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Radial tunnel syndrome: Diagnostic and treatment algorithm

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Abstract

Radial tunnel syndrome is a compressive neuropathy of Posterior interossei nerve(PIN) in the radial tunnel. Radial tunnel is commonly misdiagnosed and often treated as lateral epicondylitis. The difficulty in diagnoses is due to overlapping features among both the conditions. Understanding the anatomy of radial tunnel and possible sites of compression of PIN in the tunnel guides the surgical planning and management of radial tunnel syndrome. Dynamic ultrasonography helps in early diagnosis by assessing compression of the nerve during supination and pronation. Rule of 9 test and maudsley's test are sensitive for detection of radial tunnel syndrome. Conservative treatment is less successful and surgical decompression is the treatment of choice. Complete release of possible sites of compression prevents recurrence.

Keywords: Radial Tunnel Syndrome, Conservative management, diagnosis

Introduction

Radial Tunnel Syndrome(RTS) is a compressive neuropathy of Posterior interossei nerve (PIN) in the proximal forearm. In 1972, Maudsley and Roles termed it as resistant tennis elbow. It is commonly seen among female patients [1] and athletes with repeated activities involving pronation and supination of forearm. The site of compression of PIN is most commonly seen under the proximal tendinous edge of supinator which is also known as Arcade of Frohse[2]. A patient diagnosed with lateral epicondylitis not improving on conservative management should be evaluated clinically and radiologically for RTS.

Anatomy of Radial tunnel

The radial nerve pierces the lateral intermuscular septum and divides into a deep branch (Posterior interosseous nerve, PIN) and superficial branch (superficial radial nerve) within 3 cm of the elbow joint. The posterior interosseous nerve courses along the radial tunnel, extending approximately 5 cm from the radio-capitellar joint to the inferior edge of supinator muscle and later gives off the muscular branches. It is laterally bounded by the brachioradialis, extensor carpi radialis longus, and extensor carpi radialis brevis and medially by the brachialis and biceps tendon. The floor is formed by the radio-capitellar joint capsule and the deep portion of the supinator[3]. The point where the posterior interosseous nerve passes deep to the superficial head of the supinator is accepted as the distal margin of the radial tunnel[2]. Apart from Arcade of Frohse, there are other sites of compression of PIN along the radial tunnel (Table 1).

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Clinical features and evaluation

The most common presentation is lateral elbow pain radiating along the distribution of the radial nerve without neurological deficits. If there is presence of neurological deficit which manifests as weak finger and thumb extension it is termed as PIN syndrome. The pain aggravates on activities and night. Pain occurs more frequently in the dominant arm. Middle aged women (age 30 to 50 years) are predominantly affected.

Clinical signs

Tenderness is present approximately 5cms from the lateral epicondyle over the radial aspect of the proximal forearm. Neurological examination is mandatory to rule out PIN syndrome which is associated with extensor weakness. Commonly performed tests for diagnosis in a patient with RTS are -

- Rule of 9 test - Loh et al described this test for non-specific elbow pain in 2004 [4]. He dissected 19 cadaveric forearms to know the course of PIN and median nerve. A square box is drawn on the volar aspect of the forearm with elbow crease as a guide for width of the square. The square is further divided

Figure 1: a) division of the volar aspect of proximal forearm into 9 squares with elbow crease taken as reference line b) Tenderness over box 1 and 2 suggests PIN irritation

into 3 rows and columns (Fig.1a). The three medial squares (7,8,9) act as control. Tenderness over the two proximal squares [1,2] on radial aspect suggests irritation of PIN nerve (Fig. 1b). The middle column determines irritation of the proximal median nerve [5,6]. The basis of the test in RTS is based on the findings in the cadaveric study that lateral column corelated with the course of PIN.

- Maudsley's test - Resistance to active extension of third finger results in pain around the elbow. Bolster et al considered it as pathognomonic test of RTS [5] (Fig. 2a).
- Resisted supination test - It is performed with elbow in extension and forearm in pronation. Patient is asked to actively supinate the forearm while maintaining elbow in extension. Resistance is given at wrist against active supination. It is often positive in patients with lateral epicondylitis (Fig. 2b).
- Cozen's test - Resistance provided to the wrist dorsiflexion with elbow in extension and forearm in pronation results in pain. It is mainly done to rule out lateral epicondylitis. Since Extensor carpi radialis brevis can be involved in both RTS and lateral epicondylitis, the test is sensitive but not specific. Site of pain while performing this test is important in differentiating the etiology of lateral elbow pain (Fig. 3a). Pain distal to lateral epicondyle in proximal forearm denotes RTS.
- Mill's Maneuver - While palpating the lateral epicondyle, the elbow is extended with forearm in pronation followed by passive volar flexion of the wrist (Fig. 3b).

Figure 2: a) Maudsley's test b) Resisted supination test

All these provocative tests can be positive in both RTS and lateral epicondylitis. The most important clinical sign is to elicit the site of tenderness and rule of 9 test.

