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Case report

Radial nerve trapped posterior to the proximal fracture end after closed reduction of supracondylar humerus fracture in children: A case report

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ABSTRACT

Introduction and importance: Radial nerve injury is very common in supracondylar humerus fractures, but radial nerve entrapment between the fracture ends after closed reduction is very rare, and we report a case of radial nerve entrapment after closed reduction.
Case presentation: A 7-year-old boy was admitted to the Department of Pediatric Orthopedics 24 days after closed reduction of a supracondylar fracture of the humerus with radial nerve injury. Preoperative ultrasound showed radial nerve entrapment between the fracture ends, which was confirmed by surgery. After nerve release surgery, the radial nerve recovered well.
Clinical discussion: How to treat supracondylar humerus fractures in case of nerve damage remains controversial. We presented a rare case with radial nerve injury after supracondylar humerus fracture caused complete motor palsy in which the main trunk of the radial nerve above the right elbow traveled posterior to the fracture site. Awareness of the status of the nerve before and after surgery can help in the clinical decision to perform a concomitant nerve exploration, and in the context of this, ultrasound may be more helpful.
Conclusion: We recommend identifying the radial nerve using ultrasound during the closed reduction. If the nerve is entrapped between the fracture ends, exploration is recommended. For cases without entrapment, closed reduction with Kirschner wire fixation can be performed first, and the nerve should be re-examined with ultrasound.

1. Introduction

Supracondylar humerus fractures (SCHF) are the most frequent injury in children, accounting for 17% of all fractures. The recommended therapy for SCHF is a closed reduction with percutaneous Kirschner wire fixation, however, how to treat it in case of nerve damage remains controversial. We presented a rare case with radial nerve injury after closed reduction of SCHF, and the radial nerve was discovered to be entrapped posterior to the proximal fracture end during exploration. Thus, ultrasound should be used to examine the nerve condition during the initial treatment for SCHF combined with nerve injury. This case report was prepared in accordance with the SCARE guidelines [1].

2. Case presentation

The patient was a 7-year-old boy who presented to Shandong provincial hospital affiliated to Shandong First Medical University on July 5th 2021 with a complete right radial nerve injury. The patient complained of wrist drops. The patient had no other previous diseases and no history of oral medication. He underwent closed reduction and Kirschner wire fixation for a right SCHF 24 days ago at a local hospital, the medical records at the time showed a severe Gartland type III SCHF, however, the radial nerve condition was neglected. The only X-ray radiograph is shown in Fig. 1a, and the one before the reduction was lost by the parents. Physical examination showed the right wrist drop, dorsal extension limitation of the right wrist and fingers, loss of skin sensation over the back of the forearm and hand, and normal radial artery pulsation. The ultrasound examination revealed the main trunk of the radial nerve above the right elbow traveled posterior to the fracture site, the embedded part could not be explored by ultrasound due to bone acoustic shadowing, and the radial nerve proximal to the trapped part was hypoechoic and thickened to about 0.27 cm (Fig. 1d).

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As the radial nerve was trapped posterior to the fracture site and severely injured, the surgical exploration was performed soon by corresponding author in our hospital. Intraoperative findings revealed (Fig. 1b/c, e/f) that the radial nerve was stretched and angled with high tension, coursing closely posterior to the fracture site. The nerve could not be released unless the bone anterior to it was removed. Adhesions were found around the nerve and carefully released. The segment length of the entrapped nerve was 1 cm, with partial rupture of the outer membrane and the bundle membrane. After surgery, methylcobalamin was prescribed. 13 months after exploration, the sensory and motor functions of the radial nerve were restored completely. The patient is very satisfied with the postoperative results.

3. Discussion

Closed reduction with percutaneous Kirschner wire fixation is preferred in the treatment of SCHF, while its treatment in the presence of nerve injury remains controversial.

