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Surgical management and outcome of iatrogenic radial nerve injection injuries

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ABSTRACT

Objective: Iatrogenic injury to the radial nerve can occur following intramuscular or intravenous injections of the upper extremity. In this study, we review the injury mechanism, operative techniques, and outcomes of patients evaluated for radial nerve injection injuries.
Methods: Data from 33 patients evaluated by the senior authors (DGK and DHK) from 1970–2011 with radial nerve injection injuries were reviewed retrospectively. All patients had injury of the nerve during injection. All corrective operations involved the use of direct intraoperative nerve action potential (NAP) recordings and either neurolysis, neurectomy, or suture/graft repair. The Louisiana State University Health Science (LSUHS) grading system was used for clinical assessment.
Results: Of the 33 patients, 23 underwent surgical intervention for persistent neurological deficit and/or pain. Of the 24 patients evaluated for injuries at the arm level, 17 required surgical exploration and repair for persistent symptoms. Nine patients required external neurolysis because the lesions were in continuity and positive NAP recording was across the lesion. All of these patients achieved a Grade 4 or better in functional recovery. Eight patients with lesions in continuity but in which NAP could not be recorded underwent either end-to-end suture (7) or graft repair (1) following resection of a 3.0 cm non-recordable segment. All patients achieved Grade 3 or 4 functional recovery. Six patients with forearm injuries involving the superficial sensory branch of radial nerve underwent either neurolysis (3) or neurectomy (3).
Conclusions: Surgical exploration may be indicated when pain or disabling motor deficits persist. Early diagnosis and operative intervention can achieve favorable outcomes through exploration and radial nerve repair.

1. Introduction

The radial nerve (RN) is a commonly injured nerve in the upper extremity, and injuries following injection procedures are responsible for nearly half of such injuries [1–11]. Considering the high frequency of intramuscular injections into the upper extremity, and intravenous access to the cephalic vein, the incidence of injuries to the radial nerve may be underreported. Injury to the RN can result in significant functional motor impairment of the arm and wrist, as well as numbness, pain, and even paralysis [4,9,12,13]. Injury to this nerve affects the ability to extend the forearm, wrist, and fingers, which leads to a decline in the ability to grasp by loss of flexion at the distal interphalangeal joint by the flexor digitorum profundus. Sensory deficits as a result of RN injury are functionally less significant because they involve the anatomical snuffbox and the radial dorsum of the hand, but painful hyperesthesia can be debilitating. RN recovery depends on the extent of nerve damage, amount and toxicity of the injected solution, the internal structure of the nerve at the site of injury [4], and the predominance of motor fibers which can reduce the possibility of cross motor-sensory reinnervation. In this study we review the injury mechanism of 33 patients evaluated by two surgeons over a period of four decades. We present the surgical anatomy of the radial nerve and the outcomes of 23 patients who underwent surgical exploration and repair.

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Table 1
Surgical procedures for radial nerve injection injuries (RNIIs).

Location of RNII	No. of Cases evaluated	No. surgically treated	Procedure
Arm level	24	17	Neurolysis = 9 Suture = 7 Graft = 1
Forearm level	9	6	Neurolysis = 3 Neurectomy = 3

2. Materials and methods

2.1. Patient population

Between 1970 and 2011, 33 patients with RN lesions resulting from injections were evaluated retrospectively to assess functional outcome. The lesions were monitored clinically and by needle electromyography (EMG) for several months for signs of early regeneration. If spontaneous regeneration did not occur, surgical exploration and intraoperative NAP recordings were used to determine whether the lesions required repair by nerve grafts or end-to-end suture. The minimum follow-up period was 12 months, and the mean follow-up period was 18 months. The patients' age ranged from 8 to 64 years (mean, 42 years). Twenty-three patients with severely damaged or poorly recovering lesions underwent surgical exploration and repair. 17 patients had lesions at the upper arm level and 6 had lesions at the elbow/forearm level (Table 1). Patients underwent preoperative and postoperative clinical assessment of functional impairment using the Louisiana State University Health Science (LSUHS) grading system (Table 2). Each patient's initial impairment of motor function and recovery at the time of each follow-up was assessed. Using the LSUHS scale Grade 3 or better recovery was considered a favorable functional outcome.

