

Chronic compression syndromes (entrapment) of nerves, tumors of peripheral nerves

Syndromes of chronic compression (entrapment) of nerves

Carpal tunnel syndrome

Syndrome canalis carpi (carpal tunnel syndrome, SKT) is a compression neuropathy in the wrist area. It is the most common entrapment syndrome, the most common mononeuropathy and at the same time the most common occupational disease. The main risk factors include long-term, excessive and unilateral overloading hands and wrists, vibrations with transfer to the hands, but also diabetes mellitus or thyreopathy. The subjective symptoms mainly include paresthesia and dysesthesia of the 1st to 4th finger, and the objective symptoms include atrophy of the outer part of the thenar. Impairment is quantified using electromyography.^[1]

Incidence

The incidence is reported to be between 180 and 346 diagnosed cases/100,000 population per year, with women being affected approximately 3 times more often than men. The average age of patients is between 45 and 55 years of age with a predominance of disability in the working population. SKT often occurs bilaterally and the dominant hand is more commonly affected.^{[1][2]}

It is more common in older, petite women.^[3]

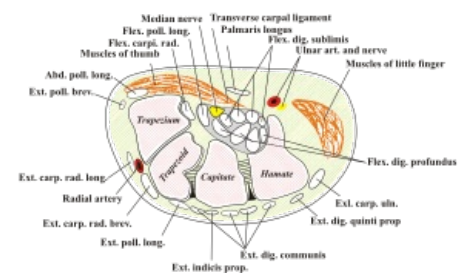
Carpal Tunnel Anatomy

The walls of the carpal tunnel form:

- *Eminentia carpi ulnaris: os pisiforme, hamulus ossis hamati,*
- *Eminentia carpi radialis: tuberculum ossis scaphoidei and tuberculum ossis trapezii,*
- Palmar side: *ligamentum carpi transversum* or *retinaculum musculorum flexorum,*
- Dorsal side: carpal bones.

The **n. medianus** and **9 tendons of the finger flexors** pass through the tunnel. The "nervus medianus" transmits above the carpal tunnel the "ramus palmaris nervi mediani" — a sensitive branch for the lateral area of the carpus and the lateral parts of the palm; this area is therefore not sensitively affected in SKT. After passing through the carpal tunnel, it sends the **rami musculares** to the thenar muscles except the **adductor pollicis** and the deep head of the **flexor pollicis brevis**, which are supplied by the ulnaris nerve. It also sends out the "nervi digitales palmares", which supply motorically "musculi lumbricales I et II" (for the 2nd and 3rd fingers) and sensitively the 1st finger to half of the 4th finger from the palmar side, and their innervation extends over the tips fingers up to the dorsum of the hand, where they sensitively supply the distal parts of the joints fingers.^[1]

🔗 For more information see *Canalis carpi*.



Transverse section of the wrist. Based off Gray's anatomy diagram of the same.

Etiology and Pathogenesis

The carpal tunnel is a strait, so it anatomically predisposes to nerve damage. Any abnormality of the nerve or its surroundings, which results in a reduction of the surrounding space, leads to nerve compression. First, the "vasa nervorum" is oppressed, resulting in ischemia of the nerve and its edema, which further increases the pressure on the nerve at the point of passage through the carpal tunnel. Persistent chronic compression of the nerve can then induce structural changes in the nerve (initially there is a lesion of the myelin sheath, later individual axons are affected) with a gradual loss of function of sensitive and motor fibers. Sometimes intraneural fibrosis can occur. Weakly myelinated fibers leading to pain perception are more resistant.^{[1][4]}

Risk factors for the development of SKT:

- Excessive, long-term and unilateral local muscle load of the small muscles of the hand and forearm — use of greater muscle power with a lower frequency of movements or smaller muscle power with a high frequency of movements (working with a screwdriver, holding heavier hand tools, playing stringed instruments, working with a computer keyboard and mice in an inappropriate position) — leads to hypertrophy, traumatization and edema of soft tissues;
- Vibration transmitted to the hands (working with a chainsaw, jackhammer, pneumatic hammer or drill) — leads to microtraumas directly in the nerve, or damage to the "vasa nervorum" with subsequent ischemia of nerve fibers;

- Diseases that affect the nervous, vascular or musculoskeletal system: diabetes mellitus, hormonal changes (thyreopathy, 3rd trimester of pregnancy — problems disappear within a few weeks after birth, use of hormonal contraception, menopause, acromegaly), rheumatological diseases (rheumatoid arthritis, systemic lupus erythematosus), traumatic changes (wrist bone fractures with subsequent bone muscle formation, Colles fracture), obesity, gout, alcoholism, nutritional deficiencies and many others;
- Congenitally narrow carpal tunnel, anomalous tendon spacing, vascular anomaly, ganglion, tumor.^{[1][4]}

Diagnostics

- Medical history, physical examination and EMG.