Some researchers suggested an open reduction and simultaneous exploration of the damaged nerve [2]. Ihsan Kitta M stated that the fracture should be explored and stabilized as soon as possible when the radial nerve injury is suspected, and that radial nerve tears were very rare but did exist after SCHF [3]. In a study by Kwok IH [4], 101 displaced extension types with medial displacement SCHF were collected, of which eight nerves were released in five cases in which nerve function didn't recover, and six of them were found to be wrapped by fibrous scar and two by bone callus. The continuity of the nerve can be confirmed by simultaneous exploration during open reduction and can be released immediately if there is compression, or repaired by anastomosis if the nerve has been already disconnected. Combining nerve exploration with open reduction ensures a better prognosis and avoids iatrogenic injuries and subsequent operations, but holds the disadvantage of being more invasive than closed reduction.

In contrast, some authors have suggested that closed reduction with Kirschner wire fixation is feasible for SCHF with nerve injury, and secondary surgical exploration should be performed only if nerve function doesn't restore. In previous literature, up to 80 % of nerve injuries with SCHF recovered spontaneously after closed reduction [5,6]. Most of the literature reported that the radial nerve recovered spontaneously at an average of 3–5 months after injury or may extend up to 7–8 months [7,8]. Shore BJ's study found that 93 % of patients with most single nerve injuries (218/244 89 %) recovered motor function 6 months after injury [9]. The advantage of closed reduction is that it avoids unnecessary nerve exploration and is less invasive, while the shortcoming is that patients with nerve entrapment or laceration still require a second surgery.

Some doctors suggested that primary closed reduction in SCHF patients with nerve palsy should be performed in the emergency room as early as possible, with the aim not to achieve complete reduction but to fully release the tension on the nerve at the fracture. They also stated that pulling on the nerve at the sharp fracture end may put the nerve at risk of laceration or rupture and that SCHF with nerve injury should be accompanied by nerve exploration if an open reduction is required to achieve satisfactory reduction [2].

For the patient in this report, good alignment and fixation was achieved during the initial surgery, but the radial nerve condition was neglected. Afterward, the radial nerve entrapment was confirmed by ultrasound and surgical exploration. Although the preoperative radiographs were lost, we could imagine that the radial nerve was trapped posterior to the proximal fracture fragment which was displaced anteriorly. During closed reduction, it was impossible to free the nerve anterior to the fracture site, so it was also entrapped posterior to the proximal end. The phenomenon is different from nerve injuries in published literature, in which the radial nerve was contused or poked by the fracture but also located anterior to the bone [10]. We have another patient with SCHF with an injured median nerve which was also trapped posterior to the proximal fracture part, and an open reduction was performed (Fig. 2).

In children with nerve palsy even after a closed reduction of the SCHF, the traditional recommendation is to closely observe the nerve recovery for 3–6 months after surgery and to perform nerve exploration if the nerve function does not recover [4,11]. It has also been suggested that exploration should also be performed within 3 months after surgery if the nerve does not recover satisfactorily, even if neurophysiology confirms the nerve continuity. Incomplete nerve damage and intact continuity do not mean that spontaneous recovery is possible [12]. In our case, although it was only 24 days after the initial surgery, the child had limited movement and sensation, and the ultrasound clearly showed that the nerve was not a simple adhesion but embedded between the fracture ends, so we promptly explored and released it surgically.

Recently, it has been suggested to combine intraoperative ultrasound to help us better decide whether to explore the radial nerve

