JSES Reviews, Reports, and Techniques 5 (2025) 70–78

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Median nerve entrapment neuropathy: a review on the pronator syndrome

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A R T I C L E I N F O

Keywords:
Pronator syndrome
Pronator teres syndrome
Median nerve compression
Nerve entrapment
Neuropathy
Surgical decompression

Level of evidence: Level V; Review Article

Pronator syndrome is a compression neuropathy of the median nerve within the anatomical structures of the elbow and forearm. It presents with neuropathic pain, numbness, and weakness of the forearm and hand, which are often exacerbated by repetitive pronation-supination movements. Patient presentation may mimic the signs and symptoms of carpal tunnel syndrome. Diagnosis requires comprehensive clinical assessment, employing provocative examination along with electrophysiological and imaging studies for accurate evaluation. Treatment strategies encompass conservative measures such as activity modification and physical therapy, whereas surgical intervention may be warranted in severe cases that are refractory to conservative treatment. By reviewing the current literature within the spectrum of median nerve entrapment neuropathies, this review aimed to enhance and summarize the current understanding by consolidating the existing knowledge for improved patient outcomes.

The median nerve is one of the main nerves of the upper extremities. It arises from the brachial plexus, specifically originating from the nerve roots of the fifth cervical vertebra to the first thoracic vertebrae (C5-T1). It divides into the anterior interosseous nerve (AIN) 5-8 cm distal to the lateral epicondyle, which supplies the deep flexors of the forearm.[50] The nerve continues down the forearm to innervate the superficial flexor and thenar muscle groups of the hand. It terminates by providing sensation to the radial surface of the hand. Compression of the median nerve can occur at different levels in the upper extremity. Known entrapment sites include the supracondylar processes at the distal humerus, ligament of Struthers, bicipital aponeurosis, and most commonly between the ulnar and humeral heads of the pronator teres (PT) muscle. Pronator syndrome is an umbrella term used to describe the compression of the median nerve through various anatomical structures of the forearm.[6] It is quite rare; it occurs more commonly in women and in occupations that involves repetitive forearm and wrist movements.[6] The female patients affected are most commonly in their 40s and 50s.[6] Patients mostly present with focal proximal forearm pain and paresthesia extending to the thumb, index, middle finger, and radial half of ring finger. The diagnosis is based on the confluence of history-taking and clinical examination. In addition to electrodiagnostic investigations, nerve conduction studies (NCS) and electromyography tests are also used. Carpal tunnel syndrome (CTS) is the most common compressive neuropathy of the upper limbs, and compression above the level of the carpal tunnel is rare. Differentiating pronator syndrome from CTS and AIN syndrome is crucial for successful treatment. The management of pronator syndrome is primarily conservative; it focuses on physical therapy, immobilization, nonsteroidal anti-inflammatory medications, oral steroids, and local steroid injections.[40] Surgical treatment is reserved for patients in whom conservative management fails. Open-incision surgical release techniques are widely used for decompression. Several studies have described the use of minimally invasive endoscopic median nerve release to avoid the complications associated with open release. Conservative treatment generally provides symptomatic relief in the majority of patients with pronator syndrome, and open surgery and minimally invasive endoscopic releases have shown a high success rate in the literature for patients in whom conservative management fails.

Anatomy and pathology

Median nerve anatomy

The median nerve is named after its central location at the end of the brachial plexus and forearm. It originates from the medial

Institutional review board approval was not applicable to this study.

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https://doi.org/10.1016/j.xrrt.2024.10.001

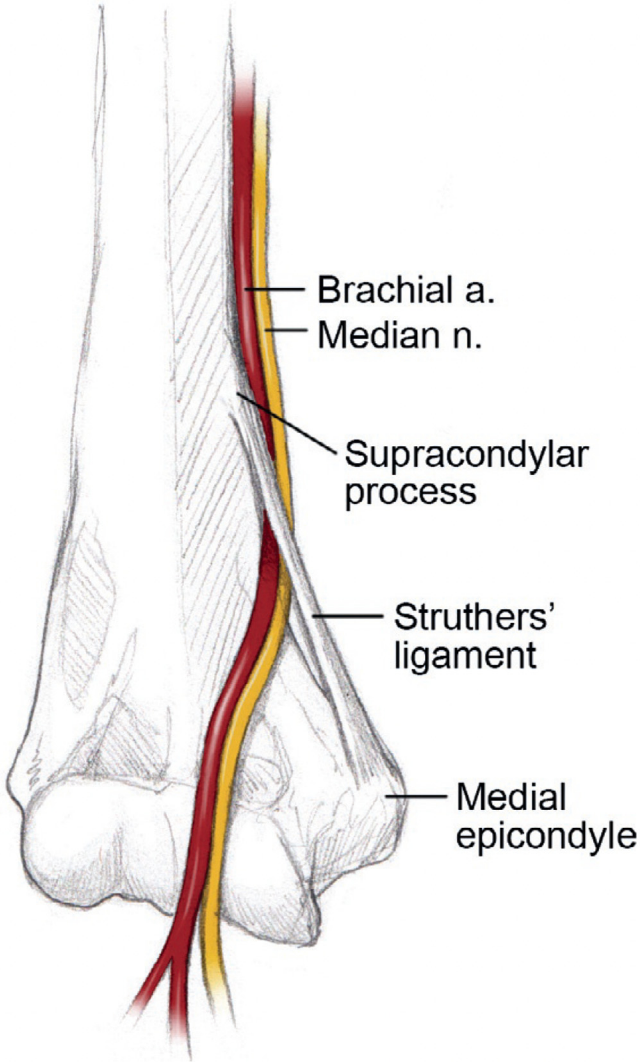

Figure 1 Struthers' ligament of right arm. Reprinted from Nerves and Nerve Injuries, vol.1, Savastano and Yang, Anatomy of the Median Nerve and Its Branches, pp. 553-562, Copyright (2015), with permission from Elsevier.