Clinical picture

- Sensitive symptoms appear first:
 - Paresthesia (tingling sensation) or dysesthesia of the 1st to 3rd and adjacent parts of the 4th finger on the palmar side of the hand and dorsally around the nails of the same fingers (i.e. in the range of sensitive innervation of the median nerve), sometimes the symptoms can affect all fingers (on the basis of anastomoses between the median nerve and the ulnaris nerve: Martin-Gruber anastomosis on the forearm or Cannie-Riche anastomosis in the palm)^[4];
 - A "swollen hand" sensation without obvious swelling;
 - At first, typically at night — it wakes the patient up in the morning, and after shaking the hand and moving the fingers, there is relief, later even during the day;
 - Or during manual work, when bending the wrist in a static position of the hand (holding the handlebars of a bicycle) or when elevating the upper limb (holding in a means of transport).
- Mild to severe hypoesthesia in the region of the 1st to radial half of the 4th finger from the ventral part and on the dorsal tips of the fingers
- Deterioration of fine motor skills (difficulty turning on a button or picking up a small coin)
- Motor symptoms: paresis of abduction and opposition of the thumb
- In the severe stage, sensitive symptoms may disappear, there is atrophy of small thenar muscles due to severe denervation
- Atypical symptoms include pain radiating from the hand to the forearm, arm or shoulder, or pain in the carpal area
- Fasciculations or spasm of thenar muscles rarely occur
- Autonomic symptoms may also appear — a change in temperature, color and trophism of the skin and nails^[1]



What is carpal tunnel syndrome? Video in English.

Development of subjective symptoms

- 1st stage – morning numbness in the fingers;
- 2nd phase – nocturnal paresthesia;
- 3rd phase – daytime paresthesia – mainly when working with hands above the head (for example, holding on to a handrail in public transport);
- 4th stage – clumsiness of small movements.^[3]

Objective finding

Sensitivity disorders - we assess them on the 2nd finger (we compare sensation on the belly of the 2nd and 5th fingers).

Motor defect arises later - it mainly atrophies m. abductor pollicis brevis;

- We demonstrate the sign of a candle – hand palm up, thumb sticking up, we press it into the palm, watch its resistance;
- The resulting atrophy of this muscle makes such a hole laterally on the thenar.

Sensation above the thenar is normal (the subcutaneous branch originates from the median nerve before entering the carpal tunnel!!!).

A **pseudoneuroma n. mediani** is formed - a spindle-shaped thickening of the nerve resulting from compression of the nerve and accumulation of axonoplasm.^[3]

Investigation

Provocation tests — maneuvers that narrow the space for the nerve in the carpal tunnel:

- Tapping with a hammer or finger above the carpal tunnel (Tinel's test)
- Compression with our fingers over the carpal tunnel for 30 seconds (Durkan's test)
- Flexion of the hand at the wrist for 60 seconds (Phalen's test),
- Extension of the hand at the wrist for 60 seconds (reverse Phalen test)
- Hand elevation test for 60 seconds^[1]

Classification according to the severity of clinical findings

1. Light degree: intermittent symptoms, physically only positive provocation tests can be provided, event. hypersensitive response to a vibrational stimulus, irritation of the median nerve without the presence of extinction symptoms;
2. Moderate degree: positive provocation tests, muscle weakness, possible hypotrophy of the thenar muscle, reduced vibration perception in the distribution of n. medianus;
3. Severe degree: muscle atrophy, sensitive symptoms are permanent, abnormal two-point discrimination sensation, extinction symptoms are prominent.^{[4][5]}

Electromyography (EMG)

- To verify the diagnosis and to determine the severity of the disability and to objectively monitor the disease;
- Verifies the involvement of the sensory and motor fibers of the median nerve (neurography) and shows whether the process is chronic, acute or subacute;
- Evidence of demyelinating signs of nerve damage — reduced speed of sensitive conduction and prolonged distal motor latency (DML), picture of dispersion of potentials;
- In the later stages, evidence of axonopathy — a decrease in the amplitudes of the sensory nerve summation action potential (SNAP) and the summation muscle action potential (CMAP);
- Needle EMG — reinnervation potentials (chronic impairment) and abnormal spontaneous activity (acute impairment).^[1]

