

CASE REPORT

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Post-Traumatic Delayed Union of an Open Pediatric Clavicle Fracture with Ulnar and Axillary Neuropathy Treated with Open Reduction and Neurolysis

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ABSTRACT Clavicular fractures are common in pediatric patients, typically healing with conservative management. However, nonunion, though rare, can lead to functional impairment and chronic pain. This case report presents an 11-year-old boy with a delayed union of an open mid-shaft clavicle fracture, complicated by neurological deficits affecting the ulnar and axillary nerves. Despite initial conservative treatment, persistent symptoms led to surgical intervention. Open reduction and internal fixation with a plate, alongside intraoperative neurolysis of the brachial plexus, successfully restored function. The patient demonstrated full neurological recovery and fracture healing without the need for bone grafting. This case highlights the importance of timely surgical management in pediatric clavicle nonunion with neurological involvement, emphasizing the role of neurolysis in symptom resolution.

Keywords: Clavicle; pediatrics; nerve block; internal fracture fixation

Clavicular fractures are a common injury in the pediatric population, accounting for 10% to 15% of all pediatric fractures, often resulting from falls or sports-related activities.¹ While most clavicular fractures heal uneventfully with conservative management, a small subset can progress to nonunion.² Pediatric clavicle nonunion is rare but can cause functional impairment and pain.³

The incidence of clavicular fracture nonunion in children is estimated to be low, given the robust healing potential in this age group.¹ Risk factors include high-energy trauma, inadequate treatment, age, displacement, refracture, and conditions like vitamin D deficiency.^{3,4}

In both adult and pediatric populations, primary brachial plexus injuries are rare, occurring in less than 1% of cases, and are usually caused by direct compression of the fragments linked to mechanical trauma with high kinetic energy.^{5,6} Symptoms may appear acutely or develop later from muscle edema or bleeding.⁶

The management of pediatric clavicular fracture nonunion with neurological deficits involves a multifaceted approach. Open reduction and internal fixation with plate and if necessary, bone grafting may promote healing and restore function.^{1,2,4} Fixation via elastic stable intramedullary nailing (ESIN) is also an accepted procedure for pediatric patients.⁷ Postoper-

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actively, physical therapy and pain management, play a supportive role in the comprehensive care of these patients.

Reported cases of pediatric clavicle nonunions are rare in the literature. To the best of our knowledge, this case report is the first to document a pediatric open clavicle fracture delayed union with a neurological deficit.

CASE REPORT

Three months before being referred to our clinic, an otherwise healthy 11-year-old boy suffered an open mid-shaft right clavicle fracture when a construction pallet fell on his right shoulder while he was playing. The initial wound was sutured by his primary orthopedic surgeon, and it healed without complications (Figure 1). The fracture was initially managed conservatively with a sling and rehabilitation at another hospital.

Three months after the injury, the boy was referred to our clinic with a delayed union of the right clavicle with 2 cm displacement and deficits in the ulnar and axillary nerves (Figure 2). He presented with limited range of motion in the right shoulder accompanied by pain, a claw hand, numbness in the 4th and 5th digits, and hypoesthesia in the axillary nerve dermatome. There were no signs of local infection.

After a thorough evaluation, electromyography confirmed incompatible ulnar nerve findings and partial axonal neuropathy of axillary nerve. Magnetic resonance imaging revealed denervation of the right

supraspinatus and infraspinatus muscles. A multidisciplinary approach was planned, involving neurosurgical and thoracic surgical support. A superior approach was used for brachial plexus exploration and saline neurolysis; nerves were intact. The plexus and nerves were intact. There was no contact between the bony ends of the fracture. The atrophic bony ends of the clavicle were resected, and a 3.5 mm S-plate was placed on the clavicle. Grafting was not necessary (Figure 3 and Figure 4). Post-operatively, a sling was used to immobilize the affected limb for 3 weeks. After this period, the boy began mobilization exercises.

At one month, passive motion was full, but active flexion and abduction were limited to 10°. The strength of the right shoulder flexion and abduction was graded at 1/5, elbow extension at 0/5, and the nerve deficits persisted.