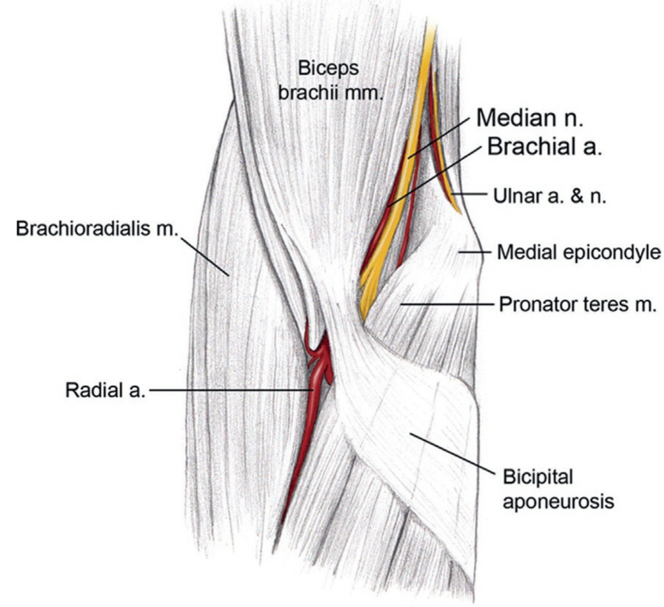

Figure 2 Antecubital fossa of right arm. Reprinted from Nerves and Nerve Injuries, vol.1, Savastano and Yang, Anatomy of the Median Nerve and Its Branches, pp. 553-562, Copyright (2015), with permission from Elsevier.

and lateral cords of the brachial plexus. At the level of the axilla, the median nerve passes anterior to the subscapularis muscle and posterior to the pectoralis major and minor muscles. Superior to the cubital fossa, the nerve runs anterior to the brachialis muscle and descends between the brachialis and biceps brachii muscles. It gives branches to the PT muscle and intra-articular branches to the elbow joint.[46] At the level of the cubital fossa, the nerve lies deep to the brachial artery and the bicipital aponeurosis (BA). Multiple muscular branches supply the flexor carpi radialis, palmaris longus, and flexor digitorum superficialis (FDS). The median nerve then descends between the 2 heads of the PT. Midway between the 2 heads of the PT, the median nerve gives rise to the AIN, which supplies the anterior deep muscles of the forearm. After crossing the PT muscle, the median nerve travels within the sublimis bridge of the FDS muscle and continues down to the distal forearm to give rise to the palmar cutaneous nerve, which supplies sensation to the palm of the hand. After emerging from the carpal tunnel at the level of the wrist joint, the nerve gives 2 terminal branches: the recurrent branch, which supplies the muscles of the thenar eminence and the palmar digital nerve, which provides sensation to the palm of the hand and fingers.[45]

Median nerve neuropathy

Entrapment of the median nerve can occur at 5 different sites within its course. The first is compression by a supracondylar humerus spur and by the ligament of Struthers (Fig. 1). The ligament of Struthers is a fibrous band running from the medial epicondyle to a bony spur on the distal medial humerus and is seen in only 1%-2% of the population.[15] The ligament of Struthers has not been constantly found to be associated with the presence of a supracondylar humeral process.[9] In a cadaveric study of 60 dissected arms, the ligament was identified in 6 arms and the supracondylar process was absent in all cadavers.[9] The ligament is viewed as an uncommon source of upper-limb neuropathies.[9] In a meta-analysis exploring 6 studies with a total of 513 arms, only a single study reported neurological entrapment by the ligament.[31] The second site is possible compression of the median nerve beneath the BA (Fig. 2). This is attributable to the different anatomical and structural variations of this membranous band. The contribution to the formation of the BA can vary from the long or short head of the biceps brachii muscle.[11] Thickened BA was found to be a risk factor contributing to nerve compression in cadaveric studies.[11] Anatomical variations can alter the shape and thickness of the BA, resulting in some patients having an accessory BA, leading to partial median nerve compression.[18,46] The release of BA at the level of the elbow causes a significant decrease in the median nerve perineural pressure during elbow flexion.[4,46] The third site is compression between the 2 heads of the PT muscle. The relationship between the median nerve and the PT muscle varies. In a cadaveric study of 50 isolated upper limbs, the nerve passed between the 2 heads in 74% of the cases, under the 2 heads in 12%, and the presence of only the humeral head was observed in 14% of the cadavers.[10,35] Anatomical differences may narrow the nerve course and act as a contributing factor to median nerve compression.[35,36] Furthermore, the presence of a thickened tendinous band between the 2 muscle heads, in addition to a high insertion point of the muscle, was found to contribute to

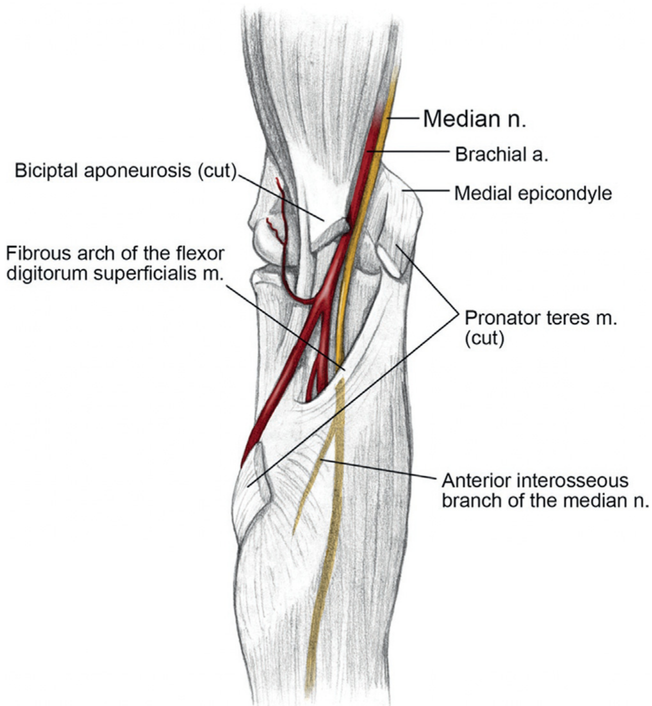

Figure 3 Cutaway view of right elbow showing deep dissection of median nerve as it enters the forearm. Reprinted from Nerves and Nerve Injuries, vol.1, Savastano and Yang, Anatomy of the Median Nerve and Its Branches, pp. 553-562, Copyright (2015), with permission from Elsevier.

Table I
Sites of median nerve entrapment and anatomical differences.

