Advantages of simultaneous radial nerve and tendon reconstruction – a case report

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Summary
Transection of the radial nerve is frequently associated with humeral shaft fractures that are part of a very complex upper extremity injury. In the presented case, a 19-year-old man with a 10-cm radial nerve defect with a need for nerve grafting to recover complete sensory and motor deficit of the radial nerve. In our case, at the same time we provided the tendon transfer of musculus (m.) pronator teres to m. extensor carpi radialis brevis, m. flexor carpi ulnaris to m. extensor digitorum communis, m. palmaris longus to m. extensor pollicis longus, and long sural nerve graft because of an extensive zone of the injury. The assumption was that if these two procedures are performed in one surgery, it will accelerate overall recovery, restore the functionality of the upper limb more quickly, and thus enable a faster recovery.

Key words
nerve reconstruction – radial nerve injury – tendon transfer – humeral shaft fracture

Introduction
Nerve defects are one of the most challenging surgical problems. Radial nerve injury is a complication associated with humeral shaft fractures. It belongs among the most prevailing peripheral nerve injuries associated with fractures of long bones. In general, with these types of injuries, the success and speed of recovery is much better in young people, while healing is also related to the degree of injury, its extent and whether there were other associated traumas at the time of injury. Autologous nerve grafts are the gold standard in peripheral nerve reconstruction in nerve injuries that cannot be bridged by direct epineural suturing. In this case report we present a young man who suffered a work injury of the right humerus with radial nerve trauma. In order to improve the motor function, a muscle transposition with a nerve grafting for peripheral nerve injury with extended defect size was performed in one-stage surgery.

Case report
We present a case of a 19-year-old man, without medical history, who suffered an injury in an accident at work. His hand in a glove was caught in a conveyor belt and he suffered a humeral bone fracture with a radial nerve injury. Before surgery, clear clinical signs of paresis of the radial nerve were detected. The right humeral shaft fracture was an indication for acute surgery. The fracture was treated by open reduction and internal fixation with plate osteosynthesis (Fig. 1). A defect of the radial nerve in the length of 10 cm was found intraoperatively. The level of radial nerve injury was the middle part of the humerus. Because the plastic surgeon was not part of the operative team, the founded ends of the radial nerve were marked with non-absorbable monofilament blue 4/0 suture. The second surgery followed after 16 days. The procedure was performed under general anaesthesia in a bloodless operating field with arm abducted under tourniquet control (Fig. 2). The nerve gap was bridged by sural nerve graft, the length of the nerve graft was 12 cm (Fig. 3). The graft was taken from the right leg and sutured to both ends of the radial nerve with 3 cables using nylon 9/0 and 10/0. At the same time, multiple transpositions were performed. To provide wrist extension, distal tendon of m. pronator teres (PT) was transferred to the tendon part of m. extensor carpi radialis brevis (ECRB) using end to side suture technique. This manoeuvre reconstructed the dorsiflexion of the wrist. All following tendons were sutured end to end. The m. flexor carpi ulnaris (FCU) tendon to the tendon part of the m. extensor digitorum communis, restoring…
finger extension, and m. palmaris longus (PL) tendon to m. extensor pollicis longus (EPL), restoring thumb extension. These transfers were sutured using (4/0 non-absorbable) sutures with the Pulvertaft weave technique. The tendons were transferred and sutured in the required tension, so free movement of the hand into flexion and extension was secured. The intraoperative tension of tendon transfers was tight enough to provide full extension of the wrist and digits. The wrist was kept in 30-degree extension with thumb and fingers just short of full extension. The forearm was immobilised in the volar cast with elbow flexed and distal joints in maximal extension. Postoperative rigid fixation in the extension of fingers and wrists was applied for four weeks, assisted physiotherapy began immediately after the wound had healed. The patient received fifteen physiotherapeutic sessions. Electrostimulation of the forearm muscles was performed daily. The rehabilitation aimed to maintain the passive motion of various joints and to limit the risk of adhesions. Abduction of thumb carpometacarpal and interphalangeal joint extension returned to normal range. The patient returned to his work seven months after the second surgery. One and a half years after the surgical solution postoperative measurement of sensitivity by the Semmes-Weinstein monofilament test was determined. A two-point discrimination sensitivity of the dorsum of the hand and fingers was 12 mm. In motor terms, the grade was evaluated at M4 (Fig. 4).

