Double-Flexor Tendon Transfer for Radial Nerve Laceration Secondary to Holstein-Lewis Fracture: A Case Report

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Abstract: The purpose of this article is to present a case where a double flexor tendon transfer was used to restore thumb, finger and wrist extension in a patient who sustained a complete radial nerve transection secondary to a distal humeral shaft or Holstein-Lewis Fracture. The patient in this case sustained his injury during a motor vehicle collision. He subsequently underwent open reduction and internal fixation (ORIF) with exploration of his radial nerve, which was completely transected. The patient then underwent tendon transfer to restore his thumb, finger and wrist function. Tendon transfers using Flexor Carpi Ulnaris, Flexor Digitorum Superficialis, and Pronator Teres were utilized to restore function. Typically, it is not ideal to utilize two flexor tendons, but because the patient lacked a Palmaris Longus, necessary in this case. When performing such a procedure it is expected that wrist and digital flexion will be negatively impacted which was not seen in this case.

Key Words: Holstein-Lewis fracture, distal humeral shaft fracture, radial nerve palsy, radial nerve transection, radial nerve tendon transfer

Introduction

Humeral shaft fractures account for approximately 3% of all long bone fractures and nearly 237,000 of these fractures occur each year in the United States. Holstein Lewis Fractures (HLF), or extra-articular fractures in the distal third of the humeral shaft are a special subset of distal third humeral shaft fractures. Holstein Lewis Fractures are defined as a distal third humeral shaft fracture with associated radial nerve palsy. These injuries are typically associated with a higher energy trauma and most commonly affect male patients under the age of 35.[1,2] The anatomical location of the radial nerve is what predisposes it to injury in these types of fractures. As the nerve courses from medial to lateral it courses through the spiral groove. It's this close association between the nerve and bone that predisposes the nerve to injury. In the distal third the nerve is in direct contact with the humerus near the lateral supracondylar ridge where the nerve pierces the lateral intermuscular septum coursing along the surface of the brachialis muscle. This anatomical structure decreases nerve mobility and is said to contribute to nerve injuries at this point in the humerus.[5] With displaced distal humerus fractures the distal bone fragments can displace oftentimes trapping the radial nerve within the fracture site. In fractures where there is minimal to no displacement radial nerve injuries are much less common.[3] Loss of radial nerve function will result in severe disability as it innervates the muscles responsible for elbow, wrist, thumb and finger extension.[4,5]

The management of the humerus in HLF is generally agreed upon. The fracture is treated with compression plating to ensure stabilization and union. The management of radial nerve injury associated with HLF is much more controversial. With open fractures exploration is generally recommended, but in closed fractures such as the one in this case study, exploration is not routinely recommended. The reason for this is because spontaneous nerve recovery occurs approximately 87.3% of the time.[1] Early exploration is recommended in cases of complete nerve laceration with spiral oblique fractures, such as the one seen in this case.[1] Tendon transfers are recommended for those with irreparable radial nerve injury. Most commonly a flexor carpi ulnaris (FCU), pronator teres (PT), and palmaris longus (PL) tendons are used as transfers to Extensor Digitorum Communis (EDC), Extensor Carpi Radialis Brevis (ECRB) and Extensor Pollicis Longus (EPL) respectively. In our case the patient lacked a palmaris longus. With this deficiency the Flexor Digitorum Superficialis (FDS) to the long finger was used as a substitute creating a double flexor tendon graft.[6]

Case Report

A 21-year-old male patient who presented to the office three days following a motor vehicle collision (MVC). During the injury he sustained a distal third humeral shaft fracture. While in the ER the patient was splinted and given referral to an Orthopaedic Surgeon. The patient presented with complaints discomfort, stiffness, soreness, numbness, tingling, tenderness, instability, popping grinding, and swelling. Radiographs revealed an acute traumatic closed distal right humerus fracture of the diaphysis with angulation, displacement, and comminution. Upon physical exam at initial evaluation the patient was unable to extend his fingers or his wrist and had no sensation overlying the dorsum of thumb.

The nature of the fracture warranted an open reduction internal fixation (ORIF) to ensure proper healing. An ORIF with plate and screw construct via Smith and Nephew was utilized. During the course of the procedure the radial nerve was dissected and identified. A complete transection and a large stretch of bruising and retraction the radial nerve was noted. Injury to the nerve spanned approximately 4 cm, and the severed ends were completely retracted. The nerve was then evaluated for possible direct repair at that time, it was determined that the nerve would not be amenable to repair and a double flexor tendon transfer would be necessary to restore function. After the completed ORIF the patient had retained full function in the median and ulnar nerve distribution as observed prior to the procedure, but he was still unable to extend his wrist, thumb, or fingers. It was determined the patient would need tendon transfers to correct his radial nerve transection.

A tendon transfer would be made more complicated because the patient did not have a palmaris longus. As a result, the tendon FDS of the long finger was transplanted to the EPL to achieve thumb extension. PT tendon was transplanted to ECRB to achieve wrist extension and lastly, the FCR was utilized to restore digital extension. The harvested tendons were transferred from the volar side of the wrist to the extensor side of the forearm and were attached using a Pulvertaft weave. A long arm splint was applied, immobilizing the elbow in neutral with wrist in extension and digits in extension. Ten days post-surgery the patient was fitted with a custom splint, and 14 weeks post-surgery physical therapy began. The patient recovered remarkably well. At four months post-surgery full flexion of all digits, the wrist, and elbow as well as, full digital, wrist, and elbow extension had been achieved.

Discussion

Holstein Lewis Fractures represent a unique subset of distal humerus fractures. Standard treatment with compression plating is necessary for fracture stabilization, but the management of radial nerve injuries becomes much more controversial.[1] In closed fractures the initial management of the nerve palsy is close observation.[1,7] This has been shown to have excellent results with nearly 87% of patients having complete return of radial nerve function.[1,7] When ORIF is performed for HLF care must be taken to correctly identify and dissect the radial nerve. The integrity of the nerve must then be inspected.[1,7] In this case, the patient presented with a fracture pattern that required operative intervention. During the initial operation the nerve was explored and was found to be completely transected and retracted. Given the complete transection direct repair was not amenable.

This case presented a challenge as the patient did not have a palmaris longus tendon. The palmaris longus tendon is the preferred tendon to restore function to the EPL because it can restore function without creating a functional compromise of FDS.[8] With lack of a palmaris longus the FDS tendon is used as a substitute in this case. The PT was used as a transfer to ECRB to regain wrist extension and the FCU tendon was used to restore finger extensions by transferring it to EDC. With tendon transfers the surgery is only one small component of the process. Coordinated and structured physical therapy is paramount to a successful surgery. The patient recovered remarkably well, as full digital, wrist and elbow range of motion were restored. The typical deficit thought to result from a double wrist flexor transplant was not seen in this case, the patient was not only able to maintain digital and wrist flexion with little to no impairment as well as regain full digital, thumb, and wrist flexion.[5] This case demonstrates that in the absence of a palmaris longus tendon thumb function can be restored by using one of the FDS tendons instead. The outcomes of this case show that not only can wrist and hand extension be restored by using flexor tendon transfers, but wrist and hand flexion was not affected by the transfers. Additional research is needed to determine if utilizing the FDS tendon has more favorable outcomes than utilizing PL.

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