Sites of median nerve entrapment	Structural anatomical differences
Supracondylar ridge of the humerus	Presence of struthers ligament/ Supracondylar bone spur
BA	Thickened/Accessory BA
PT muscle	Tendinous band in between muscle heads/high-PT insertional point
FDS arch	Narrow FDS aponeurotic arch
Mass effect forearm compression	Lipomas/Schwannoma/ Neurolymphomatosis/Hematoma
Wrist carpal tunnel	Thickened transverse carpal ligament

BA, bicipital aponeurosis; *PT*, pronator teres; *FDS*, flexor digitorum superficialis.

median nerve entrapment.[20,29] The fourth site is compression caused by the aponeurotic arch of the FDS (Fig. 3). Patients often present with focal neuropathic pain and paresthesia within the proximal forearm.[17] In a study involving 36 patients who underwent median nerve release, compression by the FDS was observed in 22 patients and 15 of the patients had symptomatic improvement postoperatively.[20] In a different study, compression by the FDS arcade was recognized in 12 of 32 forearms, and the majority of the patients experienced excellent outcomes postoperatively.[35] The fifth site is compression within the carpal tunnel. CTS neuropathy is more commonly observed than pronator syndrome. The 2 syndromes can mimic each other and can occur simultaneously in what is known as the double crush syndrome.[15] Other rare causes of pronator syndrome have been mentioned in the literature, including lipomas, schwannomas, neurolymphomatosis, and in trauma patients receiving anticoagulation treatment.[1,2,16,49,51] These conditions are mainly caused by a mass effect within the tight muscular compartments of the forearm (Table I).

Figure 4 Forearm compression test. Reprinted from New Mini-invasive Decompression for Pronator Teres Syndrome, Eduardo R. Zancolli III, , Eduardo P. Zancolli IV, Christian Jorge Perrotto. Copyright (2012), with permission from Elsevier.

Figure 5 Resisted forearm pronation. Kasparyan, N.G., Weiland, (2002). Pronator Syndrome. pp 141-147. Operative Treatment of Elbow Injuries. Springer), Reproduced with permission from Springer Nature.

Clinical presentation

The diagnosis of pronator syndrome is mainly based on medical history and clinical examination. Patients affected by the syndrome are usually involved in activities involving constant forearm movement, as seen in carpenters and machine milkers.[47] Patients tend to present with aching pain affecting the proximal forearm. The palmar cutaneous branch is usually affected, causing numbness and tingling extending to the palm of the hand. Similar to CTS, paresthesia affects the index, middle, and ring fingers. Multiple provocative maneuvers can be utilized to aid in diagnosis. First, focal forearm tenderness can be elicited upon palpation, in line with a positive pronator compression test result and Tinel's sign at the proximal forearm (Fig. 4). Second, pain with resisted elbow flexion was observed with BA entrapment. Third, compression of the nerve between the 2 heads of the PT causes pain with resisted forearm pronation in the extended elbow (Fig. 5). Finally, FDS arch compression can be

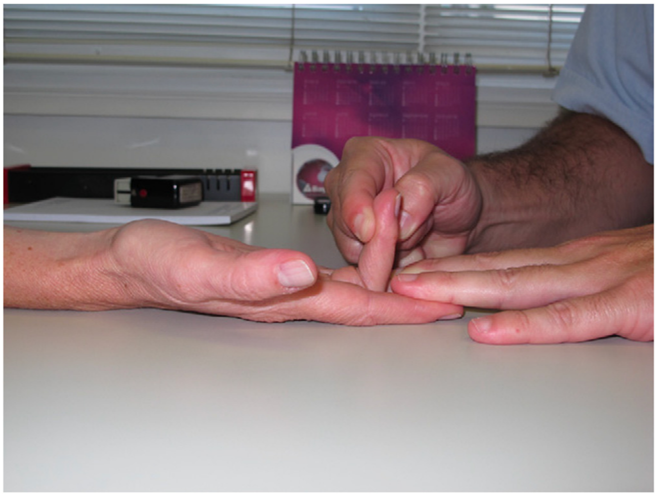

Figure 6 Flexor digitorum superficialis test. Reprinted from New Mini-invasive Decompression for Pronator Teres Syndrome, Eduardo R. Zancolli III, , Eduardo P. Zancolli IV, Christian Jorge Perrotto. Copyright (2012), with permission from Elsevier.

tested with resisted flexion of the isolated middle finger FDS tendon with the elbow fully extended (Fig. 6). In contrast to pronator syndrome and CTS, patients diagnosed with AIN syndrome present with pure motor findings.[3] Certain symptoms and clinical findings of pronator syndrome can help differentiate it from CTS. First, pain is mainly felt over the proximal volar forearm; second, loss of sensation affects the thenar eminence due to the involvement of the palmar cutaneous nerve.[42] Thenar eminence atrophy can be seen in patients with CTS. Third, wrist pain at night is frequently associated with CTS.[38] Double crush syndrome represents the concurrence of both conditions in the affected patients. The prevalence of pronator syndrome among patients with CTS is 6%-11.5% in different studies.[5,21] Other proximal causes of upper-limb pain and numbness, such as cervical radiculopathy and thoracic outlet syndrome, can be ruled out with a detailed history and physical examination.

Evaluation

The diagnosis of pronator syndrome is based on the clinical presentation and physical examination. Different diagnostic modalities can be used to confirm a diagnosis and assist in the exclusion of other pathological conditions. Anatomical variations in the distal humerus should be considered when evaluating patients with neuropathic forearm symptoms. They are seen in 0.3%-2.7% of the population.8 Elbow radiographs are required as part of the workup to exclude supracondylar humeral processes. In most cases, NCS and electromyographystudies are negative.[30,39] A positive electrodiagnostic test can be helpful in confirming the diagnosis in certain cases. A nerve conduction test can show a slow motor conduction in the forearm with normal distal motor latency.[34] Sensory and motor amplitudes are seen to be lower than conduction velocities.[14] Unlike pronator syndrome, the majority of patients affected with CTS will show diagnostic findings on NCS studies.[37] A decrease in the median nerve conduction velocity across the wrist and increased distal motor latency is indicative of CTS.[41] Ultrasonography is a practical, quick, and dependable way to diagnose nerve entrapment conditions.[22] It is a useful tool for examination of the PT muscle while allowing fixed and dynamic assessments of the median nerve.[12] Sonography and magnetic resonance imaging (MRI) can be helpful in ruling out space-occupying lesions contributing to median nerve compression, as reported previously.[2,16,49,51] The role of MRI in

