT and c.) positional CT with arm abducted and externally rotated (ABER) show callus (orange dotted line) and rib (orange asterisk). Green double arrows indicate space for neurovascular structures. d.) Non-positional MRI. e.) Positional MRI with arm ABER demonstrates diminished space for brachial plexus between the rib and fracture callus (green double arrows) than seen in the neutral position in d.) non-positional MRI. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Case 2

Presentation

A 71 year-old male fell from 6 ft and sustained polytrauma, including a displaced middle-third left clavicle fracture initially treated conservatively. He presented to our institution 5 weeks later complaining of persistent weakness in the left upper extremity. Physical exam revealed 2/5 ulnar nerve strength and weakness of the intrinsic muscles of the hand and finger abduction. Dullness to sensation was noted over the tips of the first, second and third digits. Radiographs revealed a comminuted, displaced, shortened left clavicle fracture (Fig. 3). The workup for a brachial plexopathy was initiated.

Workup

MRI revealed nonspecific signal hyperintensity in the C5 and C7 nerve roots and the upper trunk of the brachial plexus. Electrodiagnostic studies revealed a posterior cord brachial plexopathy with severe denervation of the extensor indicis proprius, extensor digitorum communis, and extensor carpi radialis. The brachioradialis, triceps and latissimus dorsi showed some denervation with good motor unit preservation.

Treatment

Six weeks from injury, the patient underwent left clavicle ORIF. Extensive callus, gross motion and impending nonunion were noted about the fracture fragments. The posterior fragment was oriented in an anterior to posterior fashion causing significant compression on the brachial plexus. After callus resection and brachial plexus debridement, the fracture was reduced and fixed with the same construct as Case 1.

Follow-up

By 6 weeks postoperatively, ulnar nerve strength improved to 4+ /5 from 2/5 preoperatively. By 3 months postoperatively, the patient reported resolution of his symptoms, and ulnar strength improved to 5/5. Radiographs revealed a well-aligned healing clavicle fracture (Fig. 3).

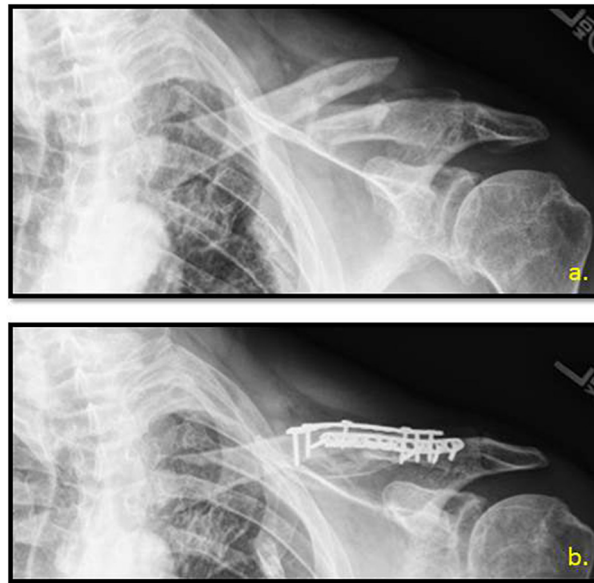


Fig. 3. a.) Case 2 preoperative AP radiograph showing a comminuted displaced midshaft clavicle fracture with significant shortening. b.) Case 2 AP radiograph at 3 months postoperatively showing a well-aligned, healing midshaft clavicle fracture.

Discussion

Nonunion rates for displaced midshaft clavicle fractures managed conservatively have been reported up to 15% [5]. A rare complication of nonunited and malunited clavicle fractures is brachial plexus compression. Rates of brachial plexus irritation following conservative treatment of midshaft clavicle fractures have been reported from 14 to 29% [5,6], although few reports of neurogenic thoracic outlet syndrome requiring reoperation exist in the literature. Furthermore, the timing and presenting patterns of compressive symptoms often vary, with some patients presenting acutely and others presenting with delayed onset of symptoms, making diagnosis difficult and often missed.

In Case 1, the patient developed subjective positional symptoms of neurogenic TOS months after conservative treatment of the initial injury. Although her initial EMG/NCV testing was negative, repeat testing was positive when the delayed symptoms appeared, as was positional MRI. These findings are similar to other cases of delayed TOS reported in the literature in which hypertrophic nonunion or excessive callus formation causes nerve compression. Teunis et al. reported a patient with a midshaft clavicle nonunion presenting with neurologic symptoms 13 years after the initial injury [1]. This patient was treated successfully with plate osteosynthesis. Beliaev et al. reported a similar case in which the patient presented 3 months post-injury with brachial plexus symptoms due to a displaced, shortened, malunited clavicle fracture with excessive callus formation [2]. ORIF with a plate and a corrective clavicle osteotomy served as adequate treatment.

In contrast to our first case, Case 2 presented more acutely weeks after the initial injury with obvious motor weakness in the hand muscles on physical exam. Neurodiagnostic studies helped localize the lesion to the brachial plexus. At the time of surgery, a bone fragment was noted to be compressing the brachial plexus in addition to excessive callus and an impending nonunion. This scenario of early direct compression by a bone fragment is seemingly rare, with few reports found in the literature. One similar case reported by Barbier et al. involved a 32 year-old who sustained a comminuted clavicle fracture in which a bone fragment caused compression of the posterior cord with resultant upper extremity muscle weakness [7]. This patient also was treated with ORIF and neurolysis.

Both of our patients were treated successfully with ORIF with dual anterior and superior mini-fragment plate fixation. This technique was chosen as it has been used to manage displaced midshaft clavicle fractures at our institution with excellent results, as the two plates offer multiplanar fixation with good biomechanical stability without the bulkiness of a single larger plate [8]. In both cases, morcellized graft from the resected callus was used to augment the fixation construct, as initially described by Schumacker [9] and used in a previous report of brachial plexopathy caused by clavicular hypertrophic nonunion [3].

In cases of TOS or brachial plexus compression caused directly by fracture callus or bone fragments, callus resection, fragment excision and proper anatomic reduction of the clavicle fracture provide adequate decompression of the costoclavicular space, as shown by the neurologic symptom relief in our cases. To the best of our knowledge, our cases are the first reports of clavicular nonunion/impending nonunion with resultant brachial plexus compression to be treated with this fixation construct. Larger, longer-term studies are needed to better study the effectiveness of this specific surgical technique.

Conclusion

These two cases illustrate the following learning points:

1. Conservatively treated displaced midshaft clavicle fractures can cause brachial plexus compression at different time points during the healing process, and patients can present with a variety of neurologic symptoms acutely or in a delayed manner.
2. Patients with these fracture types should be monitored routinely for the development of brachial plexopathy and undergo the appropriate workup in a timely fashion if symptoms arise, including positional MRI and EMG/NCV testing.
3. Open reduction internal fixation with mini-fragment dual anterior and superior plating, callus resection, local bone grafting and concurrent brachial plexus decompression can be used as a technique to manage nonunited displaced midshaft clavicle fractures causing brachial plexus compression.

Funding source

No funding was received for this study.

Declaration of Competing Interest

All authors (Naomi Gadinsky, Emma Smolev, Michael Ricci, Douglas Mintz, and David Wellman) declare no conflict of interest for the present study.

Acknowledgements

None.

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