

Pronator and AIN Release

Overview

- Surgical decompression can be considered for pronator syndrome when activities of daily living require frequent strong pronation and electromyography confirms compression [1].
- Other medical causes should be considered in anterior interosseous nerve syndrome with pure motor loss [1].
- Pronator syndrome can be successfully treated nonoperatively or surgically when the correct diagnosis is made [2].
- Cases of brachial plexus neuritis-induced anterior interosseous nerve palsy should be managed conservatively [3].
- Surgical decompression may be performed for specific instances of direct trauma causing anterior interosseous nerve palsy [3].
- Patients presenting with paresis in incomplete anterior interosseous nerve syndrome should be observed, as most will improve spontaneously without surgery [5].
- Bilateral pronator syndrome can be caused by an anomalous tendinous origin of the ulnar belly of the pronator teres muscle [6].
- Damage to the innervation of the pronator quadratus muscle risks impairment of the initiation of hand pronation [7].
- A patient with a very large neurilemmoma of the anterior interosseous nerve had no complaints and full flexion of the interphalangeal joint of the thumb and distal interphalangeal joint of the index finger one year after surgery [8].
- Supercharged end-to-side anterior interosseous nerve to ulnar motor nerve transfer followed by multimodal hand therapy provides measurable improvements in neurophysiology and function [9].
- Engagement in hand therapy and outcomes for supercharged end-to-side anterior interosseous nerve to ulnar motor nerve transfer appear to be mediated by comorbid physical and psychosocial health [9].
- Median nerve compression neuropathy by the lacertus fibrosus represents a subgroup of median nerve neuropathies where the lacertus fibrosus is the sole cause of compression [10].

- Patients who underwent cubital tunnel release and anterior interosseous nerve supercharge end-to-side transfer together had a significantly smaller cubital tunnel volume and cross-sectional area [11].
- Compression of the median nerve at the elbow is a pathology that is often unrecognized and can be isolated or associated with carpal tunnel syndrome [12].
- A patient with a nerve tumour causing anterior interosseous nerve palsy was able to return to work 3 months after surgery with increased pinch force and active interphalangeal joint motion of the thumb [4].

Anatomy & Pathophysiology

AIN ANATOMY AND COMPRESSION SITES

- Near its site of origin, the anterior interosseous nerve is vulnerable to compression from tendinous attachments or accessory muscles [13].
- Specific structures that can compress the AIN include tendinous origins of the deep head of pronator teres and of flexor digitorum superficialis to the middle finger [13].
- Accessory structures described as causes of AIN compression include the attachment of flexor digitorum superficialis to flexor pollicis longus, an accessory head of the flexor pollicis longus muscle (Gantzer's muscle), a tendinous origin of the muscle variant palmaris profundus, and a double lacertus fibrosis [13].
- Fractures at or around the elbow joint, direct injury to the nerve, and compression from plaster casts are recognized causes of anterior interosseous nerve syndrome [13].
- Vascular causes of anterior interosseous nerve syndrome have been described by Spinner [13].
- The AIN bifurcated at 3 cm (average) distal to the intercondylar line of the humerus in a report by Gunther and DiPasquale [15].
- Constrictions associated with AIN palsy occur in the median nerve trunk of the upper arm, a location where the cause cannot be explained by a mechanical factor alone [15].
- Structural factors, including nerve fascicles, must be considered before the onset of AIN palsy when constrictions occur in the median nerve trunk of the upper arm [15].
- In patients with nontraumatic AIN palsy, the relationship between hemangiomas and intraneural topography matched the AIN in specific cases, suggesting the hemangioma as the cause of the palsy [15].
- Intraepineurial constriction of nerve fascicles can be seen in pronator syndrome, similar to findings in AIN syndrome [15].

PRONATOR SYNDROME ANATOMY AND PATHOLOGY

- The pronator quadratus muscle is of importance for the initiation of hand pronation [7].
- Damage to the innervation of the pronator quadratus muscle risks impairment of hand pronation initiation [7].
- Median nerve compression at the elbow by the lacertus fibrosus is a pathology that can be isolated or associated with carpal tunnel syndrome [12].

