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Callus-related supraclavicular neuropathy after a pediatric clavicle fracture

Joseph Rauca, Oliver Richard Boughton, Patrick O'Toole

ABSTRACT

Introduction: This report highlights the rare occurrence of a callus-related supraclavicular nerve neuropathy after clavicle fracture in a 9-year-old boy, presenting with hypoesthesia and dysesthesia over the clavicle and infraclavicular region. A detailed literature search revealed no such case previously described in a child, making this a unique incident.

Case Report: The young boy sustained a closed, comminuted, left clavicle fracture from a significant fall while playing on a school astroturf. On examination, only a bump was noted. There was clear documentation of normal sensation and no other neurovascular damage. The patient was initially managed with oral analgesics and a sling support. The 3-week review revealed an adequate callus formed around the fracture. However, the patient still reported a lot of tenderness at the site of injury and experienced paresthesia and dysesthesia in the distribution of the supraclavicular nerve, which had developed in the three weeks leading up to this review. He was further managed with an arm sling for an additional three weeks and was given pendulum exercises to do. A review of the patient four weeks later revealed that the numbness had fully resolved about 1-month after its onset. The patient went on to fully heal and was discharged from the clinic.

Conclusion: Supraclavicular nerve neuropathies with a callus-related etiology are of very infrequent incidence. Callus-related supraclavicular neuropathies can be characterized by a delayed presentation over weeks to months of tenderness or sensory changes in the regions supplied by the nerve.

Keywords: Callus, Clavicle fracture, Paresthesia, Supraclavicular neuropathy

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Joseph Rauca[1], Oliver Richard Boughton[2], Patrick O'Toole[3]

Affiliations: [1]Children's Health Ireland (CHI) at Crumlin Hospital, Medical Student, School of Medicine, Trinity College, Dublin, Ireland; [2]Children's Health Ireland (CHI) at Crumlin Hospital, Pediatric Orthopaedic Fellow, Orthopaedic Department, CHI at Crumlin, Dublin, Ireland; [3]Children's Health Ireland (CHI) at Crumlin Hospital, Pediatric Orthopaedic Consultant, Orthopaedic Department, CHI at Crumlin, Dublin, Ireland.

Corresponding Author: Joseph Rauca, Trinity College Dublin, The University of Dublin, College Green, Dublin 2, Ireland; Email: raucaj@tcd.ie

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INTRODUCTION

The supraclavicular nerve branches course closely to the clavicle and are thus susceptible to injury during clavicle fractures and surgeries on or near the clavicle [1]. Injuries to the supraclavicular nerve can present as severe tenderness over the clavicle, hypersensitivity, or altered sensation to light touch, hypoesthesia, paresthesia, or dysesthesia of the skin over the anterior chest wall, clavicular area, or proximal shoulder girdle [2–5].

This report highlights the rare occurrence of a callus-related supraclavicular nerve neuropathy in a 9-year-old boy, presenting with hypoesthesia and dysesthesia over the clavicle and infraclavicular region. A detailed literature search revealed that such a case has not been previously described in a child, making this a unique incident.

CASE REPORT

A 9-year-old boy sustained a closed, comminuted, left clavicle fracture from a significant fall as a result of tripping while playing on a school astroturf. Three weeks prior, the boy had suffered a right clavicle fracture, and at this point was still in recovery with ongoing follow-up.

Upon examination, the boy was alert but appeared to be in discomfort. A bump was noted, but no bruising or erythema was present above the site of injury. Upper limb power, tone, and reflexes remained unaffected. Clear documentation of normal sensation and no other neurovascular damage was made at the initial presentation. No paresthesia in the infraclavicular region was specifically noted.

Plain radiography showed a comminuted, midshaft, left clavicle fracture with a Z-shaped fracture pattern (Figure 1). There were no indications of damage to the sternoclavicular or the acromioclavicular joints.

The patient was initially managed with oral analgesics and a sling support.

The 3-week review revealed an adequate callus formed around the fracture (Figure 2). However, the patient still reported a lot of tenderness at the site of injury and experienced paresthesia and dysesthesia in the distribution of the supraclavicular nerve that had developed in the three weeks leading up to this review. Examination did not reveal any motor weaknesses or reflex abnormalities, and he was otherwise neurovascularly intact. Further management consisted of an arm sling for an additional three weeks, pendulum exercises to do in the meantime, and a follow-up in four weeks, with the possibility of further reviews in the months to come.

