RADIAL TUNNEL SYNDROME & PIN SYNDROME

Although compression neuropathies of the forearm are far less common than those of the wrist for the patient suffering from one of these neuropathies, a missed diagnosis has far-reaching consequences.

3 types of Radial nerve entrapment
1) posterior interosseous nerve syndrome
2) radial tunnel syndrome
3) superficial radial nerve compression (Wartenberg's syndrome)

Carpal tunnel syndrome	Annual incidence 0.35%
Cubital tunnel/ Guyon's canal	Annual incidence of 0.03%.
Posterior interosseous nerve (PIN) & Superficial radial nerve (SRN)	Annual incidence of 0.003%.

Pathogenesis

The effects of compression on peripheral nerves can be attributed
a. To alterations of blood circulation to and from the nerve
b. Direct injury to the axonal transport systems.
c. Venous blood flow from the peripheral nerves is shown to be reduced at 20 to 30 mm Hg

The subsequent edema can lead to fibrosis, which increases further pressure on the nerve, leading to a progressive deterioration of the nerve.
In addition to the mechanical effects, an increase in connective tissue has been hypothesized to cause secondary changes in the mechanical sensitivity of the thin afferent fibers responsible for pain.
Finally, compression may also produce local intraneural sprouting and neuroma formation.

Splinting prevents the patient from moving the extremity into positions that result in additional compression to the nerve, and therefore reduces inflammation that can lead to progressive worsening of symptoms. In instances when conservative management has failed, surgical decompression may be warranted to eliminate the anatomical structures responsible

The PIN is a motor nerve that courses deep beneath the supinator muscle; the SRN is a sensory nerve that travels anteriorly on the undersurface of the brachioradialis and, in the distal one-third of the forearm, travels subcutaneously to provide sensation to the dorso-radial hand.

COMPRESSION SYNDROMES OF THE POSTERIOR

The radial nerve continues to travel distally and ultimately bifurcates into deep (PIN) and superficial (SRN) branches approximately 6.0 to 10.5 cm distal to the lateral intermuscular septum and 4 cm proximal to the leading edge of the supinator.

The PIN is thought of as a "motor-only" nerve that travels through the radial tunnel. The radial tunnel is a potential space 3 to 4 finger breadth long, lying along the anterior aspect of the proximal radius through which the PIN travels.

Anatomically, there are 5 potential sites of compression of the PIN in the area of the radial tunnel:

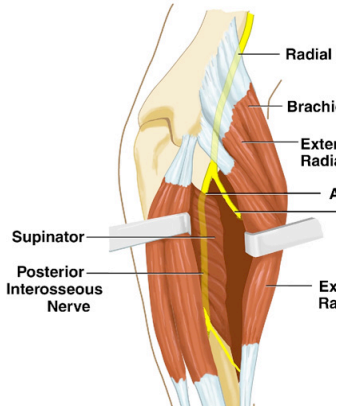
(1) Fibrous bands of tissue anterior to the radiocapitellar joint between the brachialis and brachioradialis

(2) Recurrent radial vessels that fan out across the PIN at the level of the radial neck as the so-called "leash of Henry"

(3) ECRB: the leading (medial proximal) edge of the ext carpi rad brevis

(4) Proximal edge of the superficial portion of the supinator, commonly referred to as the arcade of Fröhse;

(5) The distal edge of the supinator muscle.



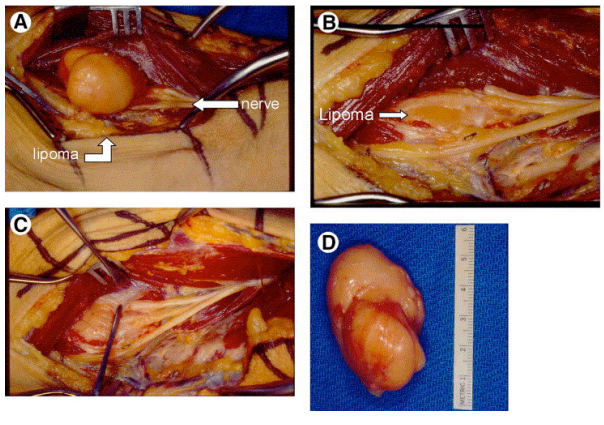
The proximal border of the superficial head of the supinator muscle, or arcade of Fröhse, lies approximately 1 cm distal to the leading edge of the ECRB and is thought to cause most PIN neuropathies. The lateral portion of the supinator is tendinous and originates on the lateral portion of the lateral epicondyle. These tendinous fibers course distally before joining the supinator's medial fibers, which originate from the medial portion of the lateral epicondyle, and can be membranous or tendinous. In individuals with a tendinous arcade, the PIN experiences pressures of 46 mm Hg during passive pronation of the forearm and peak pressures of 190 mm Hg during maximal active muscle contraction.