Diagnosis

Pain on the dorsal forearm that worsens at night and arm fatigue are typical presentation of Radial Tunnel Syndrome. However, diagnosis can be difficult as the provocative tests are non-specific. It should be remembered that lateral epicondylitis and RTS can coexist in 5 percent of the individuals, where patients often present as recurrent lateral epicondylitis[6]. However, this may be spurious as many RTS go undetected. Electromyography and nerve conduction studies are typically found to be normal in RTS[7]. However, Kupfer et al considered latency of more than 0.30 milliseconds as the diagnostic criteria of RTS[8]. Verhaar et al performed nerve conduction studies with forearm in forced supination to look for latency and only one patient had significant latency among 16 patients[9]. Ultrasonography is a useful tool in detecting the thickening of supinator edge, ECRB thickening, space occupying lesion in the radial tunnel, radio-capitellar arthritis and diameter of the nerve. Since the nerve root compression in radial tunnel can be missed using static ultrasound, dynamic ultrasound during different positions of forearm can detect early nerve compression in patients suspected with RTS. Muscle denervation, edema or atrophy along the distribution of the posterior interosseous nerve is the most common finding on MRI in RTS[10].

Treatment

Correct diagnosis of Radial Tunnel Syndrome is the key to treatment. Often the diagnosis is missed which results in delay in treatment or treated as persistent lateral epicondylitis. The goal of treatment in RTS is to relieve the pain and early return to functional activities. Non-operative treatment include splinting, non-steroidal anti-inflammatory drugs and local steroid injection in the radial tunnel. Steroid injection is frought with risk of damage

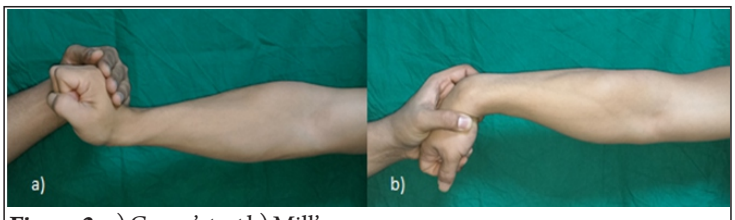


Figure 3: a) Cozen's test b) Mill's maneuver

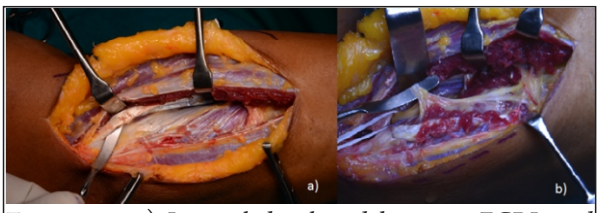
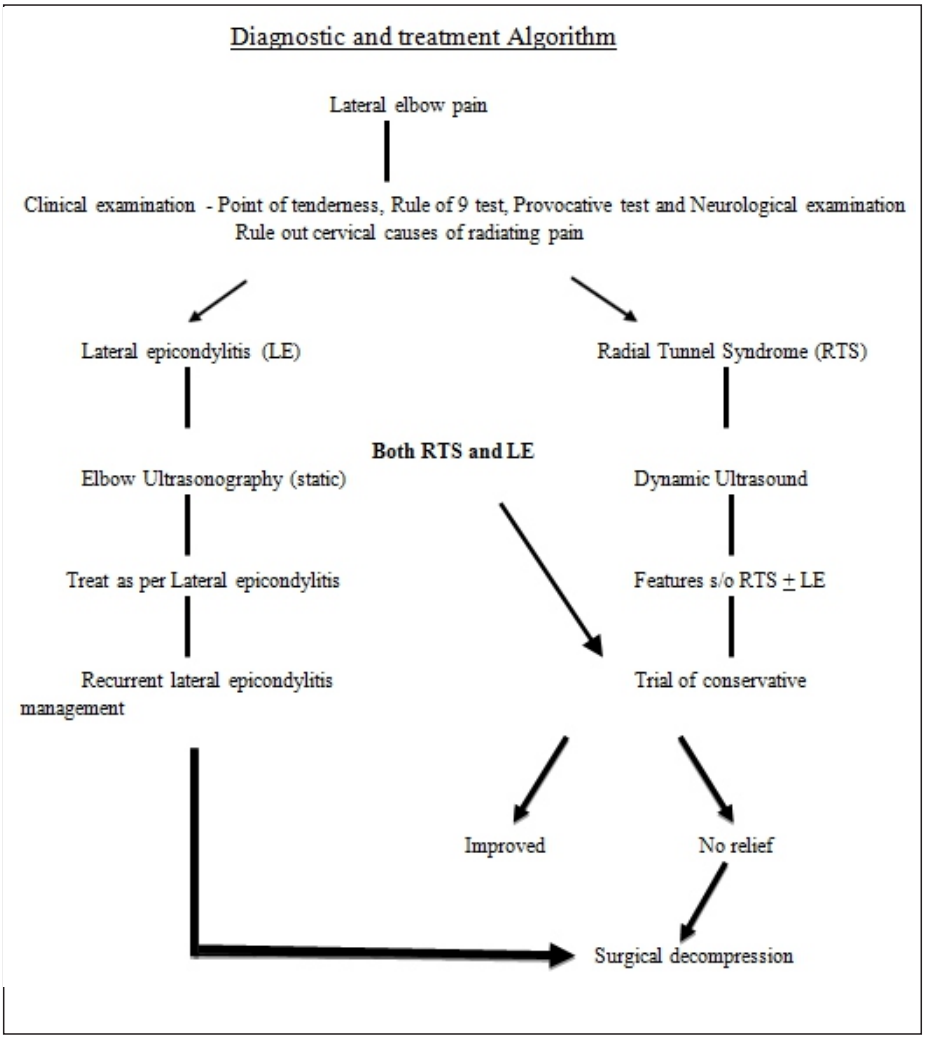


