Radial tunnel syndrome

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Abstract

Radial tunnel syndrome is an entrapment neuropathy of the radial nerve as it passes through the radial tunnel, from the level of the head of the radius to the distal edge of the supinator muscle. There are four potential sites of compression within the radial tunnel. The first is by fibrous bands lying anterior to the radial head at the entrance to the tunnel. The second site occurs at the radial recurrent vessels, lying across the radial nerve. The third potential site of compression occurs at the tendinous margin of the extensor carpi radialis brevis muscle. The fourth, and most common site, is at the arcade of Fröhse. Recently a fifth site has been identified: a fascial arcade is often present lining the deep surface of the superficial head of the supinator muscle and this band can exert pressure on the posterior interosseous branch of the radial nerve just before it emerges from beneath that muscle. The diagnosis is confirmed by diagnostic nerve block and surgical decompression is an effective form of treatment.

Keywords entrapment neuropathy; posterior interosseous nerve; radial nerve; radial tunnel syndrome

Pathophysiology of compression neuropathies

The initiating mechanism in the neurologic disturbance of a compression neuropathy is often uncertain in any particular patient; in one patient an ionic lesion may be prominent as an initiating factor, while in another a mechanical or vascular lesion may produce the initial symptoms. The vascular lesion seems to be the most understandable from the pathophysiological standpoint.[1] Segmental vascular supply to the nerve trunk is carried in a mesoneurium.[2] The smaller vessels enter the epineurium and divide into ascending and descending epineural branches. These form an anastomotic network in the sub-epineurium and then divide into a vascular plexus on the perineurium. The capillary bed within the nerve itself is contained within the fascicles of the nerve.[2] Obstruction of the venous return from the nerve initially causes venous congestion in the epineural and perineural vascular plexuses and a generalized slowing of circulation within the nerve trunk. Hypoxia of the nerve trunk follows and this leads to dilatation of the small vessels and capillaries within the nerve and endoneural œdema results.[3,4] The swelling of the nerve increases the effect of the original compression, with further slowing of venous return. If this is allowed to persist for prolonged periods fibroblasts proliferate within the nerve with consequent scarring.[5]

When a nerve is rendered relatively ischæmic by reduced blood flow (possibly as small a reduction as 30%—50% of normal) the resultant loss of oxidative phosphorylation and high energy phosphate will lead to some decreased efficiency of the sodium pump and the axoplasmic transport system, and some reduction of maintenance of the cell membrane; this in turn will lead to a loss of conduction and transmission by the axon.[5] This ischæmia of the segment of an axon, brought about by either a change in position, local anatomy or internal pressure, alters the ionic relationship between the axon and its environment further aggravating the normal internal pressure of the nerve trunk resulting in a deterioration of its normal function. The swift reversibility of intra-operative motor conduction latencies associated with carpal tunnel syndrome suggests that this vascular lesion may be paramount in the ætiology of a compression neuropathy.[1] The results of a study in a paper by Thurston and Krause in which they measured pressures within the carpal tunnel and demonstrated a congestive phenomenon in carpal tunnel syndrome would support this.[6]

Radial tunnel syndrome

> *"The radial tunnel syndrome,[7,8] a compression neuropathy of the radial nerve from the radial head to the supinator muscle, is the most common entrapment neuropathy of the radial nerve. A patient with this syndrome presents with aching pain in the extensor-supinator muscle mass in the proximal forearm that commonly radiates to the distal arm and distal forearm. If the fascicles of the superficial radial nerve are involved in the entrapment, radial to the dorsal radial aspect of the hand and dysesthesias and paresthesias in the superficial radial distribution can be found. Two point discrimination testing of the superficial radial nerve has not been helpful in my patients."*
>
> Eversman,
> "Green's Operative Hand Surgery"[9]

Although this information is some 20 years old now there have been no significant advances in the understanding either of radial tunnel syndrome (RTS) or of its diagnosis and management.

Anatomy

There are four potential sites of compression within the radial tunnel.[10] The first is by fibrous bands lying anterior to the radial head at the entrance to the tunnel. The second site occurs at a fan-shaped leash of vessels (the radial recurrent vessels, the so-called leash of Henry) lying across the radial nerve and supplying the brachioradialis and extensor carpi radialis longus muscles. The third potential site of compression occurs at the tendinous margin of the extensor carpi radialis brevis (ECRB) muscle. Laulan et al. reported the results of an anatomical study of 45 upper limbs from 40 cadavers in which the relationship between the medial edge of the ECRB and the posterior interosseous nerve (PIN). The medial edge of the ECRB was a real fibrous arch in 43 cases (95%). It crossed over the PIN in 42 cases (93% of cases), 9 mm more proximally than the arcade of Fröhse[11] (*vide infra*).