Interestingly, RTS and PIN syndrome describe compression of the same nerve and therefore can be approached with identical surgical interventions. Although in each syndrome the same nerve is affected, the clinical presentations are divergent. Whereas patients with PIN syndrome have a loss of motor function, patients with RTS typically present with mobile wad and lateral forearm pain without motor involvement. The difference in clinical presentation may well be attributed to a difference in the degree of compression of the nerve.

Posterior Interosseous Nerve (PIN) syndrome

It does not innervate the extensor carpi radialis longus (ECRL). PIN syndrome occurs when there is sufficient compression on the PIN—presumably of its large myelinated fibers—to produce a motor loss, which can result from benign tumors (most commonly lipomas or ganglia) or peri-elbow synovitis associated with rheumatoid arthritis.

It has been suggested in an orchestral conductor whose palsy was attributed to the repetitive trauma of alternating forearm pronation and supination. As a result of this first description, occupations with repetitive prono-supination were considered to be a risk factor for injury to the PIN.



Patients with PIN syndrome typically present with dropped fingers and thumb resulting from compression of the PIN at the proximal aspect of the supinator muscle.

Buffalino Sign: a soft tissue lucency adjacent to the radial head

Partial lesions are seen when there is compression not of the PIN in its entirety, but rather of isolated PIN branches. For example, compression of the medial branch would cause weakness of the extensor carpi ulnaris, extensor digiti minimi, and extensor digitorum communis, whereas compression of the lateral branch would cause weakness of the abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, and extensor indicis proprius.

of course, be helpful to delineate a soft tissue mass responsible for compression. Once a PIN palsy has been diagnosed, lipomas should be considered as a causative factor, because they are the most commonly reported tumor to cause PIN syndrome. Other sources of compression that have been described include ganglia arising from the anterior capsule of the proximal radioulnar joint and in the supinator muscle, rheumatoid pannus, septic arthritis of the elbow, synovial chondromatosis, and vasculitis.

Because loss of motor function is the hallmark of PIN syndrome, electromyographic evaluation is usually positive (in contrast to RTS).

The characteristic feature of extensor tendon subluxation is the ability to maintain but not obtain metacarpophalangeal extension, whereas tendon rupture can be evaluated by passively bringing the wrist from a position of extension to flexion and determining whether there is an appropriate tenodesis effect.

Radial Tunnel Syndrome (RTS)

Although it is the same PIN that is being compressed in both RTS and PIN syndrome, patients with these 2 conditions present altogether differently.

1. Rather than weakness or paralysis as their chief report, patients with RTS typically present with lateral proximal forearm pain, which must be distinguished from lateral epicondylitis.

2.Today, the existence of RTS remains a source of controversy owing to limited objective tools that can be used to define its diagnosis, in that *it is a pain-only phenomenon* with no significant findings on imaging nor electrodiagnostic studies.

3. The clinical diagnosis of RTS must be distinguished from that of lateral epicondylitis by the location of tenderness on physical examination. In lateral epicondylitis, the focal point of tenderness is on the lateral epicondyle at the insertion of the ECRB. In contrast, the characteristic pain of RTS is located 3 to 4 cm distal to the lateral epicondyle in the area of the mobile wad and radial tunnel.

4. Compression of the PIN is made greater by placing maximal traction on the radial nerve, by extending the elbow, pronating the forearm, and flexing the wrist. Additional physical examination tests that have been described include pain with resisted active supination or wrist extension, pain with resisted middle finger extension at the metacarpophalangeal joint, and localized tenderness along the path of the PIN.

5. The practitioner should remember, of course, that several of these clinical maneuvers would also provoke pain in the patient with lateral epicondylitis.

6. Forearm rotation can produce differential latencies in nerve conduction studies under laboratory conditions, but the vast majority of patients with RTS have normal electrodiagnostic testing.

7. Because there is a paucity of objective tests to confirm the presence of RTS, pain relief after the administration of a local corticosteroid injection adjacent to the PIN at the level of the proximal radius has a useful role in diagnosis. Injecting the corticosteroid with a short-acting local anesthetic is wise, because temporarily producing a PIN palsy confirms accurate placement of the cortisone.

Ask the patient to extend his middle finger against resistance applied by you over the proximal phalanx. Hold his forearm in full pronation and his elbow extended. Reproduction of pain in the radial tunnel region with this maneuver indicates entrapment of the PIN at the ECRB tendon. It may aggravate pain in Tennis elbow

Unlike PIN syndrome, imaging does not have a key role in the workup of RTS.

