Kiloh-Nevin Syndrome: a literature review

Síndrome de Kiloh-Nevin: uma revisão de literatura

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ABSTRACT
Kiloh-Nevin syndrome or anterior interosseous nerve syndrome (AINS) is a rare condition characterized by weakness of flexion of the interphalangeal joint of the thumb and terminal interphalangeal joints of the index finger accompanied by weakness of pronation of the forearm when the elbow is flexed. The pathophysiology is not yet fully understood: some authors suggest a compressive neuropathy, however new evidence supports the theory of an idiopathic or even immune-mediated neuritis. The diagnosis of AINS consists of clinical history, physical examination with a positive Kiloh-Nevin sign and may include electromyography (EMG) and magnetic resonance imaging (MRI). The literature shows that patients with this clinical condition are often treated conservatively in the first few months, with analgesics, non-steroidal anti-inflammatory drugs and physiotherapy. Some articles suggest a surgical approach with decompression of the medial nerve. The objective of this article is to review the main references available on AINS.

Keywords: Anterior interosseous nerve syndrome; Kiloh-Nevin syndrome; Neurosurgery

RESUMO
A síndrome de Kiloh-Nevin ou síndrome do nervo interósseo anterior é uma doença rara caracterizada por fraqueza de flexão da articulação interfalangiana do polegar e das articulações interfalangianas terminais do dedo indicador, acompanhada de fraqueza de pronação do antebraço quando o cotovelo está fletido. Sua fisiopatologia ainda não está totalmente esclarecida: alguns autores sugerem uma neuropatia compressiva, mas novas evidências apoiam a teoria de uma neurite idiopática ou mesmo imunomediada. O diagnóstico de AINS consiste na história clínica, exame físico com sinal de Kiloh-Nevin positivo e pode incluir eletromiografia e ressonância magnética. A literatura mostra que os pacientes com este quadro clínico são frequentemente tratados de forma conservadora nos primeiros meses, com analgésicos, anti-inflamatórios não esteroidais e fisioterapia. Alguns artigos sugerem uma abordagem cirúrgica com descompressão do nervo medial. O objetivo deste artigo é fazer uma revisão das principais referências disponíveis sobre a síndrome.

Palavras-chave: Síndrome do nervo interósseo anterior; Síndrome de Kiloh-Nevin; Neurocirurgia

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INTRODUCTION

The upper limb innervation originates from a complex structure called the brachial plexus and includes the Axillary, Radial, Musculocutaneous, Ulnar and Median nerves. The anterior interosseous nerve (AIN) along the forearm, following the anterior interosseous artery through the interosseous membrane between the radius and ulna. Functionally, it acts primarily as a motor nerve, controlling specific muscles in the forearm: the flexor pollicis longus (FPL), the flexor digitorum profundus (FDP) and distally the pronator quadratus (PQ)1-3.

From a clinical perspective, the injury of the anterior interosseous nerve can lead to the dysfunction of fine motor skills of the hand leading to a clinical condition called the anterior interosseous nerve syndrome (AINS). The AINS, described by Kiloh and Nevin, presents primarily with forearm pain and progressive weakness of the thumb, index and middle fingers muscles4-6.

The syndrome is characterized as a rare condition and its pathophysiology has not yet been completely elucidated. Some authors suggest a compressive neuropathy, however new evidence supports the theory of an idiopathic or even immune-mediated neuritis1,2,4-7.

The diagnosis of AINS consists of clinical history, physical examination with a positive Kiloh-Nevin sign and may include electromyography (EMG) and magnetic resonance imaging (MRI)2,4-8. Currently, literature shows that patients with this clinical condition are often treated conservatively in the first few months. Management includes analgesics, nonsteroidal anti-inflammatory drugs, and physical therapy. Some articles suggest surgical approach with medial nerve decompression2,4. Identifying the etiology is essential for better treatment planning.

This study aims to review the main available references on the anterior interosseous nerve syndrome.

METHODS

A systematic review based on the methodology outlined in the PRISMA (Preferred Reporting Project for Systematic Evaluation and Meta-Analysis) agreement was conducted (Figure 1). This study did not require ethical approval and patient consent.

