■ CASE REPORT

Complete division of the radial nerve associated with a closed fracture of the humeral shaft in a child

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The management of closed fractures of the humerus with an associated nerve palsy remains controversial. With very little written about this injury in children, we present the case of a three-year-old child with a closed humeral shaft fracture in whom surgical exploration and reconstruction of the radial nerve with a sural nerve graft was performed three months after injury. The child regained full function. To the best of our knowledge, this is the first such case to be reported in the English literature.

It is estimated that 237 000 fractures of the humerus occur in the USA each year.¹ The radial nerve is injured in approximately 18% of humeral shaft fractures,² making radial nerve palsy following humeral shaft fracture the most common nerve lesion associated with a long-bone fracture.³ Radial neuropraxia is most commonly associated with a transverse midshaft humeral fracture.³ The majority of such patients reported in the literature are adults.²⁻²²

The current case is, to our knowledge, the first report of a complete division of the radial nerve associated with a closed fracture of the humeral shaft in a child.

Case report

A three-year-old girl sustained an isolated closed transverse fracture of the left humeral shaft in a motor vehicle accident (Fig. 1). At presentation she was unable to extend her wrist and fingers. Sensory examination was difficult because of her age. The findings were consistent with a radial nerve palsy. The fracture was managed by bracing, and a custom-made cock-up splint for her wrist and hand. The fracture healed uneventfully by ten weeks (Fig. 2). However, at three months, the radial nerve showed no signs of clinical recovery. Nerve conduction and electromyogram studies were performed and no signs of recovery detected. Surgical exploration of the radial nerve was therefore recommended.

The humerus was exposed through a direct lateral approach between the triceps and brachialis. The distal end of the nerve was found at the junction of the middle and

distal thirds of the humerus. The proximal end, however, could not be seen. A separate medial approach was performed and the proximal end of the nerve was found to have retracted to the level of the junction of the proximal and middle thirds of the humerus. Nerve grafting with three cable grafts from the sural nerve (measuring 8 cm) was performed to bridge the gap (Fig. 3).

The arm was immobilised for ten days. Six months post-operatively, she had regained full function with complete return of extension of the wrist and fingers and thumb (Fig. 4).

Discussion

Injury to the radial nerve can cause significant disability and a thorough clinical examination is important following humeral fracture. Inability to extend the wrist and fingers associated with loss of function of the brachioradialis and extensor carpi radialis longus and brevis are an indication of such an injury of the nerve. Early diagnosis allows appropriate treatment and counselling of the patient and family. Examination can be difficult and unreliable in a young child.

Electrodiagnostic tests, including nerve conduction and electromyogram studies, can be very helpful. Electrodiagnostic studies should be performed if clinical evidence of radial nerve recovery is not present three months after a closed humeral fracture. This reduces the need for these invasive tests in the majority of children, but allows effective care and treatment when nerve repair or grafting is required.

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Fig. 1

Anteroposterior radiographs of the left humerus on the day of injury.

Fig. 2

Anteroposterior radiograph showing fracture healing at ten weeks.

Radial nerve palsy is most commonly seen in transverse (21.2%) and spiral fractures (19.8%) compared with oblique (8.4%) and comminuted (6.8%) fractures.³ The risk of laceration or division is increased in open injuries of the humerus.^{1,7,11,19} Therefore, exploration of the radial nerve at the time of initial debridement of open fractures and subsequent repair or grafting, is generally accepted. In the case of an intact nerve, neurolysis may be performed, but usually continued observation and monitoring is recommended, as the first signs of nerve recovery may not occur for up to four to six months. By contrast, in closed injuries, the radial nerve is intact in the majority of cases and the prognosis for complete or near complete recovery is good.^{2,4,15,18-21} Early surgical exploration in a closed injury may be indicated when transection of the radial nerve is suspected in a comminuted humeral fracture with associated loss of radial nerve function.¹⁹ Division of the radial nerve in association with closed fracture of the humerus is unusual. In one series, only 4% of patients with radial nerve palsy had division of the nerve; therefore, most patients with humeral shaft fractures had a nerve still in continuity.¹⁵ This is supported by the > 70% rate of spontaneous recovery in patients initially observed.^{3,11,13} Some recommend early exploration if paralysis occurs after the manipulation of a closed fracture, but this is debatable.^{4,22,23}

Holstein and Lewis⁸ described a distal third humeral fracture and radial nerve palsy syndrome. They warned that closed reduction can lead to additional injury. However, the nerve is rarely entrapped as originally described.¹⁹ Given that only a few radial nerve injuries treated closed will fail to recover spontaneously many advocate an initial

period of observation.^{2,4,15,18-21} Initial observation avoids the associated risks such as anaesthesia, wound infection, osteomyelitis, and iatrogenic nerve injury.

The timing of delayed exploration has been argued. The mean time to the onset of recovery is 7.3 weeks. However, the first signs may not present in some cases until four to six months after injury.³ Omer¹³ reported that 80% will recover within four months because the injuries are neuropraxic or axonotmetic in nature. Nerve regeneration takes place at approximately one mm per day.²⁴ If the distance from the origin of brachioradialis (2 cm above the lateral epicondyle) to the midshaft fracture of the humerus (about 12 cm above the lateral epicondyle) is measured the total length of regeneration required is approximately 10 cm. Therefore, function in brachioradialis should return in 90 to 120 days. Seddon²⁵ reported the importance of reducing the interval between injury and repair. Shergill et al²⁶ found that repairs undertaken after 12 months failed, 28% of those carried out between 15 and 440 days achieved good results, and 49% of those carried out within 14 days had good results.

If at exploration, the nerve is divided, primary repair or grafting of the nerve is necessary. Primary repair has been recommended if it can be performed without significant tension and if there is no evidence of widespread nerve damage. However, the results of primary nerve repair have been poor.^{1,9,16} Shergill et al²⁶ found that the violence of the injury was the most important factor in determining the outcome of repair. By contrast with primary repair, the reported results of nerve grafting are better.^{4,18,27,28} The extent of the gap to be closed is the main indication for nerve grafting.²⁵ Tension-free repair and resection of the

Fig. 3a

Fig. 3b

Sural nerve graft reconstruction.

Fig. 4a

Fig. 4b

Showing active extension of wrist with fingers.

scarred nerve facilitate recovery. The sural nerve is frequently used. This nerve is easily harvested, offers good functional results, and produces minimal side effects.⁴ Functional recovery at 26 months in deficits of 7 cm to 14 cm treated with sural nerve graft have been reported.²⁷

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