Management

Nonsurgical management of both PIN syndrome and RTS

A. A trial of rest,

B. Activity modification

C. Splinting, stretching, and anti-inflammatory medications.

After activity modification is attempted, an injection of local anesthetic and corticosteroid is frequently used to confirm the diagnosis of RTS and may additionally serve a therapeutic purpose. 72% had resolution of their symptoms in RTS with a single injection of 2 mL 1% lidocaine and 40 mg of triamcinolone.

Injection may also have a role in the management of PIN syndrome, but if there is an underlying cause detected, such as a lipoma or ganglion occupying the radial tunnel and producing motor weakness, early surgical excision of the mass is more appropriate.

If PIN syndrome is neglected for approximately 18 months, muscle fibrosis of PIN-innervated muscles will occur, leaving only tendon transfers as a viable surgical option.

Problems

Loss of extension of wrist

Loss extension of fingers

Loss extension and abduction of thumb

Jone's Procedure:

Pronator teres to ECRB

FCU to EDC

PL to EPL

Boye's Transfers

Pronator teres to ECRB

FDS long to EDC via interosseus membrane proximal to the pronator quadratus

FDS ring to EPL

Those with RTS might not be diagnosed for many months. Once a patient is diagnosed with RTS, nonsurgical treatments should be attempted. If activity modification is not helpful and if multiple cortisone injections are only temporarily efficacious, surgical intervention should be considered. Because of a lack of high-level evidence, the optimal duration of such nonsurgical treatments is unknown. Huisstede identified 6 articles: show a tendency for the efficacy of surgical decompression of the radial tunnel in patients with RTS, but say almost nothing about the natural history of untreated RTS or the effectiveness of conservative treatment. An evaluation of the literature reveals that no randomized controlled trials examine the precise role of surgical decompression versus conservative treatment in the management of patients with RTS. The efficacy of surgical decompression of the radial tunnel ranged from 67% to

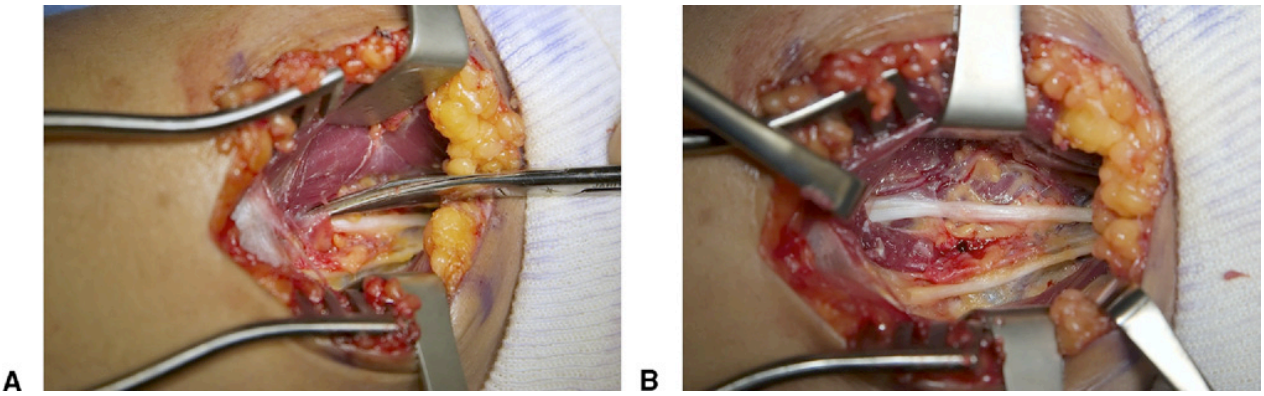
A more recent study examined the relationship between radial tunnel release and coexisting lateral epicondylitis. In that 2007 study by Lee, surgical decompression had good results in 86% of patients with a lone diagnosis of RTS, but was only 40% successful in patients with concomitant tennis elbow.

The method of radial tunnel decompression in the treatment of both PIN syndrome and RTS may vary from surgeon to surgeon, but should share the common theme of releasing the 5 potential sites of PIN compression that we have outlined previously.

Surgery

A longitudinal or 6-cm lazy-S-type incision that is centered over the mobile wad starting just distal (approximately 1 cm) to the radial aspect of the elbow flexion crease.

The brachioradialis-ECRL interval is identified by a fascial stripe.



Dissection is continued bluntly with a probing finger down to the fatty tissue surrounding the radial nerve.

Use bipolar electrocautery to maintain meticulous hemostasis during the surgery to aid in visualization

The SRN can be seen coursing along the undersurface of the brachioradialis and is protected throughout the surgery. The arcade of Fröhse and supinator muscle proper are identified, as is the PIN, which is dissected distally until it disappears, passing beneath the arcade of Fröhse. If traversing vessels compromise visualization, they may have to be bipolar electrocauterized or suture ligated, depending on their caliber.