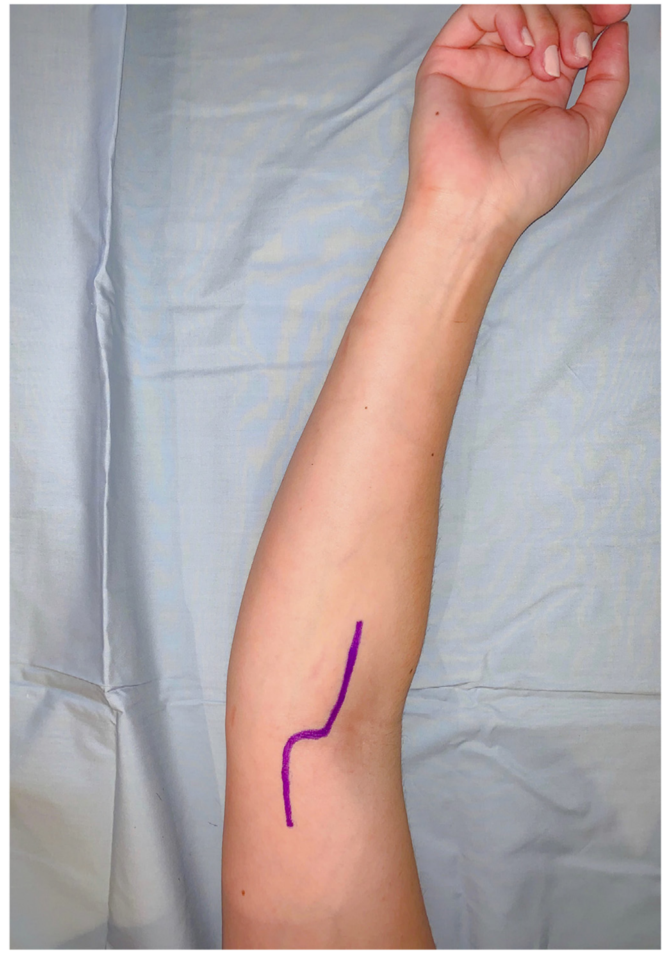

Figure 7 Surgical incision. Lazy S volar incision for proximal median nerve decompression. The incision can be extended proximally to release a ligament of Struthers if needed. Reprinted from Proximal Median Nerve Compression: Pronator Syndrome, Jeremy A. Adler, Jennifer Moriatis Wolf, The Journal of Hand Surgery, Copyright (2020), with permission from Elsevier.

proximal forearm entrapment neuropathies is growing in the literature. Images may display a hyperintense signal changes secondary to denervation edema of the anterior forearm muscles.[26-27] In patients with compression neuropathy at the level of the BA, post-exercise MRI with contrast shows high signal intensity within the PT.[31] Other techniques, such as ultrasound-guided corticosteroid injections, have recently started to be used as both diagnostic and therapeutic measure. Early studies have shown excellent symptomatic improvement in the short term; however, further studies are needed to validate its long-term effectiveness.[13,43] The diagnosis of pronator syndrome can be challenging and requires a comprehensive clinical and diagnostic approach for optimal patient assessment and treatment.

Management

Nonoperative management

Nonoperative management is the initial treatment of choice for most patients. Conservative treatment has proven reliable and shown satisfactory results in most patients.[23] The patient should be followed up for a total of 3-6 months before other treatment modalities are sought. Rest and immobilization play important roles in improving patient symptoms. Patients are advised to

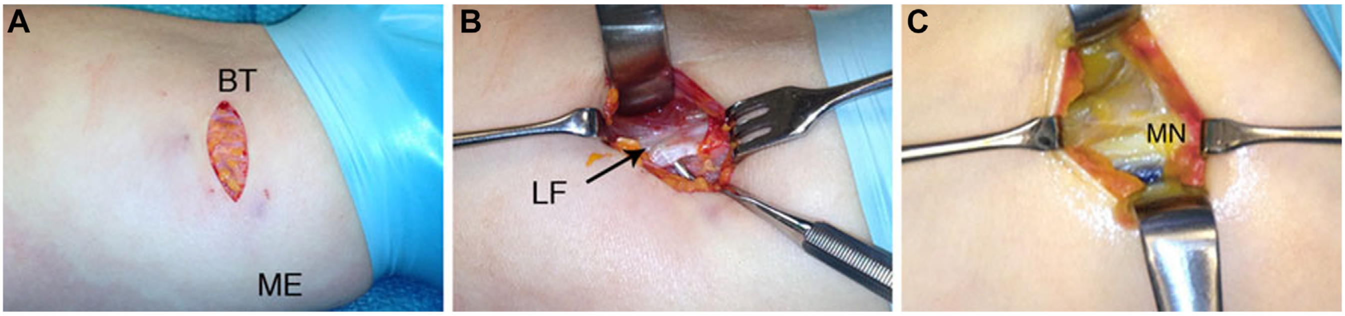

Figure 8 Surgical release of the median nerve at the level of the lacertus fibrosus (lacertus tunnel syndrome). **(A)** A transverse incision is placed from just medial to the biceps tendon to just lateral to the medial epicondyle. Following blunt dissection. of the subcutaneous tissue, the pronator teres fascia is opened, and the muscle was retracted medially. **(B)** The lacertus fibrosus is carefully isolated (arrow) and divided in its entire length while the median nerve is kept under visual control. **(C)** With the pronator teres retracted medially, the median nerve is easily seen after division of the lacertus fibrosus. Reprinted from Clinical diagnosis and wide-awake surgical treatment of proximal median nerve entrapment at the elbow: a prospective study. Elisabet Hagert, Hand Journal (Volume: 8 and Issue:1) pp. 6. Copyright © 2013 by (Sage Publications). Reprinted by Permission of Sage Publications.

avoid heavy work and labor involving recurrent forearm and wrist motions. Avoiding activities that require repeated pronosupination and a strong grip is essential. An elbow splint will be applied for 2-4 weeks to avoid forearm rotation. The splint is worn at night and intermittently during the daytime. Physiotherapy is the principal component of conservative treatment. Median nerve gliding is a manual technique that aids in stretching and releasing the compressed nerve. Its effectiveness has shown mixed results in the literature.[23] Nonsteroidal anti-inflammatory drugs are over-the-counter analgesic medications with anti-inflammatory properties. Despite their widespread use, their efficacy in the treatment of neuropathic pain remains unclear.[32] Recent minimally invasive treatments have shown promising results. Ultrasound-guided hydrodissection is an emerging technique for separating tissue planes and releasing the entrapped nerves. This technique uses fluids such as normal saline, sterile water, or 5% dextrose in water injected into the forearm to separate the entrapped nerves from the surrounding soft tissue. More than 75% pain relief was seen following ultrasound-guided nerve hydrodissection with steroid injection.[13] As other studies also report favorable outcomes, further research is needed for validation of this treatment modality.[42]