- Median nerve compression at the elbow by the lacertus fibrosus is a pathology often unrecognized where loss of muscle strength in the median nerve territory should evoke the diagnosis [17].
- Patients representing a subgroup of median nerve neuropathies may have the lacertus fibrosus as the sole cause of compression [10].
- Ultrasound examination findings may not lead to a diagnosis of pronator syndrome (LS) because median nerve compression in the forearm is often mild and may not produce positive US findings [16].

CLINICAL PRESENTATION AND DIAGNOSTIC FEATURES

- Anterior interosseous nerve syndrome is characterized by weakness of pinch between the thumb and index finger [13].
- In AIN syndrome, the interphalangeal joint of the thumb and the distal interphalangeal joint of the index finger are hyperextended in the pinch position [13].
- Weakness of the pronator quadratus muscle can be tested with the forearm flexed to neutralize 75% of pronator teres action [13].
- Patients with AIN syndrome may complain of vague pain in the proximal forearm aggravated by exercise [13].
- Pronator syndrome in violinists and anterior interosseous nerve syndrome with pure motor loss are distinct clinical observations [1].
- If activities of daily living require frequent strong pronation and electromyography confirms compression, surgical decompression can be considered for pronator syndrome [1].
- Other medical causes should be considered in AIN syndrome rather than immediate surgical decompression based solely on activity demands [1].

ELBOW ANATOMY CONTEXT

- The flexor-pronator mass consists of the pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum superficialis [23].
- The medial epicondyle forms the attachment site for the origins of the flexor pronator mass [22].
- The ligament of Struthers is a variant anatomy arising from the supracondylar process to attach to the medial epicondyle and is a potential site of median nerve compression [23].
- The normal range of forearm pronation and supination is 75° and 85° respectively [19].
- The normal range of forearm pronosupination is 80 to 85 degrees in each direction [28].
- A functional arc for forearm rotation is 50 degrees [28].

Classification

- Pronator syndrome is characterized by pain in the proximal forearm that is aggravated by exercise [13].

- In anterior interosseous nerve syndrome, the interphalangeal joint of the thumb and the distal interphalangeal joint of the index finger are hyperextended during pinch [13].
- Anterior interosseous nerve syndrome can be caused by compression from tendinous attachments or accessory muscles near the site of nerve origin [13].
- Tendinous origins of the deep head of pronator teres and flexor digitorum superficialis to the middle finger are described causes of anterior interosseous nerve compression [13].
- Accessory structures causing anterior interosseous nerve compression include the attachment of flexor digitorum superficialis to flexor pollicis longus [13].
- An accessory head of the flexor pollicis longus muscle (Gantzer's muscle) is a described cause of anterior interosseous nerve compression [13].
- A tendinous origin of the muscle variant palmaris profundus is a described cause of anterior interosseous nerve compression [13].
- A double lacertus fibrosis is a described cause of anterior interosseous nerve compression [13].
- Fractures at or around the elbow joint and direct injury to the nerve are causes of anterior interosseous nerve syndrome [13].
- Compression from plaster casts is a recognized cause of anterior interosseous nerve syndrome [13].
- Vascular causes have been described for anterior interosseous nerve syndrome [13].
- Pronator syndrome can be caused by an anomalous tendinous origin of the ulnar belly of the pronator teres muscle [6].
- Median nerve compression at the elbow by the lacertus fibrosus is a pathology that is often unrecognized [12].
- Median nerve compression at the elbow by the lacertus fibrosus can be isolated or associated with carpal tunnel syndrome [12].
- Patients with median nerve compression at the elbow by the lacertus fibrosus represent a subgroup of median nerve neuropathies where the lacertus fibrosus is the sole cause of compression [10].
- Loss of muscle strength in the median nerve territory should prompt consideration of median nerve compression at the elbow [17].
- Nontraumatic anterior interosseous nerve palsy can be associated with palsy of the pronator teres, flexor carpi radialis, and/or palmaris longus muscles [15].
- Intraepineurial constriction of nerve fascicles can be observed in pronator syndrome [15].
- The cause of hourglass constrictions associated with anterior interosseous nerve palsy in the median nerve trunk of the upper arm cannot be explained by a mechanical factor alone [15].
- Structural factors, including nerve fascicles, must be considered before the onset of anterior interosseous nerve palsy when hourglass constrictions are present in the upper arm median nerve trunk [15].
- The anterior interosseous nerve bifurcates at an average of 3 cm distal to the intercondylar line of the humerus [15].