Once the PIN is identified as coursing deep to the supinator muscle, the surgery is performed by either excising the soft tissue mass encroaching upon it (as in PIN syndrome, for example) or freeing it up from all the potential sites of compression (as in RTS). The decompression should begin with the release of any proximal fascial bands connecting the brachialis to the brachioradialis, and then continue through the leash of Henry, the fibrous edge of the ECRB, and all the way through the radial tunnel with a complete release of the arcade of Fröhse and distal supinator muscle. Current opinion suggests that release of the arcade of Fröhse may be the most important element in decompressing the radial tunnel.

Controversy

Although RTS is classically described as a nerve compression and entrapment syndrome, there is dispute over its etiology. Skeptics note that the signs and symptoms of RTS contrast from other well-described entrapment neuropathies such as carpal tunnel syndrome and cubital tunnel syndrome in that there is: (1) prominent focal tenderness, (2) normal neurologic function, and (3) no confirmatory electrodiagnostic evidence of nerve dysfunction.

Prominent focal tenderness in the area of the radial tunnel remains one of the principal diagnostic criteria for RTS. However, focal tenderness at the radial tunnel in RTS differs from a positive Phalen's test in carpal tunnel syndrome in

reports supporting the efficacy of surgery in RTS, there has been no randomized controlled trial that compares surgical with nonsurgical treatment or with a placebo. Skeptics of RTS point to the great variability of surgical results reported in the literature as one of the characteristics of placebo surgery.

Although the PIN is classically thought of as being a "motor-only" nerve, the PIN also carries unmyelinated (group IV) afferent fibers from the wrist capsule as well as small myelinated (group IIA) afferent fibers from the muscles along its distribution. Unmyelinated group IV fibers from muscles (designated as C-fibers when of cutaneous origin) have long been associated with nociception and pain.

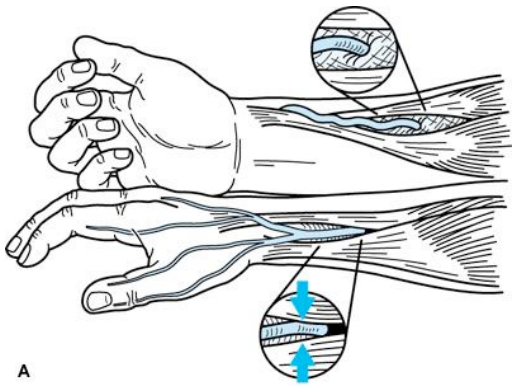
COMPRESSION OF THE SUPERFICIAL RADIAL NERVE (SRN)

Approximately 9 cm proximal to the radial styloid, the SRN becomes a subcutaneous structure by traveling between the brachioradialis and ECRL tendons. The SRN continues to travel in the subcutaneous tissues and branches out into dorsal digital nerves responsible for afferent sensory input from the dorsum of the thumb, index, and middle fingers proximal to the proximal interphalangeal joints.

In 1932, Wartenberg published a series of 5 adult patients. Wartenberg coined the term "cheiralgia paresthetica" for this syndrome. The SRN can be compressed at any point along its course in the forearm, but it is believed to be at greatest risk at the posterior border of the brachioradialis as the nerve transitions from a deep to a subcutaneous structure. Trauma is also a common etiology for SRN compression, which can occur from direct pressure on the nerve (ie, by a wristband or handcuffs.

Patients with SRN compression typically report pain or dysesthesias on the dorsal radial forearm radiating to the thumb and index finger, although the distribution of symptoms may vary owing to differences in anatomy. When such sensory disturbances present concomitantly with weakness of the PIN-innervated muscles, the clinician should consider alternative diagnoses, such as a more proximal lesion.

A Tinel's sign over the course of the SRN is the most common physical examination finding, although the clinician should be mindful that this may also be positive in patients with more proximal pain generators, such as a lateral antebrachial cutaneous neuritis. Although electrodiagnostic testing is often negative in cases of SRN, it is part of a thorough workup and may be helpful if positive.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When the forearm is in supination, the sensory branch lies deep to the fascia, without compression from the tendons of the brachioradialis and ECRL muscles. As the forearm pronates, the ECRL tendon crosses beneath the brachioradialis tendon in a scissors-like fashion, pinching or compressing the nerve

Management

Patience is the cornerstone of therapy in patients with SRN compression symptomatology because spontaneous resolution is common. As external compression is a common underlying etiology, removal of the inciting element such as a wristwatch or bracelet is an essential component of nonsurgical management.

Surgical decompression, which was offered only to patients who failed conservative therapy or whose symptoms were longstanding and had no distal progression of a Tinel's sign, had a 74% success rate in 23 patients.

References

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