Operative management

Surgical interventions have yielded excellent results. Surgery is considered the last treatment option for such cases. Most authors recommend conservative treatment as the first line of management for 3-6 months. Surgical interventions for median nerve release fall into 3 categories: wide expander open release, limited expander open release, and endoscopy-assisted minimally invasive decompression surgery. The wide exposure release starts with a 6-8-cm extended incision in a lazy S shape, oblique, or transverse pattern (Fig. 7). The key technical steps in each approach include identification and protection of the medial and lateral antebrachial cutaneous nerve followed by incising and dividing the fascia of flexor-pronator mass and retracting them medially to expose the median nerve and decompression of the nerve between the superficial and deep heads.[28,40] This method allows for a step-wise decompression of the ligament of Struthers, lacertus fibrosus, PT superficial and deep head, and FDS fibrous arch. It offers the advantages of increasing the probability of symptomatic relief, managing concomitant neuropathy with a single exposure, and identifying and addressing the ligament of Struthers and bone spurs.[28,40,48] A wide surgical incision is required for the treatment of the supracondylar humerus process and the accompanying ligament of Struthers compression of the median nerve. The choice of approach is determined by the side and proximity of the bony processes. After excision and decompression, patient symptoms are seen gradually resolved over the course of 5 months postoperatively.[8,44] The disadvantages are related to extensive soft tissue dissection, extended surgical wounds, and neurovascular compromise. Limited-exposure open-release techniques offer a limited soft tissue dissection, more cosmetic surgical wounds, and decreased operative time. Limited exposure decompression of the median nerve at the level of the distal BA can be performed using a single- or 2-incision technique.[21,28] Releasing the BA can be done utilizing a 2-3-cm transverse single incision, 1-cm medial of the biceps tendon, and 2-cm lateral of the medial epicondyle (Fig. 8).[19] Two incision techniques proximal and distal to the elbow can also be used to avoid crossing the antecubital fossa. This technique has reported good outcomes at follow-up 1 month after surgery.[23] For PT decompression, a 3.5-cm oblique incision (from proximal-medial to distal-lateral) is used 6-cm distal to the medial epicondyle and over the flexor/pronator muscles. The limitations of limited exposure decompression include the need for multiple incisions for concomitant neuropathy, the possibility of incomplete median nerve release, the specific nerve compression site that needs to be confirmed beforehand, and management of the ligament of Struthers and bone spurs that need wider exposure (Table II). Recently, endoscopically assisted pronator release of the median nerve has been reported. The advantages of endoscopically assisted pronator release compared with the standard open approach include fewer deforming scars, fewer surgical site complications, and faster recovery times.[7,25] The incision site is approximately 3-cm medial to the biceps tendon and 3-4-cm above the antecubital crease. A 4.0-mm endoscopic camera is used for visualization, and a long nasal speculum is required for blunt soft tissue dissection (Fig. 9). Dissecting scissors are used under endoscopic view to release the BA, fibrous band of the PT, fibrous arch of the FDS (Fig. 10).[7] Possible complications associated with this technique include residual pain with forearm activity, transient AIN palsy, surgical site hematoma, and surgical site and scar tenderness (Table II). The overall outcomes of using this technique are encouraging.[25,52]

Prognosis and complications

The prognosis of pronator syndrome largely depends on the timing of diagnosis, severity of nerve compression, and effectiveness of treatment interventions. Early recognition and prompt initiation of appropriate therapy are paramount for achieving favorable outcomes. A key aspect that influences prognosis is the degree of nerve entrapment. In mild cases where compression is

Table II
Treatment summary of pronator syndrome.

<table>
<tr><th>Treatment</th><th>Description</th><th>References</th></tr>
<tr><td>Activity Modification/Splinting/Physical Therapy/Nerve Gliding/Therapeutic Ultrasound//Nonsteroidal Anti-inflammatory Drugs /Corticosteroids injections</td><td>1- Advantages:
Activity and life style modifications, avoiding the risks of surgical interventions
2- Disadvantages:
Mandate patients' compliance, may interfere with occupational and work productivity, prolonged treatment duration as final outcomes are evaluated 6 mo after starting therapy
3- Prognosis and complications:
Data and clinical reports are still limited on the role of conservative treatment of pronator syndrome, several studies reported improvement in 29% to 70% of patients, most sources in the literature recommend 3-6 mo of conservative treatment before planning any surgical interventions.</td><td>13,24,33,42</td></tr>
<tr><td>Complete Exposure Open Median Nerve Release</td><td>1- Incision and Approach
(A) Longitudinal/Oblique incision: 6-8-cm longitudinal incision along the radial edge of flexor-pronator mass and 4-cm distal to the cubital flexion crease
(B) Transverse incision: 6-8-cm transverse incision is made at the volar aspect of the forearm 4-cm distal to the cubital flexion crease
(C) lazy S-shaped incision: Starting on the medial elbow superior to the antecubital flexion crease and extending distally along the PT muscle
2- Technique:
(A) Lazy S-shaped incision:
- Exploration of the median nerve proximal to the antecubital flexion crease
- Identifying the median nerve proper and exploring for the presence of the ligament of Struthers
- Distal exploration of the median nerve through lacertus fibrosus, PT and the arch of FDS
(B) Longitudinal/Oblique incision:
- Identifying and protection of the medial antebrachial cutaneous nerve and cubital vein
- Incising and dividing the fascia of flexor-pronator mass
- Exposing the median nerve by retracting the flexor-pronator mass medially followed by distal nerve release as required
(C) Transverse incision:
- Identifying and protection of the medial and lateral antebrachial cutaneous nerve and cubital vein
- Incising and dividing the fascia of flexor-pronator mass and lacertus fibrosus
- Exposing and isolating the median nerve
- The aponeurotic fibers and the deep head of PT along the arch of FDS are released
3- Advantages:
Wide surgical exposure increases the probability of symptomatic relief, concomitant neuropathy can be managed with a single exposure, ligament of Struthers and bone spurs can be identified and addressed accordingly
4- Disadvantages:
Extensive soft tissue dissection, extended surgical wound, neurovascular compromise
5- Prognosis and complications:
complete symptomatic relief in majority of patients with some patients experiencing recurrent symptoms of pain and paresthesia</td><td>28,40,48</td></tr>
<tr><td>Limited Exposure Open Median Nerve Release</td><td>1- Incision and Approach:
(A) Bicipital aponeurosis release: A 2-3-cm transverse incision is placed in the flexion crease of the cubital fossa, from 1 cm medial of the biceps tendon to 2-cm lateral of the medial epicondyle.
(B) PT release: A 3.5-cm oblique incision starting proximal-medial and ending distal-lateral, 6 cm distal to the medial epicondyle and over the flexor/pronator muscles
2- Technique:
(A) Bicipital aponeurosis release:- Subcutaneous dissection to the PT fascia
- Identifying and protection of the branches of medial antebrachial cutaneous nerve
- Incising the PT fascia to expose the lacertus fibrosus
- Dividing the lacertus fibrosus and exposing the median nerve
(B) PT release:- Subcutaneous dissection to medial cutaneous nerve of the forearm
- Identification and protection of the medial cutaneous nerve of the forearm
- Incising the fascia of the flexor/pronator muscles
- Incising the septum between the PT and Flexor Carpi Radialis and the deep aponeurosis of the PT to expose the median nerve
3- Advantages:
Limited soft tissue dissection, Cosmetic Surgical wound, Decrease Operative Time
4- Disadvantages:
Need of multiple incisions for concomitant neuropathy, Incomplete release of the nerve, specific nerve compression site needs to be identified beforehand, ligament of Struthers and bone spurs need a wider exposure
5- Prognosis and complications:
Most patients showed complete relief of pain and paresthesia postoperatively, while few patients had occasional paresthesia and pain on follow-ups.</td><td>19,21,28</td></tr>
</table>