By the subsequent review, at seven weeks post-injury, the numbness had fully resolved. The patient reported that normal sensation over the supraclavicular nerve zone returned about one month after the paresthesia and dysesthesia first began. The patient went on to fully heal and was discharged from the clinic after the 3-month review (Figure 3).

The delayed presentation of symptoms suggests that this development was due to callus-related nerve entrapment. We speculate that it will probably self-resolve with time.

Figure 1: AP radiograph of the fractured left clavicle at presentation.

Figure 2: AP radiograph of the left clavicle at 3-week post-injury review.

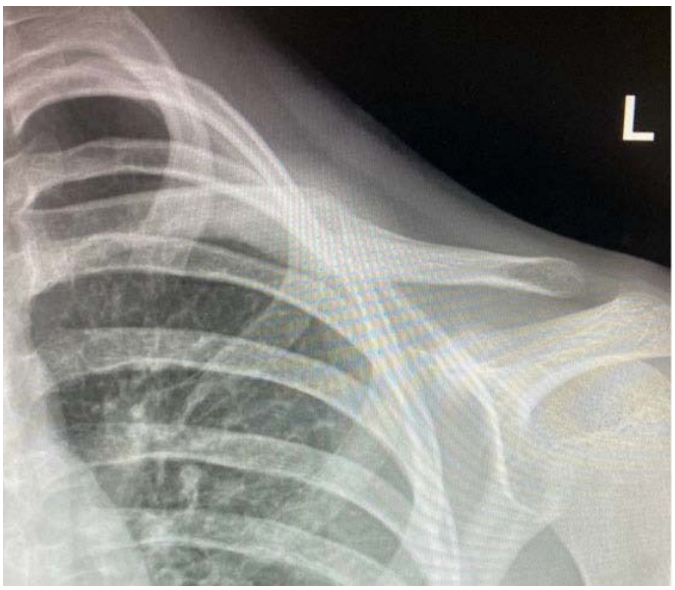

Figure 3: AP radiograph of the left clavicle at three months post-injury.

DISCUSSION

The supraclavicular nerves arise from the ventral rami of the C3 and C4 spinal roots. A common trunk is first formed, and then it branches off into the medial, intermediate, and lateral branches to supply sensory innervation to the skin overlying the medial head of

the clavicle, pectoralis major and deltoid, the superior and posterior shoulder, respectively [2, 6]. While the branches of the supraclavicular nerve usually run in the subcutaneous tissue after piercing through the deep fascia above the clavicle, they may occasionally pierce through the clavicle [2, 6]. A very recent morphometric and topographic study of clavicular canals and grooves for the supraclavicular nerves reported an incidence of 4.2% in the presence of clavicular canals and 1.1% in clavicular grooves [7]. The course of the intermediate supraclavicular nerve corresponded to the location of these canals and grooves. A double canal in the clavicle was present in 3 cases (0.5%). Despite its extremely rare occurrence, a double osseous canal for the branches of the supraclavicular nerve has been reported in the literature before this large-scale study [3, 8].

Epidemiology of supraclavicular nerve neuropathies

Due to its proximity to the clavicle, the supraclavicular nerve is particularly susceptible to injury during clavicle fractures or their surgical management [1]. There is no current data on the overall incidence of supraclavicular nerve injury; however, Labronici et al. found that 5 out of 255 patients with fractures of the clavicle presented with paresthesia in the anterior region of the thorax [9]. While supraclavicular nerve injuries resulting from clavicle fractures are uncommon, paresthesia following surgery on clavicle fractures can range from 12–29%, with some studies reporting a rate of up to 55% in clavicle open reduction and internal fixation (ORIF) [9, 10]. Rare variations in the anatomical course of the supraclavicular nerves, as described above, pose an increased risk of injury to the nerve in cases of clavicle fractures and manipulations of these fractures [11].