Our research was based on PubMed database, on April, 2024, using these following keywords: “Anterior interosseous nerve syndrome” OR “Kiloh-Nevin syndrome”, obtaining 346 articles. After that, the authors restricted the evaluation period to 10 years (2014-2024), resulting in 123 articles. The selection of these articles was determined by the authors according to relevance, remaining 19 articles. Of these, only 13 were available for access. Only studies in humans and in English were selected for analysis. The final selected articles were read and approved by all authors.

In addition, Figures 2 and 3 were provided by the senior author of this article.

DISCUSSION

Anatomy and physiopathology

The anatomy of the AIN is influenced by its origin, course, and innervation. The nerve originates from the median nerve, formed by the union of the C5 to T1 roots of the brachial plexus. Progressing through the arm, elbow, and forearm, the median nerve gives rise to the AIN approximately 5 cm below the intercondylar line of the humerus2,4,7,9.

The AIN traverses the forearm along the anterior aspect of the interosseous membrane, in close proximity to the anterior interosseous artery. It innervates the muscles including the FPL, radial part of the FDP, and PQ. Its course concludes at the wrist joint, without branching into cutaneous nerves7-9,11.

The physiopathology of Kiloh-Nevin syndrome is grounded in the compression or injury of the anterior interosseous nerve by various factors, which can be mechanical, vascular, inflammatory, or traumatic. Nerve compression may alter its normal course and reduce available space, resulting in changes in nerve conduction and muscle function. Nerve injury can range from neuropraxia (transient blockage of nerve conduction) to neurotmesis (complete nerve rupture). The syndrome presents with pain, weakness, and difficulty in moving the thumb, index, and middle fingers. Pain may be localized in the forearm or elbow, or it may radiate to the arm or hand2,4,10,11.
Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flowchart showing the selection process.

Figure 2. The anterior interosseous nerve leaves the main median nerve trunk. AIA = anterior interosseous artery; AIN = anterior interosseous nerve.

Figure 3. Schematic representation of Figure 2.
Furthermore, some authors mention an idiopathic form of Kiloh-Nevin Syndrome, with no trauma or compression involved. In this case, the pathophysiology is still poorly understood\textsuperscript{2,11}.

Weakness is evidenced by the inability to perform the pinch movement of the thumb and index finger, meaning the patient cannot flex or hold anything between the thumb and index finger. Difficulty in finger movement can be observed by the inability to make the “OK” sign with the thumb and index finger or to touch the thumb to the base of the little finger. Kiloh-Nevin syndrome is a form of AIN entrapment neuropathy, which may be confused with other conditions affecting the median nerve, such as carpal tunnel syndrome or pronator syndrome\textsuperscript{2,10,11}.

**Clinical presentation**

Patients with spontaneous AIN palsy may have profound motor weakness, with cutaneous sensory function spared. Also can occur the loss of active flexion or total paralysis, most commonly the FPL\textsuperscript{7,9,12}. This group of patients can present specific positive tests in clinical examinations, an example is the inability to bring the thumb and index finger together in the shape of an “O” that receives the name of “Kiloh-Nevin sign”.

Other positive tests in clinical presentation can include increased pulp contact between the thumb and index finger with hyperflexion of the proximal interphalangeal joint of the index finger; inability to hold a piece of paper between the thumb and first finger with possible key pinch maneuver. Tinel’s and Phalen’s test usually present negative results in AINS\textsuperscript{2,4,10,11}. Serial electrodiagnostic findings may help to prognosticate neurological recovery and help to guide surgical decision-making\textsuperscript{5}.

MRI is not commonly used to diagnose AINS, but it has been described in the literature as helpful in early diagnosis, with T2-weighted MRI often showing increased signal intensity in the AIN distribution\textsuperscript{2,4}. On fluid-sensitive sequences such as short Tau inversion recovery (STIR), proton density, or T2-weighted fat-saturated images, increased signal intensity can be observed in some or all muscle groups innervated by AIN, especially in the PQ\textsuperscript{2,8}. In more chronic stages, T1-weighted sequences will show fatty infiltration and amyotrophy\textsuperscript{8}.