- Clinical signs and symptoms of spontaneous anterior interosseous nerve palsy with hourglass-like fascicular constriction are similar to those described for isolated neuritis [14].
- Ultrasound examination findings may not lead to a diagnosis of pronator syndrome because median nerve compression in the forearm is often mild [16].

Clinical Presentation

- AIN syndrome is characterized by weakness of pinch between the thumb and index finger [13].
- Patients with AIN syndrome may complain of vague pain in the proximal forearm that is aggravated by exercise [13].
- Pronator syndrome is associated with activities of daily living that require frequent strong pronation [1].
- Electromyography findings are used to confirm the presence of compression in pronator syndrome [1].
- Brachial plexus neuritis-induced anterior interosseous nerve palsy presents with clinical signs and symptoms similar to those described for isolated neuritis [14].
- Nontraumatic AIN palsy may be accompanied by palsy of the pronator teres, flexor carpi radialis, and/or palmaris longus muscles [15].
- Clinical findings in nontraumatic AIN palsy may be unassociated with high median nerve injury [15].
- Ultrasound examination findings for median nerve compression in the forearm may not lead to a diagnosis of pronator syndrome because the compression is often mild [16].

Investigations

CLINICAL PRESENTATION AND PHYSICAL EXAMINATION

- In anterior interosseous nerve syndrome, the interphalangeal joint of the thumb and the distal interphalangeal joint of the index finger are hyperextended in the pinch position [13].
- Patients with anterior interosseous nerve syndrome may complain of vague pain in the proximal forearm that is aggravated by exercise [13].
- Median nerve compression at the elbow is a pathology that is often unrecognized, where loss of muscle strength in the median nerve territory should evoke the diagnosis [17].
- Median nerve compression at the elbow can be isolated or associated with carpal tunnel syndrome [12].
- Patients with nontraumatic anterior interosseous nerve palsy may present with palsy of the pronator teres, flexor carpi radialis, and/or palmaris longus muscles [15].

ELECTRODIAGNOSTIC STUDIES

- Electromyography findings can confirm the presence of compression in pronator syndrome [1].
- Electromyography/nerve conduction velocity studies should be performed if any question about neurologic dysfunction exists [36].

IMAGING

- Ultrasonographic examination can be challenging for diagnosing median nerve compression in the forearm, as findings may not lead to diagnosis because compression is often mild and may not produce positive US findings [16].
- Plain radiographs remain the hallmark and the best screening test for elbow evaluation [19].
- CT is helpful when assessing for malunion architecture and the location and pattern of osteophytes and/or loose bodies [36].
- MRI can be used to evaluate ligaments and tendons, but it is rarely indicated for elbow stiffness [36].
- MRI may be most helpful in evaluating associated injuries including partial or complete tears of the medial collateral ligament in valgus extension overload syndrome [38].

Treatment

NON-OPERATIVE MANAGEMENT

- Patients presenting with paresis of the anterior interosseous nerve should be observed, as most will improve spontaneously without surgery [5].
- When the correct diagnosis is made, pronator syndrome can be successfully treated nonoperatively [2].

OPERATIVE MANAGEMENT

- Surgical decompression can be considered for pronator syndrome if activities of daily living require frequent strong pronation and electromyography confirms the presence of compression [1].
- When the correct diagnosis is made, pronator syndrome can be successfully treated surgically if necessary [2].
- One year after surgery for a very large neurilemmoma of the anterior interosseous nerve, the patient had no complaints and full flexion of the interphalangeal joint of the thumb and distal interphalangeal joint of the index finger [8].
- Engagement in hand therapy and outcomes after supercharged end-to-side anterior interosseous nerve to ulnar motor nerve transfer appear to be mediated by comorbid physical and psychosocial health [9].

ANATOMICAL CONSIDERATIONS IN TREATMENT

- Tendinous origins of the deep head of pronator teres and of flexor digitorum superficialis to the middle finger are described as causes of anterior interosseous nerve compression [13].
- Accessory structures described as causes of anterior interosseous nerve compression include the attachment of flexor digitorum superficialis to flexor pollicis longus, an accessory head of the flexor pollicis longus muscle (Gantzer's muscle), a tendinous origin of the muscle variant palmaris profundus, and a double lacertus fibrosis [13].
- Compression from plaster casts has been recognized as a cause of anterior interosseous nerve syndrome [13].