The fourth, and most common site; is at the arcade of Fröhse (Figure 1a and b) a fibrous band that lies immediately across the PIN as it enters the interval between the two layers of the supinator muscle. Recently a fifth cause of RTS has been described.[12] As the PIN passes through the supinator muscle and exits along

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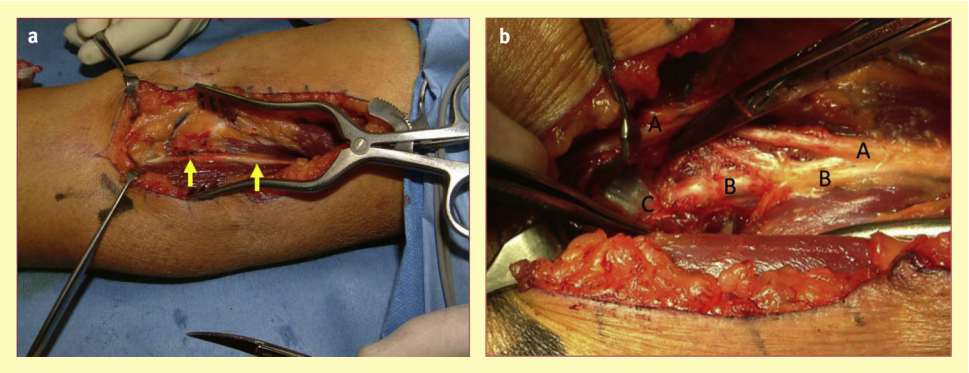

Figure 1 (a) Decompression of radial tunnel — anterior approach: (left arm, patient's hand is to the left): The radial nerve (right arrow) is found between brachialis (top) and brachioradialis (bottom). At the level of the elbow crease the posterior interosseous nerve is given off and lies directly deep to the radial nerve (left arrow). (b) Decompression of radial tunnel: A — radial nerve sensory branch, B — posterior interosseous nerve, C — arcade of Fröhse.

its distal border (Figure 2a—d), a fascial arcade is often present, lining the deep surface of the superficial head of the supinator muscle just above the exiting PIN. This band can exert pressure on the PIN just before it emerges from beneath the supinator muscle.

Riffaud et al. described how they looked again at the anatomy of the radial tunnel. The anatomy of the radial tunnel was studied in 25 elbow preparations. They noted five different elements that could affect the PIN in the radial tunnel and cause an entrapment syndrome: a capsule-tendon-aponeurotic complex on the anterior aspect of both the humero-radial joint and the radial head, the vascular arcade formed by the radial recurrent artery, and its branches, the arcade formed by the medial edge of ECRB, and the superior and inferior arcades of the superficial layer of the supinator muscle.[13]

In another anatomical study, 34 upper limbs were dissected and three segments of the PIN were distinguished:

- segment I, from its origin to its entry into the supinator muscle;
- segment II, corresponding to its passage through the supinator muscle; and
- segment III, extending from its exit from the supinator muscle to the origin of the nerves to the common extensor muscles.

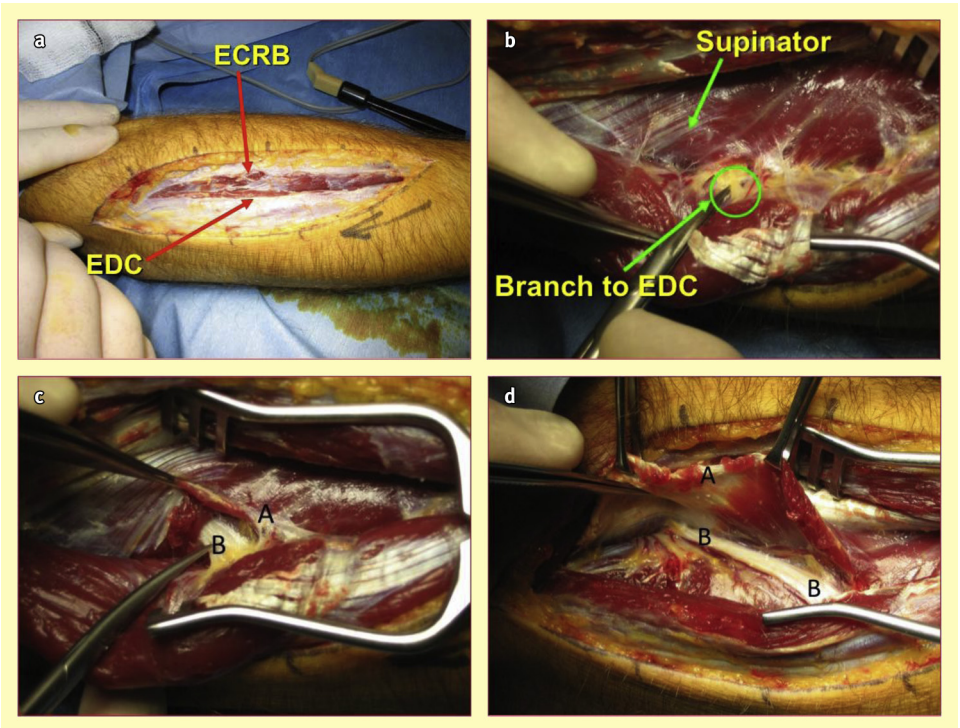

Figure 2 (a) Decompression of the PIN (right arm, the patient's hand is to the right): Dorsal approach developing the interval between extensor carpi radialis brevis and extensor digitorum communis. (b) Decompression of the PIN: ECRB and EDC retracted exposing the superficial layer of supinator muscle and the branch of the PIN to EDC. (c) Decompression of the PIN: Elevating the superficial layer of supinator muscle (A) from the radius and exposing the PIN (B). (d) Decompression of the PIN: Complete elevation of the superficial layer of the supinator muscle (A) exposing the PIN (B) in its course between the two layers of supinator muscle, as far proximally as the arcade of Fröhse.