Ultrasound can be used to view AIN despite its small size\textsuperscript{4}.

EMG is the main diagnostic test in AINS, and there is also a potential role of ultrasound and MRI neurography in the diagnosis and differential diagnosis\textsuperscript{12}.

The Kiloh-Nevin sign is represented in Figure 4 to introduce a complete understanding.

**Table 1.** Correlation between physical examination and clinical presentation.

<table>
<thead>
<tr>
<th>Physical Exam</th>
<th>Clinical Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalen’s test</td>
<td>Negative</td>
</tr>
<tr>
<td>Tinel’s test</td>
<td>Negative</td>
</tr>
<tr>
<td>Muscle stretch reflex</td>
<td>Normal</td>
</tr>
<tr>
<td>Cutaneous sensory testing</td>
<td>Normal</td>
</tr>
<tr>
<td>Pinch paper (thumb and index finger) and resist removal of paper</td>
<td>Unable to perform</td>
</tr>
<tr>
<td>Kiloh-Nevin sign</td>
<td>Unable to perform</td>
</tr>
</tbody>
</table>

**Figure 4.** Kiloh-Nevin sign.
Treatment

The treatment of AINS typically begins conservatively, with surgery considered in cases of no improvement. However, there is no consensus on the ideal duration of conservative treatment before surgical intervention. While some authors suggest surgical exploration after three months of treatment without improvement, others recommend waiting for six to 12 months. Despite many cases improving without surgery, the optimal approach remains uncertain, highlighting the need for further studies and clinical evaluation to determine the appropriate timing for surgical intervention in AINS patients.\(^4,9,13\).

Initial therapy involves conservative and symptomatic management, including analgesics, non-steroidal anti-inflammatory drugs, physiotherapy, hand immobilization, electrical stimulation therapy, and vitamin B12 supplementation as needed. Studies suggest that conservative treatment may be more effective in younger patients; however, in many cases, it is insufficient, justifying surgical intervention.\(^4\).

Despite of conservative treatment, residual symptoms such as weakness are common even after three years of symptom onset. In such cases, invasive treatment options such as internal neurolysis, epineurotomy, and endoscopic decompression are considered. Nerve exploration and neurolysis may be indicated when there is no evidence of recovery after months of conservative treatment. Some patients may not regain motor function even after conservative and endoscopic interventions, with tendon transfers reported, although results are inconsistent.\(^4,9\).

During surgical decompression of the median nerve, meticulous dissection is crucial to identify and release any additional fibrous bands or compressive edges, as we can see in Figures 2 and 3. Given imaging and surgical findings demonstrating swelling and fascicular constriction of the anterior interosseous nerve proximal to the elbow, surgery should focus on this region.\(^2,5\).

The presence of pathology in individual nerve fascicular groups may require external and internal neurolysis. The technique involves focal epineurotomy of the nerve trunk at the suspected site of pathology, followed by separation of fascicular groups under magnification to identify constrictions. These lesions are treated with perineurolysis to separate and divide the perineural bands surrounding the nerve fascicles. Internal microneurolysis is justified to improve recovery, and alleviating mechanical blockage caused by perineural fibrosis. Studies demonstrate the superiority of neurolysis in cases without spontaneous recovery and with focal constrictions.\(^5\).

CONCLUSION

In conclusion, the anterior interosseous nerve syndrome (AINS) presents itself as a rare clinical condition with diverse etiologies and diagnostic challenges. This syndrome, characterized by pain and weakness primarily in the thumb, index, and middle fingers, requires a comprehensive understanding of its anatomy, pathophysiology, and clinical presentation for accurate diagnosis and management. Despite of advancements in diagnostic modalities such as electromyography (EMG) and magnetic resonance imaging (MRI), the gold standard for diagnosis remains EMG. Conservative management is typically the first-line approach, including analgesics, physiotherapy, and immobilization, with surgical intervention reserved for cases refractory to conservative treatment. However, the optimal timing and selection criteria for surgery are areas of ongoing debate, necessitating further research to guide clinical decision-making and improve outcomes for patients with AINS.

REFERENCES

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