Five months postoperatively, the patient showed no neurological deficits upon evaluation, and his



FIGURE 1: Healed wound of the right shoulder of the patient at first admission



FIGURE 2: X-ray showing delayed union of the right clavicle

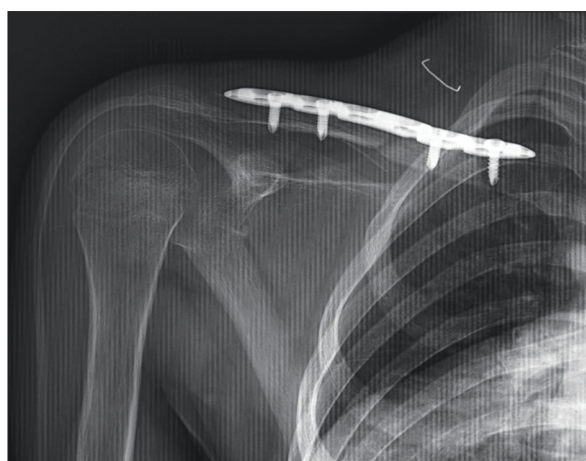


FIGURE 3: Early postoperative X-ray of the right clavicle

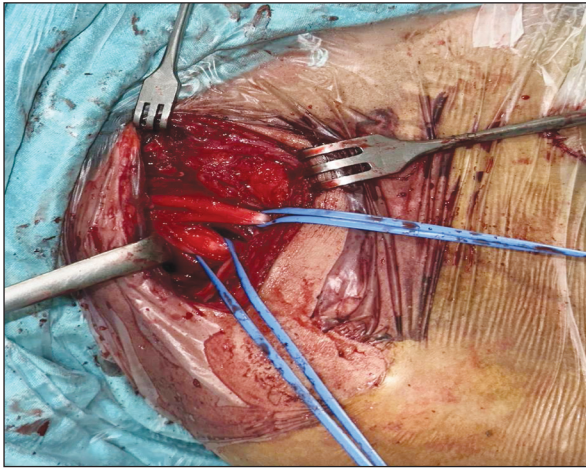


FIGURE 4: Intraoperative image of intact neural structures



FIGURE 5: X-ray of right clavicle after hardware removal

shoulder's active and passive range of motion was full and painless, without limitations. There were no signs of local infection. Hardware was removed at 13 months without complications (Figure 5 and Figure 6). A prior written consent was obtained from the patient's parents for the case presentation.

DISCUSSION

In this case, we presented a rare instance of pediatric clavicle fracture nonunion accompanied by neurological deficits and an open wound—an unusual combination not commonly reported in the literature. Surgical intervention was ultimately indicated due to persistent neurological symptoms and radiographic evidence of delayed union, despite initial conservative management. While pediatric clavicle fractures typically heal uneventfully, nonunion can occur in the presence of factors such as inadequate immobilization, soft tissue interposition, or compromised vascularity.² In our patient, the presence of neurological

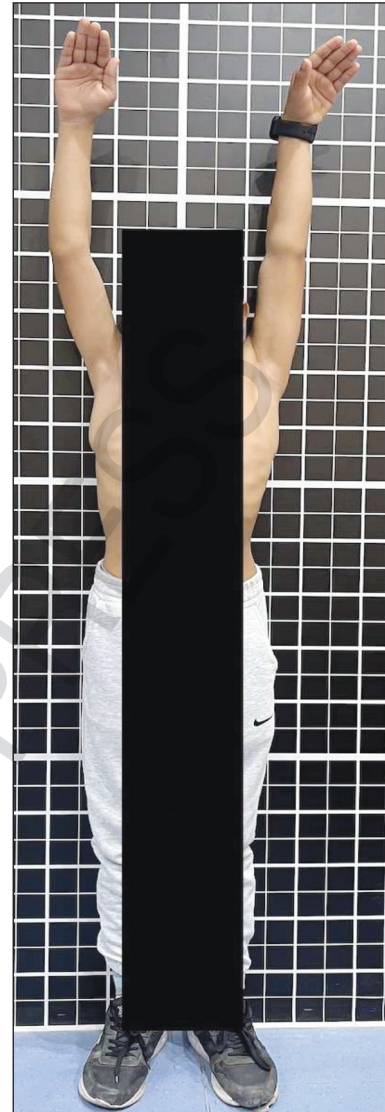


FIGURE 6: Full range of motion of both shoulder was achieved at the last follow-up

symptoms suggested possible brachial plexus involvement, which has been rarely described in similar cases. Compared to existing reports, our case highlights the importance of early recognition of atypical healing patterns and the potential need for surgical decompression and neurolysis in the presence of nerve involvement.