(*continued on next page*)

Table II (*continued*)

Treatment	Description	References
Endoscopic Minimally Invasive Median Nerve Release	**1- Incision and Approach:** 3-cm incision is made medial to the bicep tendon and 3-4-cm Superior to the antecubital crease. **2- Technique:** (A) Long nasal speculum is used for soft tissue separation around the Median Nerve. (B) A 30 endoscopic camera is introduced for median nerve identification (C) Dissecting scissors are used under endoscopic view to release the bicipital aponeurosis, fibrous band of the PT, fibrous arch of the FDS. **3- Advantages:** Small incision, minimized soft-tissue trauma, decreased operative time **4- Disadvantages:** Need of multiple incisions for concomitant neuropathy, Incomplete nerve release, long learning curve for proficiency, ligament of Struthers and bone spurs need a wider exposure **5- Prognosis and complications:** Overall positive outcomes and patient. satisfaction reported complications include, Forearm discomfort, Scar tenderness, Residual pain with Forearm activity. Other rare complications as transit AIN palsy and hematoma formation were also reported·	7,25,52

PT, pronator teres; *FDS*, flexor digitorum superficialis; *AIN*, anterior interosseous nerve.

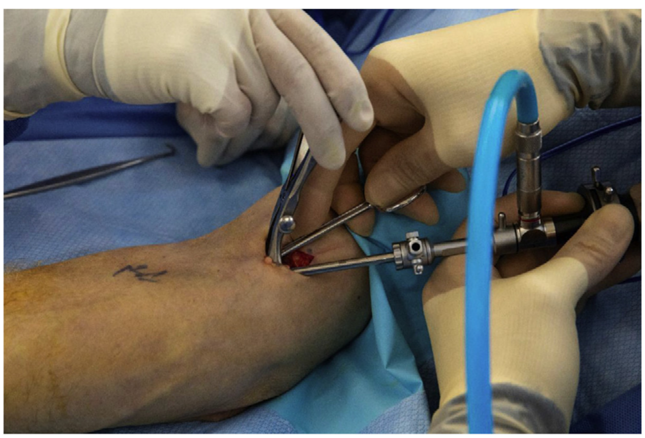

Figure 9 Instrument positioning during endoscopic proximal median nerve decompression . Reprinted from Endoscopic Proximal Median Nerve Decompression: An Alternative Treatment for Pronator Syndrome, Scott A. Barnett, Sagar A. Shah, Rasheed I. Ahmad. Copyright (2021), with permission from Elsevier.

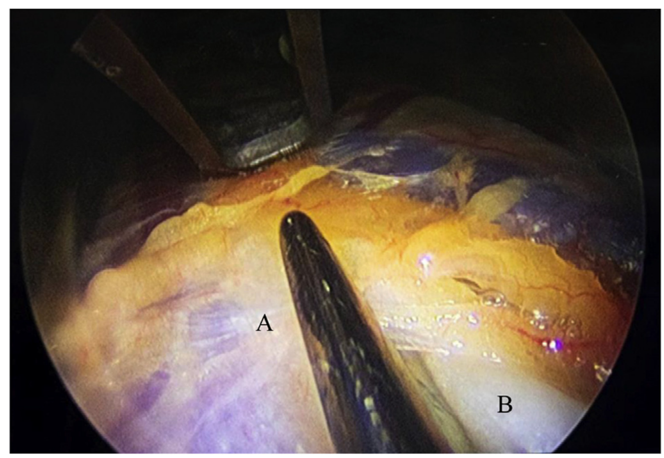

Figure 10 Endoscopic view of proximal median nerve decompression with tenotomy scissors. **(A)** The fascia of the PT overlying the **(B)** median nerve is carefully released under direct visualization. Reprinted from Endoscopic Proximal Median Nerve Decompression: An Alternative Treatment for Pronator Syndrome, Scott A. Barnett, Sagar A. Shah, Rasheed I. Ahmad. Copyright (2021), with permission from Elsevier. *PT*, pronator teres.

identified early, conservative measures such as activity modification, splinting, and physical therapy may be sufficient, leading to the complete resolution of symptoms. However, in cases of advanced nerve compression or chronic neglect, Wallerian nerve degeneration may occur, leading to persistent symptoms and necessitating more aggressive intervention.[24] Surgical decompression is often considered when conservative measures fail or in cases of severe nerve compression. Studies have shown that surgical intervention can lead to significant improvement in symptoms and functional outcomes, particularly when the exact pathological area is identified and addressed.[53] However, similar to any surgical procedure, risks such as infection, scar tissue formation, and incomplete relief of symptoms must be considered.[53] The overall prognosis of pronator syndrome is generally favorable with appropriate management. Studies have reported high rates of symptom relief and functional improvement following conservative and surgical interventions.[14] However, individual variability exists, and some patients may experience residual and recurrent symptoms despite treatment.[14] It is essential to address contributing factors such as ergonomic issues, repetitive activities, and underlying medical conditions to prevent recurrence and optimize long-term outcomes. Multidisciplinary approaches involving orthopedic surgeons, physical therapists, and occupational therapists are often necessary to tailor treatment plans to individual patient needs and optimize functional recovery. Long-term follow-up is essential to monitor recurrence, assess treatment efficacy, and address residual symptoms or functional deficits. Patient education on self-management strategies and ergonomic principles can empower individuals to play an active role in their recovery and minimize the risk of recurrence. In conclusion, while pronator syndrome poses challenges in diagnosis and management, the prognosis is generally favorable with timely and appropriate intervention. Collaborative efforts between healthcare providers and patients are essential for optimizing outcomes and improving the quality of life of individuals affected by this condition.