3. Surgical anatomy

3.1. Radial nerve in the arm

The proximal RN is the larger of the two terminal branches of the posterior cord of the brachial plexus, supplying the triceps, anconeus, brachioradialis, extensor carpi radialis longus (ECRL), and extensor carpi radialis brevis (ECRB) muscles. The nerve passes laterally and posteriorly to the profunda brachii artery, running deeply with respect to the long head of the triceps, and then across the posterior surface of the humerus. It then courses along the spiral groove under the cover of the lateral head of the triceps muscle (Fig. 1).

When the RN reaches the lateral border of the medial head of the triceps, it pierces the lateral intermuscular septum and crosses laterally and anteriorly to the humerus. The RN then supplies one or two branches to the brachioradialis muscle 2–3 cm proximal to the elbow and 7–8 cm distal to the humeral groove [3]. The nerve enters and is bounded by the brachialis medially and brachioradialis anterolaterally. The brachialis receives a dual nerve supply from the radial and musculocutaneous nerves, which results in a lack of brachialis muscle weakness in a patient suffering from a radial palsy.

3.2. Radial nerve at the elbow

The RN sits in a groove between the brachialis and brachioradialis muscles. The motor branch to the brachioradialis muscle originates approximately 2 or 3 cm proximal to the elbow and 7 or 8 cm distal to the humeral groove. Several branches of the RN in the distal arm proximal to the elbow also contribute a motor supply to the brachioradialis muscle. The RN also provides input to the ECRL muscle before it splits into the PIN and SSRN.

Near the lateral intermuscular septum, the RN has two cutaneous branches: the inferior lateral brachial cutaneous and the posterior antebrachial cutaneous. The inferior lateral brachial cutaneous branch is also known as the upper branch of the posterior antebrachial cutaneous. This branch pierces the deep fascia close to the lower brachial portion of the cephalic vein and supplies the skin that lies over approximately the lower half of the lateral and anterior aspects of the arm. The posterior antebrachial cutaneous branch is the lower and larger of the two cutaneous branches.

The RN divides into the superficial sensory radial nerve (SSRN) and the deeper posterior interosseous nerve (PIN) in the antecubital fossa under the cover of the brachialis and ECRL muscles (Fig. 2). The SSRN traditionally innervates the radial dorsum of the hand and the thenar web space, while the PIN innervates the extensor muscles in the back of the forearm, except the ECRL, and contains afferent fibers from the wrist joint.

3.3. Superior sensory radial nerve

The SSRN runs distally in the forearm under the edge of the brachioradialis muscle lateral to the radial artery. In this superfi-

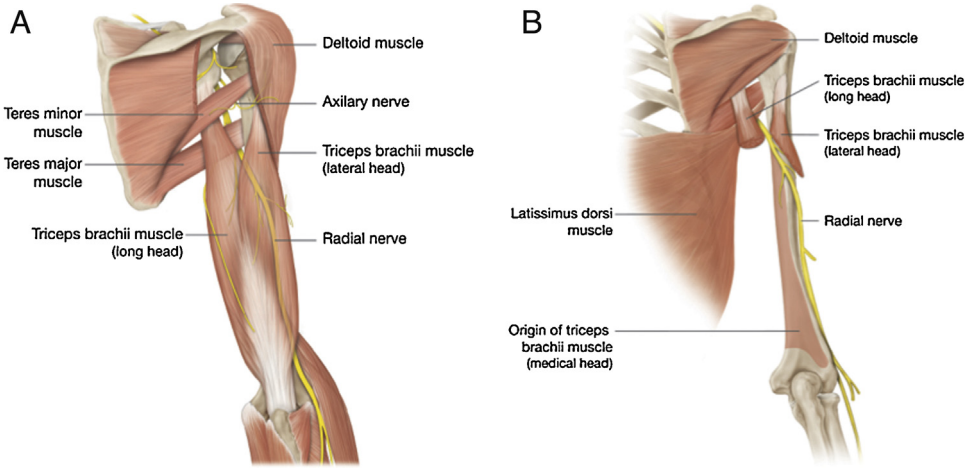

Fig. 1. (A) The radial nerve lies deep to the long head and between the lateral and medial heads of the triceps brachii in the spiral groove. (B) On removing the long and lateral heads of the triceps brachii, the radial nerve can be seen at the spiral groove. Injection should be given between the acromion and deltoid tuberosity due to the superficiality of the radial nerve in the mid-third of the arm.