Pediatric clavicle fracture nonunions are infrequently reported in the literature primarily through case reports.^{2-4,7-11} Operative intervention is typically indicated for pediatric patients with open clavicle fractures or fractures associated with acute neurovascular injury.¹ However, in this instance, the out-

patient clinic opted for conservative management of both the wound and the fracture. The patient exhibited neurological deficits without signs of infection, and a delayed union was observed 3 months post-trauma.

Pediatric clavicle shaft fractures typically heal uneventfully with conservative management.^{12,13} There is insufficient evidence to definitively recommend the use of either a sling or an 8-bandage for conservative treatment.¹⁴ Recently, the number of pediatric patients receiving operative treatment for clavicle fractures has been increasing.¹² Nonetheless, conservative and operative treatment options have shown similar outcomes in children and adolescents regarding function, patient-reported outcomes, and nonunion rates.⁸ Pain control and a quicker return to activity are factors that may influence the choice of operative treatment.¹²

Although an extremely rare complication, clavicular fracture nonunion is typically treated surgically, regardless of whether the initial treatment was surgical or conservative.^{4,7} Despite the invasive nature of open reduction with plate fixation, which can compromise blood supply and cause postoperative discomfort due to skin irritation, this method has demonstrated successful union in the literature and is therefore the most commonly employed technique.⁷ Our patient's 3 months old fracture was initially managed conservatively with the expectation that union could be achieved with ongoing follow-up. However, due to the presence of neurological symptoms and the family's expectations, a decision was made to proceed with surgical intervention. Additionally, in pediatric patients, hardware removal may be necessary after union due to their growth potential, regardless of whether a plate or ESIN is used. In this case, hardware was removed 13 months postoperatively without complications, and both radiographic and clinical union were achieved.

Many authors recommend using bone grafts to achieve better union in patients.^{4,7} In the literature, pediatric clavicle nonunion patients have received bone grafts locally from the nonunion site fracture callus, from the iliac crest, or an allograft.⁴ Collecting local callus autografts from patients with atrophic

nonunion is not feasible. While iliac crest autografts are considered safe, they are invasive and can cause postoperative pain. Additionally, allografts may not be cost-effective for the healthcare system and the patient. Although we were prepared to harvest an iliac crest autograft if necessary, our patient had his atrophic bone ends minimally resected, resulting in no defects that required grafting. Thus, the patient did not receive any bone graft.

As part of a multidisciplinary approach, our patient underwent intraoperative neurolysis of the brachial plexus following surgical decompression. Neurolysis is not a common procedure in orthopedic clinics but has been previously reported as a method to alleviate neurological symptoms.¹⁵ In this case, the patient underwent decompression and neurolysis with saline, resulting in the complete resolution of all neurological symptoms.

Our study had a few limitations. Although the patient showed no signs of infection pre- and perioperatively, no infection marker work-up was conducted. Additionally, no metabolic or nutritional abnormality work-up was performed to clarify the etiology of the delayed union.

We present a unique case of pediatric clavicle delayed union accompanied by an open wound and neurological deficit. Union was achieved with ORIF using a plate, without the need for grafting. Neurological symptoms were resolved through brachial plexus decompression and neurolysis.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Murat Erem; **Design:** Murat Erem, Fırat Gülağacı; **Control/Supervision:** Murat Erem, Fırat Gülağacı, Eşref

Selçuk; Data Collection and/or Processing: Fırat Gülağacı, Savaş Yıldırım; Analysis and/or Interpretation: Savaş Yıldırım, Sami Oflaz; Literature Review: Fırat Gülağacı, Sami Oflaz; Writ-

ing the Article: Fırat Gülağacı, Eşref Selçuk, Savaş Yıldırım; Critical Review: Sami Oflaz, Murat Erem; References and Fundings: Murat Erem; Materials: Murat Erem.

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