Discussion
In an updated systematic review, Ilyas et al. claim that in the observation of 7,262 humeral shaft fractures, the overall prevalence of radial nerve palsy was 12.3% (890/7,262) [1]. In Ring’s study, it has been shown that injury on the upper limbs, especially on the radial nerves, occurs more often in men than in women. It is attributed to certain factors such as

Fig. 1. X-ray images of right humeral shaft fracture before and after the treatment by open reduction and internal fixation with plate osteosynthesis.

Fig. 2. Surface marking as well as functional identification of the tendons was an important aspect of preoperative planning.
The appropriate time to perform transfers for radial nerve palsy is controversial. Early transfer of PT to ECRB is advocated and recommended by many authors. The authors believed that the greatest functional loss in a patient with radial nerve injury is weakness of power grip. Burkhalter [9] advocated for an early PT to ECRB transfer to eliminate the need for an external splint, and, at the same time, to restore a significant amount of power grip to the patient’s hand.

The authors are convinced that even PL to EPL transfer has no impact on hand function and can also be performed immediately. Early FCU to ED II–V transfer is probably the most controversial, yet we believe that preserving maximal hand function and maintaining finger range of motion is more important than limiting it by partial loss of FCU function. Should restitution of extensor function occur, the transfer can be reversed.
Nerve transpositions provide another option for reconstruction of a paresis of the n. radialis. They are based on the assumption that the nervus medianus provides several dispensable branches for FDS available for transfer. Branches for the PL, pronator quadratus, and m. flexor carpi radialis (FCR) can be taken advantage of if these muscles are not needed for future tendon transfer [13]. However, the advantage of tendon transposition over nerve transposition is the immediate possibility of function; there is no need to wait for reinnervation results.

When direct nerve repair is not feasible due to a significant gap between the nerve endings, an autologous nerve graft is chosen to repair the nerve defect. From all the large nerves, the radial nerve is the most suitable for nerve suturing and the use of nerve grafts, because it contains mostly motor fibres and the site of nerve injury is usually close to the motor plates [9,13–15]. In the literature, it is stated that autologous nerve grafts are preferred over nerve conduits for gaps longer than (> 3 cm), for more proximal injuries and for critical nerves [16]. However, if it is not possible to use an autologous nerve graft, e.g. in patients with extensive peripheral nerve injury or insufficient amount of donor nerve for harvest, effective alternatives such as acellular nerve allografts, artificial nerve repair conduits or venous conduits can be chosen [17].

Conclusion

There is no surgical procedure that can be recommended to serve as a standard for any patient in this circumstance related to such an extensive zone of injury. Both methods, tendon transfers and nerve grafting can be used to repair the damage of radial nerve due to any aetiology. The main idea behind this surgery was to perform both procedures at the same time and thereby shorten the time from the injury to a good functional result. In order to shorten the limb's own functionality, we used this combined procedure because the actual neurotisation would take a very long time and the patient needed to be self-sufficient as a priority for his own sustenance and survival. As a standard, tendon transpositions are only used when there is no motor reinnervation of the muscles. Practically, the surgeon must tailor the surgery to the patient's needs. It is necessary to develop a unique and generally accepted evaluation scheme for the results of tendon transfers and nerve grafting that will enable comparisons of results achieved.

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References

Diabetes is a chronic disease that affects the body's ability to use food for energy. It is caused by problems with the hormone insulin, which is produced by the pancreas. Insulin is important because it allows the body to use the sugar from food for energy. There are two main types of diabetes: type 1 and type 2.

Type 1 diabetes is an autoimmune disease in which the body's immune system attacks and destroys the beta cells in the pancreas that make insulin. This type of diabetes usually occurs in children and young adults. People with type 1 diabetes must take insulin daily to manage their blood sugar levels.

Type 2 diabetes is a chronic disease in which the body's cells do not respond normally to insulin. This can lead to high blood sugar levels. Type 2 diabetes is more common in adults, but it can also affect children. People with type 2 diabetes may be able to manage their blood sugar levels with diet, exercise, and other lifestyle changes.

In the United States, diabetes is the leading cause of death due to chronic disease and is a significant cause of vision loss, kidney failure, heart disease, and stroke. The American Diabetes Association estimates that 30.2 million people in the United States have diabetes, or about 9% of the population.

Diabetes can be managed through a combination of medication, lifestyle changes, and regular medical care. Treatment may include physical activity, a healthy diet, medication, and blood sugar monitoring. People with diabetes should work closely with their healthcare provider to develop a treatment plan that works for them.

In summary, diabetes is a chronic disease that affects the body's ability to use food for energy. It is caused by problems with the hormone insulin and can be managed through a combination of medication, lifestyle changes, and regular medical care. It is important for people with diabetes to work closely with their healthcare provider to develop a treatment plan that works for them.