Display methods

- Sonography, CT, magnetic resonance — in the event of failure of the operation or to rule out a tumor as the cause of SCT;
- X-ray image — if a rheumatological disease or bone abnormality is suspected (e.g. after trauma).^[1]

Differential diagnosis

- C6 and C7 radiculopathy — pain radiates to the fingers in a belt-like distribution, worsening during movements of the cervical spine;
- Pronator tunnel syndrome — pain/tingling radiating to the fingers and hypesthesia in the distribution of the median nerve, palpable sensitivity in the area of the pronator teres muscle and, in more severe cases, paresis of the flexors

fingers;

- Cervical myelopathy — problems with the fine motor skills of the hands, but then the development of atrophy in the distribution of several nerves;
- Polyneuropathy — Tingling of the fingers of the upper and lower limbs;
- Raynaud's syndrome — Attacks of vasoconstriction and vasodilatation accompanied by pain and paresthesias of the fingers;
- Diseases of tendons, sheaths, their attachments and joints;
- Stenosing tendovaginitis — the so-called jumping or loupe finger;
- Thoracic outlet syndrome;
- Sometimes a coincidence of one of the above-mentioned diagnoses with SKT is also possible.^{[1][4]}

Therapy

Conservative therapy

- Causal treatment of the underlying disease;
- Reducing the load on the upper limb;
- Middle position of the hand, limitation of flexion and extension of the wrist (at night, a soft orthosis or bandage on the wrist to maintain the middle position);
- Physiotherapy — ultrasound, laser, magnetotherapy, iontophoresis, mobilization of wrist bones, etc.;
- Nonsteroidal antiphlogistics overall in combination with local therapy;
- Spraying with the application of local anesthetics, steroids or non-steroidal anti-rheumatic drugs;
- Group B vitamins.^{[1][4]}



Carpal Tunnel Syndrome Operation

Surgical therapy

- Moderate to severe disability according to clinical and EMG findings is indicated;
- Decompression of the nerve by dissection of the ligamentum carpi transversum;
- Classic open approach (gold standard) or endoscopy;^{[1][4]}
- In LA this procedure is performed on an outpatient basis;
- There are quite a few complications - insufficient cutting of the ligament (insufficient incision, use of the so-

called blind retinaculum...).[3]

Cubital tunnel syndrome

Consists of collateral ulnar ligament, medial epicondyle of the humerus, olecranon and aponeurosis of the *flexor carpi ulnaris muscle*.

Etiology

In general, there is an enlargement of the surrounding structures and oppression of the ulnar nerve.

The most common causes are:

- **after fractures** - a hypertrophic muscle develops.
- **professional load - long-term** elbow flexion (glass grinders).

Clinical manifestations

- **tingling of the 4th and 5th fingers**, numbness of the fingers often even **paresis and atrophy**
- **typical difficulties** - when fastening a belt, turning on a zipper, a button.
- **in severe cases** - claw-like hand and paralysis of the interosseous muscle.

Meralgia paraesthetica

Disorders of peripheral nerves

Peripheral nerve tumors can arise from **Schwann cells, fibroblasts** or **perineural cells**.

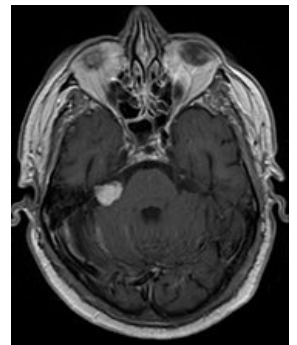
Among the most important representatives are "neurinoma (*schwannoma, neurilema*)", *neurofibroma, tumor of granular cells*, as well as perineurioma, neurothecoma or malignant peripheral nerve sheath tumor (MPNST - malignant peripheral nerve sheath tumor).

Schwannoma

- Occurs either sporadically or as part of **neurofibromatosis type II**.
 - In neurofibromatosis, these are usually multiple, chain-like tumors of various sizes on many nerves.
- The tumor usually destroys the fascicle from which it originates, the other fascicles follow the tumor and are stretched and compressed.
- They are also of considerable size.
- **Therapy:** the tumor has a capsule, the functional fascicles are usually easily separated from the capsule and only the tumor is removed.
 - Paresis may improve over time.
- In the histological image, two variants of the tumor are visible, referred to as *Antoni variant A and B*. Type A is characterized by its staggered nuclei, such an arrangement is referred to as Verocay bodies. Type B shows a more myxoid character, it does not contain stapling of the nuclei. Both variants can be found in the same tumor.



Scars from carpal tunnel release surgery. Two different techniques were used. The left scar is 6 weeks old, the right scar is 2 weeks old.



Schwannoma on MRI

Links

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