Figure 4: a) Interval developed between ECRL and Brachioradialis. ECRB is identified. b) Recurrent branches radial artery (Leash of Henry)

Figure 5: Proximal tendinous margin of supinator (Most common site of compression in RTS)



to the nerve. Even though, most authors have reported poor results with conservative management of RTS[11,12], Sarhadi et al reported relief of pain in two third of the patients after injection of lignocaine and triamcinolone in radial tunnel[13]. Usually trial of conservative management is given to the patients for three months[14]. It is to be noted that a tennis elbow brace can actually worsen the symptoms –and may be a clue for coexisting RTS.

Surgical decompression of radial tunnel

The principle of surgical decompression is to release all the possible sites of compression of PIN in the radial tunnel. In 1983, the first series of 15 patients who underwent radial tunnel decompression was reported. The results were excellent as 93% of the patients were relieved of pain following decompression[11]. Various surgical planes can be used to approach the radial tunnel including Thompson approach, anterior approach or brachioradialis splitting approach. Even though Arcade of Frohse is the most common site of compression of the nerve, it should be remembered that it is not the exclusive site of compression[15]. Sotereanos et al [16] have documented fair to poor results after decompression of RTS. He observed good results in patients who were not factory workers or labourers, patients with positive resisted supination and Maudsley's test. He stressed on careful patient selection based on these factors before surgical decompression. He found poor results subjectively in patients who were workers and involved in litigations for compensation at work. Atroshi et al [17] operated 37 patients with RTS and obtained unpredictable outcomes. He also believed preoperative and intraoperative findings do not corelate.

Surgical technique

Patient is positioned supine and a pneumatic tourniquet is applied. A bloodless interval between the brachioradialis and the extensor carpi radialis longus (ECRL) is created. Planned incision is marked along the posterior border of the brachioradialis muscle. There is a color interval between these two muscles. The brachioradialis appears red whereas the ECRL appear lighter owing to thickness of the fascia (Fig. 4a). After blunt dissection between ECRL and

Table 1- Possible sites of compression of Radial tunnel syndrome and etiology

Arcade of Frohse	Proximal tendinous edge of the supinator muscle *Most common site of compression in RTS*
Leash of Henry	Anastomosing branches of recurrent radial artery at radial neck
Fibrous edge of ECRB	Proximal tendinous edge compressing the deep branch of radial nerve
Lateral elbow joint in radial head	Fibrous bands anterior to the radio-capitellar joint or synovitis of the radio-capitellar joint *Should always be inspected during surgical decompression*
Distal edge of supinator	Distal margin of the radial tunnel *Often missed during decompression of RTS*

brachioradialis, the recurrent vessels (Leash of henry) are encountered and ligated (Fig. 4b). ECRB tendon is divided from its origin at lateral epicondyle. The extensor digitorum communis muscle can be partially detached from the lateral epicondyle anteriorly. Radio-capitellar joint is inspected to look for fibrous bands. This can also be done after distal decompression by passing finger underneath to feel for fibrous bands proximally. The proximal tendinous edge of supinator is released (Arcade of Frohse) which decompresses the radial tunnel effectively (Fig. 5). Occasionally there is compression of the nerve at the distal end of supinator, thus we prefer to release the distal edge of the supinator as well. The ECRB is sutured to ECRL and common extensor origin. Post operatively we prefer to immobilize the patients in above elbow slab till suture removal followed by cast application for a period of three weeks.

Pearls

1. Dynamic compression of PIN occurs in RTS.
2. Recurrent tennis elbow can be easily differentiated from RTS using Rule of 9 test, Maudsley's test and dynamic ultrasound.
3. Dynamic USG is useful to detect compression of nerve during supination and pronation of forearm.

Pitfalls

1. Every lateral elbow pain is not lateral epicondylitis. Recurrent lateral epicondylitis should be evaluated clinico-radiologically for Radial Tunnel Syndrome.

2. Ultrasound findings are operator dependent and radiologist should be well trained to detect subtle compression of PIN. Surgical decompression requires detailed anatomical knowledge and possible sites of compression as decompression at all possible sites is important to prevent recurrence of pain.

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