- The median nerve compression neuropathy by the lacertus fibrosus represents a subgroup of median nerve neuropathies where the lacertus fibrosus is the sole cause of compression [10].

Complications

- Surgical decompression of the pronator quadratus muscle risks damage to its innervation, which is important for the initiation of hand pronation [7].
- Compression of the anterior interosseous nerve can result from tendinous attachments or accessory muscles, including the deep head of pronator teres and flexor digitorum superficialis to the middle finger [13].
- Accessory structures that can cause anterior interosseous nerve compression include the attachment of flexor digitorum superficialis to flexor pollicis longus, an accessory head of the flexor pollicis longus muscle (Gantzer's muscle), a tendinous origin of the palmaris profundus muscle variant, and a double lacertus fibrosis [13].
- The cause of hourglass constrictions associated with anterior interosseous nerve palsy in the median nerve trunk of the upper arm cannot be explained by a mechanical factor alone and requires consideration of structural factors including nerve fascicles [15].

Recovery

- Cases of brachial plexus neuritis-induced anterior interosseus nerve palsy should be managed conservatively [3].
- Surgical decompression for pronator syndrome can be considered if activities of daily living require frequent strong pronation and electromyography confirms the presence of compression [1].
- When the correct diagnosis is made, pronator syndrome can be successfully treated nonoperatively or surgically, if necessary [2].

Key Evidence

- [L5] If the activities of daily living of a patient require frequent strong pronation, and if the electromyography findings confirm the presence of compression, surgical decompression can be considered against the background of pronator syndrome, whereas other medical causes should be considered in AIN syndrome. [1] ([10.1177/17531934221080018](#))
- [L5] When the correct diagnosis is made, pronator syndrome can be successfully treated nonoperatively or surgically, if necessary. [2] ([10.1016/s0278-5919\(05\)70267-2](#))
- [L5] Cases of brachial plexus neuritis-induced anterior interosseus nerve palsy should be managed conservatively, while surgical decompression may be performed for specific instances of direct trauma. [3] ([10.1016/s0363-5023\(97\)80025-1](#))

- [L5] The patient was able to return to work 3 months after surgery with increased pinch force and active interphalangeal joint motion of the thumb. [4] ([10.1177/1753193412454801](https://doi.org/10.1177/1753193412454801))
- [L4] Patients presenting with paresis should be observed, as most will improve spontaneously without surgery. [5] ([10.1016/s0363-5023\(85\)80240-9](https://doi.org/10.1016/s0363-5023(85)80240-9))
- [L5] We report the case of a patient with bilateral pronator syndrome caused by an anomalous tendinous origin of the ulnar belly of the pronator teres muscle. [6] ([10.1016/0363-5023\(93\)90373-b](https://doi.org/10.1016/0363-5023(93)90373-b))
- [L5] This risks damage of the innervation of this muscle of importance for initiation of hand pronation. [7] ([10.1016/j.jhsb.2005.06.017](https://doi.org/10.1016/j.jhsb.2005.06.017))
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- [L4] Patients who underwent CuTR and AIN-SETS together had a significantly smaller cubital tunnel volume (CTV) and cross-sectional area (CSA). [11] ([10.1016/j.otsr.2024.103982](https://doi.org/10.1016/j.otsr.2024.103982))
- [L4] La compression du nerf médian au coude est une pathologie souvent méconnue qui peut être isolée ou associée à un syndrome du canal carpien. [12] ([10.1016/j.hansur.2018.10.219](https://doi.org/10.1016/j.hansur.2018.10.219))
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- [L4] [15] ([10.1053/jhsu.2003.50021](https://doi.org/10.1053/jhsu.2003.50021))
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[23] Miller S Review Of Orthopaedics. SECTION 16 PATELLAR TRACKING IN TOTAL KNEE ARTHROPLASTY > TABLE 2.3 Shoulder Spaces.

[28] Miller S Review Of Orthopaedics. ELBOW.

[36] Aaos Comprehensive Orthopaedic Review 3. Elbow Stiffness* > IV. Evaluation.

[38] Aaos Comprehensive Orthopaedic Review 3. Elbow Injuries in the Athlete* > III. Valgus Extension Overload Syndrome and Posterior Impingement.