Pathophysiology

A significant number of iatrogenic supraclavicular nerve injuries have been documented relating to ORIF of the clavicle, surgeries for thoracic outlet syndrome, and even simply resulting from a surgical incision through the skin near the clavicle [12–15]. A few cases of iatrogenic supraclavicular nerve tethering due to scar tissue formation have also been reported [2]. A fracture of the clavicle has also been seen to cause a tension and entrapment neuropathy of the supraclavicular nerve [1]. In cases where the supraclavicular nerve coursed through an osseous foramen in the clavicle, traction injuries to the neck have been documented to result in entrapment neuropathy [3, 16]. As previously discussed, variation in the anatomical course of the supraclavicular nerve branches constitutes a higher risk of injury from clavicle fractures and surgical manipulation of the fractures [11]. Given the proximity of the supraclavicular nerve to the clavicle, there is a potential for the rare development of a supraclavicular nerve neuroma over months to years following the fracture of a clavicle, such as in the case reported by Mehta and Birch [2].

The development of the supraclavicular neuropathy in our case, which had a delayed presentation, was likely a callus-related nerve entrapment syndrome. Callus-related nerve entrapment neuropathies occur particularly in the setting of a middle to distal third humeral fracture, and they most commonly involve the radial nerve [17, 18]. While supraclavicular neuropathy after fracture of the clavicle is a well-recognized condition, callus-related supraclavicular nerve neuropathy is rare and underreported in the literature. Jupiter and Leibman report one case of supraclavicular nerve compression by an exuberant callus that formed around the clavicle fracture in a 26-year-old [4]. However, this pathophysiology for a supraclavicular nerve neuropathy has not been previously described in a child, making our case report a first of its kind.

Clinical presentation of supraclavicular nerve neuropathies

Many cases of supraclavicular nerve neuropathies report a semiology of severe tenderness over the clavicle, hypersensitivity, or altered sensation to light touch, hypoesthesia, paresthesia, or dysesthesia of the skin over the anterior chest wall, clavicular area, or proximal shoulder girdle [2–5]. A positive Tinel's sign over the site of injury, or the upper part of the chest has been previously observed [2, 5, 16]. Tethering of the nerve in the scar tissue from shoulder or neck surgeries can present with head movement-induced pain [2].

Diagnosis of supraclavicular nerve neuropathies

A supraclavicular nerve neuropathy should be considered following a clavicle fracture or surgery in the area near the clavicle if there is an acute onset of tenderness and sensory changes in the region of skin normally innervated by the supraclavicular nerve branches. A delayed presentation of suspected supraclavicular nerve injury may indicate the development of a neuroma, an intraosseous canal-related traction injury, or it could be a callus-related neuropathy if it presents within the healing period, like in our case [2, 3, 16]. Wang et al. recently demonstrated that ultrasound can be used to localize the terminal branches of the supraclavicular nerve along the surface of the clavicle; however, successful imaging can be limited by anatomical variants, small diameters of the rami, poor image resolution, and the availability of sonographers with neuromuscular expertise [19]. Body habitus, poor contrast resolution, and a narrow field of view can also pose challenges to ultrasound imaging of the supraclavicular nerve [20]. While magnetic resonance neurography (MRN) and newer techniques such as magnetic resonance tractography have been developed to improve nerve visualization using magnetic

resonance imaging (MRI), they are optimized for larger structures like the brachial plexus and sciatic nerve, and there is no well-established literature on the use of MRN for supraclavicular nerve identification [20]. Ultrasound imaging can be considered in cases of supraclavicular neuropathy as it is relatively inexpensive and readily available in most orthopedic and pain clinics, it facilitates real-time dynamic assessment, has no medical contraindications, and has a very high spatial resolution at shallow depths, which favors visualization of the superficially positioned supraclavicular nerve [20]. Nerve conduction studies (NCS) of the supraclavicular nerve are technically feasible but are not a standardized investigation. Non-routine antidromic surface electrode techniques have been described to record the small sensory nerve action potential (SNAP) and confirm supraclavicular nerve lesions via the absence of a SNAP [21]. However, NCS to assess supraclavicular nerve involvement remains infrequently used due to limited normative data, technical difficulty in isolating the SNAP, and lack of resource availability. Computed tomography (CT) scans can be considered to identify a neural canal in the clavicle if a canal-related neuropathy of the supraclavicular nerve is suspected [7].