Conclusion

Pronator syndrome is a compression neuropathy of the median nerve of the forearm. It is a rare condition that is more common in women and people who perform repetitive forearm and wrist movements. Symptoms of pronator syndrome include pain in the forearm and numbness or tingling of the thumb and the index, middle, and ring fingers. Pronator syndrome can be difficult to diagnose because it can mimic other more common conditions such as CTS. Clinical diagnosis is based on diagnostic and imaging studies. The treatment of pronator syndrome is usually conservative, with physical therapy and splinting being the mainstays of treatment. Surgery is preserved for patients in whom conservative treatment fails, and the outcomes of nonoperative and operative management are satisfactory in the literature.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The author, their immediate family, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Adler JA, Wolf JM. Proximal median nerve compression: pronator syndrome. J Hand Surg Am 2020;45:1157-65. https://doi.org/10.1016/j.jhsa.2020.07.006.
2. Afshar A. Pronator syndrome due to schwannoma. J Hand Microsurg 2015;7: 119-22. https://doi.org/10.1007/s12593-013-0115-1.
3. Aljawder A, Faqi MK, Mohamed A, Alkhalifa F. Anterior interosseous nerve syndrome diagnosis and intraoperative findings: a case report. Int J Surg Case 2016;21:44-7. https://doi.org/10.1016/j.ijscr.2016.02.021.
4. Archambault G, Boudier-Revéret M, Hagert E, Effatparvar MR, Sobczak S. Effect of lacertus fibrosus release on perineural pressure of the median nerve at the elbow: a cadaveric study. Int Orthop 2023;47:1277-84. https://doi.org/10.1007/s00264-023-05735-8.
5. Asheghan M, Hollisaz MT, Aghdam AS, Khatibiaghda A. The prevalence of pronator teres among patients with carpal tunnel syndrome: cross-sectional study. Int J Biomed Sci 2016;12:89-94.
6. Balcerzak AA, Ruzik K, Tubbs RS, Konschake M, Podgórski M, Borowski A, et al. How to differentiate pronator syndrome from carpal tunnel syndrome: a comprehensive clinical comparison. Diagnostics 2022;12:2433. https://doi.org/10.3390/diagnostics12102433.
7. Barnett SA, Shah SA, Ahmad RI. Endoscopic proximal median nerve decompression: an alternative treatment for pronator syndrome. J Hand Surg Glob Online 2021;3:210-4. https://doi.org/10.1016/j.jhsg.2021.03.006.
8. Bhatnagar S, Iwanaga J, Dumont AS, Tubbs RS. Lateral supracondylar spur process of the humerus. Cureus 2021;13, e13514. https://doi.org/10.7759/cureus.13514.
9. Caetano EB, Sabongi JJ Neto, Vieira LA, Caetano MF, de Bona JE, Simonatto TM. struthers' ligament and supracondylar humeral process: an anatomical study and clinical implications. Acta Ortop Bras 2017;25:137-42. https://doi.org/10.1590/1413-785220172504168330.
10. Caetano EB, Vieira LÂ, Sprovieri FA, Petta GC, Nakasone MT, Serafim BL. Anatomical variations of pronator teres muscle: predispositional role for nerve entrapment. Rev Bras Ortop 2017;52:169-75. https://doi.org/10.1016/j.rboe.2017.02.003.
11. Caetano EB, Vieira LA, Almeida TA, Gonzales LAM, Bona JE, Simonatto TM. Bicipital aponeurosis. Anatomical study and clinical implications. Rev Bras Ortop 2017;53:75-81. https://doi.org/10.1016/j.rboe.2017.11.014.
12. Créteur V, Madani A, Sattari A, Bianchi S. Sonography of the pronator teres: normal and pathologic appearances. J Ultrasound Med 2017;36:2585-97. https://doi.org/10.1002/jum.14306.
13. Delzell PB, Patel M. Ultrasound-guided perineural injection for pronator syndrome caused by median nerve entrapment. J Ultrasound Med 2020;39:1023-9. https://doi.org/10.1002/jum.15166.
14. Dididze M, Tafti D, Sherman AL. Pronator Teres Syndrome. In: StatPearls. StatPearls Publishing; 2023.
15. Flak M, Durmala J, Czernicki K, Dobosiewicz K. Double crush syndrome evaluation in the median nerve in clinical, radiological and electrophysiological examination. Stud Health Technol Inf 2006;123:435-41.
16. Gan HK, Azad A, Cher L, Mitchell PL. Neurolymphomatosis: diagnosis, management, and outcomes in patients treated with rituximab. Neuro Oncol 2010;12:212-5. https://doi.org/10.1093/neuonc/nop021.
17. Guo B, Wang A. Median nerve compression at the fibrous arch of the flexor digitorum superficialis: an anatomic study of the pronator syndrome. Hand (N Y) 2014;9:466-70. https://doi.org/10.1007/s11552-014-9639-5.
18. Hagert E, Jedeskog U, Hagert CG, Marín Fermín T. Lacertus syndrome: a ten year analysis of two hundred and seventy five minimally invasive surgical decompressions of median nerve entrapment at the elbow. Int Orthop 2023;47:1005-11. https://doi.org/10.1007/s00264-023-05709-w.
19. Hagert E. Clinical diagnosis and wide-awake surgical treatment of proximal median nerve entrapment at the elbow: a prospective study. Hand (N Y) 2013;8:41-6. https://doi.org/10.1007/s11552-012-9483-4.
20. Hartz CR, Linscheid RL, Gramse RR, Daube JR. The pronator teres syndrome: compressive neuropathy of the median nerve. J Bone Jt Surg Am Vol 1981;63: 885-90.
21. Hsiao CW, Shih JT, Hung ST. Concurrent carpal tunnel syndrome and pronator syndrome: a retrospective study of 21 cases. Orthop Traumatol Surg Res 2017;103:101-3. https://doi.org/10.1016/j.otsr.2016.10.009.
22. Kanagasabai K. Ultrasound of median nerve in the diagnosis of carpal tunnel syndrome-correlation with electrophysiological studies. Indian J Radiol Imaging 2022;32:16-29. https://doi.org/10.1055/s-0041-1741088.
23. Kraemer MR, Corriveau MD, Tuite MJ, Hanna AS. Surgical decompression of an accessory bicipital aponeurosis associated with median neuropathy in the antecubital fossa: a case report. Surg Neurol Int 2021;12:615. https://doi.org/10.25259/SNI_520_2021.
24. Lee MJ, LaStayo PC. Pronator syndrome and other nerve compressions that mimic carpal tunnel syndrome. J Orthop Sports Phys Ther 2004;34:601-9. https://doi.org/10.2519/jospt.2004.34.10.601.
25. Lee AK, Khorsandi M, Nurbhai N, Dang J, Fitzmaurice M, Herron KA. Endoscopically assisted decompression for pronator syndrome. J Hand Surg 2012;37:1173-9. https://doi.org/10.1016/j.jhsa.2012.02.023.
26. Lee HJ, Kim I, Hong JT, Kim MS. Early surgical treatment of pronator teres syndrome. J Korean Neurosurg Soc 2014;55:296-9. https://doi.org/10.3340/jkns.2014.55.5.296.
27. Low YL, Singbal SB, Zhang J. Pronator syndrome: an uncommon median nerve entrapment syndrome. Am J Phys Med Rehabil 2019;98:e6-7. https://doi.org/10.1097/PHM.0000000000000973.
28. Luangjarmekorn P, Tsai TM, Honsawek S, Kitidumrongsook P. Role of pronator release in revision carpal tunnel surgery. SICOT J 2016;2:9. https://doi.org/10.1051/sicotj/2016006.
29. Mcculloch RA, Maclean SBM, Dhaliwal J, Simons AW. Median nerve compression secondary to a high insertion of pronator teres. Shoulder Elbow 2010;2: 124-6. https://doi.org/10.1111/j.1758-5740.2010.00051.x.
30. McGurk K, Tracey JA, Daley DN, Daly CA. Diagnostic considerations in compressive neuropathies. J Hand Surg Glob Online 2022;5:525-35. https://doi.org/10.1016/j.jhsg.2022.10.010.
31. Mehl A, Stevenson J, Royal JT, Lourie GM. Lacertus syndrome: use of pre- and post-exercise MRI to aid in diagnosis and treatment. Radiol Case Rep 2021;16: 1113-7. https://doi.org/10.1016/j.radcr.2021.02.022.
32. Mizia E, Zarzecki MP, Pekala JR, Baginski A, Kaythampillai LN, Golebiowska M, et al. An anatomical investigation of rare upper limb neuropathies due to the Struthers' ligament or arcade: a meta-analysis. Folia Morphol 2021;80:255-66. https://doi.org/10.5603/FM.a2020.0050.
33. Moore RA, Chi CC, Wiffen PJ, Derry S, Rice AS. Oral nonsteroidal anti-inflammatory drugs for neuropathic pain. Cochrane Database Syst Rev 2015;2015:CD010902. https://doi.org/10.1002/14651858.CD010902.pub2.
34. Morris HH, Peters BH. Pronator syndrome: clinical and electrophysiological features in seven cases. J Neurol Neurosurgery Psychiatry 1976;39:461-4.
35. Olehnik WK, Manske PR, Szerzinski J. Median nerve compression in the proximal forearm. J Hand Surg Am 1994;19:121-6.
36. Olewnik Ł, Podgórski M, Polguj M, Wysiadecki G, Topol M. Anatomical variations of the pronator teres muscle in a Central European population and its clinical significance. Anat Sci Int 2018;93:299-306. https://doi.org/10.1007/s12565-017-0413-y.
37. Owolabi LF, Reda AA, Raafat A, M Fares DM, Enwere OO, Mba UA, et al. Nerve conduction study findings and their predictors in clinically diagnosed patients with carpal tunnel syndrome in a saudi population. Niger J Clin Pract 2021;24: 1423-9. https://doi.org/10.4103/njcp.njcp_459_20.
38. Patel A, Culbertson MD, Patel A, Hashem J, Jacob J, Edelstein D, et al. The negative effect of carpal tunnel syndrome on sleep quality. Sleep Disord 2014;2014, 962746. https://doi.org/10.1155/2014/962746.
39. Rehak DC. Pronator syndrome. Clin Sports Med 2001;20:531-40.
40. Rodner, Craig M, Tinsley, Brian A, O'Malley, Michael P. Pronator syndrome and anterior interosseous nerve syndrome. J Am Acad Orthop Surg 2013;21:268-75. https://doi.org/10.5435/JAAOS-21-05-268.
41. Rosario NB, De Jesus O. Electrodiagnostic Evaluation of Carpal Tunnel Syndrome In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
42. Sevy JO, Sina RE, Varacallo M. Carpal tunnel syndrome. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024.
43. Shojaie P, Botchu R, Iyengar K, Drakonaki E, Sharma GK. Ultrasound-guided median nerve hydrodissection of pronator teres syndrome: a case report and a literature review. J Ultrason 2023;23:e165-9. https://doi.org/10.15557/jou.2023.0026.
44. Shon HC, Park JK, Kim DS, Kang SW, Kim KJ, Hong SH. Supracondylar process syndrome: two cases of median nerve neuropathy due to compression by the ligament of struthers. J Pain Res 2018;11:803-7. https://doi.org/10.2147/JPR.S160861.
45. Soubeyrand M, Melhem R, Protais M, Artuso M, Crézé M. Anatomy of the median nerve and its clinical applications. Hand Surg Rehabil 2020;39:2-18. https://doi.org/10.1016/j.hansur.2019.10.197.
46. Spinner RJ, Carmichael SW, Spinner M. Partial median nerve entrapment in the distal arm because of an accessory bicipital aponeurosis. J Hand Surg 1991;16:236-44.