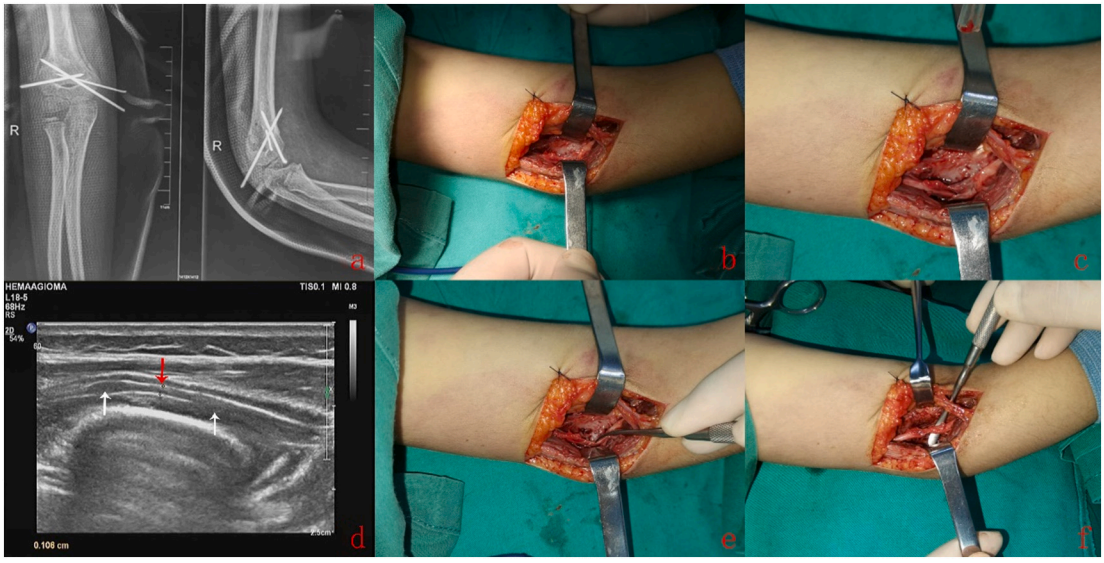

Fig. 1. a, The postoperative radiographs 24 days after the initial surgery showed the fracture was well reduced and in union. b, showed the trapped radial nerve intraoperative exploration. c showed the radial nerve after partial release. d, showed the narrowed part of the trapped radial nerve (red arrow) in ultrasound. e and f, showed continuity of the restored nerve after release.

Fig. 2. Another SCHF with an injured median nerve trapped posterior to the proximal fracture end. (The left arrow shows the fracture end and the right arrow marks the trapped median nerve.)

intraoperatively [13]. For patients with preoperative radial nerve injury, ultrasound can be used to determine the nerve condition pre-and post-closed reduction. If the nerve is discontinuous or tethered into the fracture sites, exploration should be considered. Ultrasound has some advantages for peripheral nerve injuries, including being more convenient, less costly, noninvasive, and reproducible [14,15]. Of course, it also has limitations, such as low resolution and contrast, and high requirements for experience and anatomical familiarity.

For secondary nerve exploration, procedures differ from nerve injury type, including scar release, bone callus cleanup, nerve anastomosis, or grafting. Amilo and Mora reported 36 children with a radial nerve injury in elbow fractures and found that all radial nerves were continuous and obtained functional recovery 12 months after release [16]. For cases with poor local nerve conditions, such as nerve fibrosis and neuroma, the direct anastomosis may be performed. Ihsan Kitta M presented a case of SCHF with radial nerve rupture and 2 cm defect, the nerve was sutured, and normal motor and sensory function recovered at 1-year follow-up [3]. In cases with a large defect, nerve grafting can be performed, often using a peroneal nerve graft. Martin DF reported [17] that a child had radial nerve fibrosis after SCHF and the proximal nerve part retracted to the axilla, leaving an 18 cm defect after resection, so three segments of the gastrocnemius nerve were taken bilaterally to bridge the nerve which gained function restoration 1 year later. In patients with poor nerve grafting results, functional reconstruction with tendon transfer may be used [18,19].

4. Conclusion

We recommend identifying the radial nerve using ultrasound during the closed reduction. If the nerve is entrapped between the fracture ends, exploration is recommended. For cases without entrapment, closed reduction with Kirschner wire fixation can be performed first, and the nerve should be re-examined with ultrasound. And if a nerve rupture or entrapment between the fracture ends exists, exploration should be performed immediately. For open injuries, vascular injuries, and difficult-to-reduced SCHFs, direct open reduction and nerve exploration is preferred.

Consent

Written informed consent was obtained from the patient next of kin for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Conception and writing paper: Li Tianyou, Wang Jiaqi, Li Hui.
Acquisition of data, interpretation of data and editing: Wang Yanzhou, Li Long, Li Hui.
Li Tianyou and Wang Yanzhou performed the operation, senior author and supervisor and revised the manuscript.
Wang Jiaqi and Li Hui are the co-first author.

Declaration of competing interest

None.

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