Diagnosis in our case was based on clinical examination and radiography alone, as the symptom distribution, symptom onset during the healing period of the clavicle fracture, and radiographic evidence of a callus were sufficient to support the diagnosis. Nerve conduction study techniques for the supraclavicular nerve remain non-standardized, and most supraclavicular neuropathies of this kind resolve or significantly improve within three months (as in this case), therefore, we did not perform any NCS [9]. In cases where symptoms persist beyond the recovery period, there is a reasonable basis for conducting NCS to identify nerve entrapment and guide decompression. Ultrasound was not pursued as the symptoms had resolved within the 3-month recovery period. Had the symptoms not resolved, ultrasound could have also been considered in planning for decompression surgery of the nerve. However, as previously discussed, the visualization of small subcutaneous sensory nerves, such as the supraclavicular nerve, is more challenging than larger nerves, therefore, this is not a routine investigation [19, 20].

Early recognition and clinical markers

Early recognition of supraclavicular neuropathy relies primarily on a high index of clinical suspicion rather than a validated set of diagnostic markers—there is no established clinical prediction rule or screening checklist for recognizing supraclavicular neuropathy. Key indicators may involve the onset of paresthesia, numbness, dysesthesia, or localized burning pain in the distribution of the supraclavicular nerve branches following a clavicle fracture [2–5]. Callus-related etiology is to be suspected, particularly if symptoms emerge during the callus formation period rather than at the time of injury [4]. A positive Tinel's sign over the clavicle and point tenderness at the site of callus can further support the diagnosis [2, 5]. Persistence or worsening of symptoms beyond the expected fracture-healing timeline should prompt ultrasound or radiography.

Treatment/management

Supraclavicular nerve injuries relating to clavicle fractures primarily resolve spontaneously with an average recovery time of three months according to Labronici et al. [9]. They also suggest that knowledge of the anatomy of the supraclavicular nerve would help prevent injuries to the nerve during surgical procedures in the region. Paresthesia in the region of the supraclavicular nerve following surgeries on clavicle fractures can be reduced with identification and sparing of the nerve, and while it doesn't correlate to any changes in functional outcomes or increase operative time, it can improve patient satisfaction [10]. The use of oblique incisions in the surgical treatment of clavicle fractures compared to transverse incisions has also been demonstrated to reduce iatrogenic injury to the supraclavicular nerve [14]. Local anesthesia can be useful for temporary but immediate symptom relief [3]. Long-term management of supraclavicular nerve tension and entrapment from a fractured clavicle, as well as osseous canal-related supraclavicular nerve neuropathy, can be achieved with decompression of the nerve and fixation of the clavicle if needed [1, 3, 22]. In cases of supraclavicular nerve neuromas, resection of the injured nerve zone proves to be effective in reducing pain and minimizing, if not eliminating, any paresthesia [2]. Severe, debilitating tenderness across the distribution of the supraclavicular nerve has been treated with neurolysis in a few cases [2, 4].

When it comes to callus-related neuropathies of the supraclavicular nerve, Jupiter and Liebman adopted a surgical exploration approach seven weeks after their patient's injury [4]. From the 5-week mark post-injury, their patient developed progressive dysesthesia over the anterior thorax, followed by severe pain over the shoulder and extending down the arm. The surgical exploration revealed two branches of the supraclavicular nerve that were enclosed in the fracture callus, which were subsequently freed. The patient reported an immediate improvement in pain and upper limb mobility, and by the 12-month review, there was no tenderness, sensory changes, or discomfort at all [4].

As with the findings by Labronici et al., we speculated that the supraclavicular nerve injury in our case would self-resolve with time [9]. The patient's numbness did in fact resolve about one month after its onset.

CONCLUSION

Supraclavicular nerve neuropathies are seldom a complication in clavicle fractures or surgeries on the clavicle, and those with a callus-related etiology are

an even more infrequent incidence. Callus-related supraclavicular neuropathies can be characterized by a delayed presentation over weeks to months of tenderness or sensory changes in the regions supplied by the nerve. Nerve decompression, resection of the injured nerve zone, and neurolysis have been shown to be effective in treating supraclavicular nerve neuropathies. However, most cases resolve spontaneously. This is the first described case of callus-related supraclavicular nerve neuropathy in a pediatric patient.

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Author Contributions

Joseph Rauca – Conception of the work, Design of the work, Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Oliver Richard Boughton – Conception of the work, Design of the work, Interpretation of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Patrick O'Toole – Conception of the work, Acquisition of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Conflict of Interest
Authors declare no conflict of interest.

Data Availability
All relevant data are within the paper and its Supporting Information files.