47. Stål M, Hagert CG, Englund JE. Pronator syndrome: a retrospective study of median nerve entrapment at the elbow in female machine milkers. J Agric Saf Health 2004;10:247-56.
48. Tsai TM, Syed SA. A transverse skin incision approach for decompression of pronator teres syndrome. J Hand Surg Br 1994;19:40-2.
49. Tuano KR, Fisher MH, Yang JH, Gordon MJ. A rare case of traumatic acute pronator syndrome in the setting of anticoagulation therapy. Cureus 2023;15, e36931. https://doi.org/10.7759/cureus.36931.
50. Ulrich D, Piatkowski A, Pallua N. Anterior interosseous nerve syndrome: retrospective analysis of 14 patients. Arch Orthop Trauma Surg 2011;131: 1561-5. https://doi.org/10.1007/s00402-011-1322-5.
51. Valbuena SE, O'Toole GA, Roulot E. Compression of the median nerve in the proximal forearm by a giant lipoma: a case report. J Brachial Plexus Peripher Nerve Inj 2008;3:17. https://doi.org/10.1186/1749-7221-3-17.
52. Vergara-Amador E, Castillo-Pérez S, Tovar-Cuellar W. Endoscopic release of the median nerve in the proximal third of the forearm. A new approach. Rev Esp Cir Ortop Traumatol (Engl Ed) 2019;63:439-46. https://doi.org/10.1016/j.recot.2019.05.001.
53. Zadra A, Binder H, Popp D, Komjati M, Tiefenboeck TM. Outcome of surgical treated isolated pronator teres syndromes-A retrospective cohort study and complete review of the literature. Int J Environ Res Public Health 2021;19:80. https://doi.org/10.3390/ijerph19010080.