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## CASE REPORT

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# Anterior Interosseous Nerve Syndrome: Characteristic Magnetic Resonance Findings and Applications

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### ABSTRACT

*Anterior interosseous nerve syndrome, also known as Kiloh-Nevin syndrome, is characterised by weakness of the muscles supplied by the anterior interosseous nerve, a branch of the median nerve that innervates the flexor pollicis longus, the flexor digitorum profundus of the index finger and middle finger, and the pronator quadratus. Clinically, patients have weakness in the involved muscles and are unable to form an 'O' with the thumb and index finger. Traditionally, the diagnosis relies on a clinical history, physical examination, and electrodiagnostic testing. Although magnetic resonance imaging may not visualise the anterior interosseous nerve, it aids the diagnosis of anterior interosseous nerve syndrome by recognising altered signals related to denervation of the relevant muscles and detecting any underlying mass causing nerve compression. Most patients with anterior interosseous nerve syndrome improve without any surgical intervention. During the period of conservative treatment, patients can also be monitored by magnetic resonance imaging. Controversy still exists about the treatment of anterior interosseous nerve syndrome and the optimal timing of surgical intervention. We present a patient with anterior interosseous nerve syndrome, who had characteristic clinical and magnetic resonance imaging findings.*

*Key Words: Magnetic resonance imaging; Muscle denervation; Nerve compression syndromes*

## 中文摘要

### 前骨間神經綜合症：典型的磁共振表現及應用

朱志揚、李仲啟、梁禮賢、鄭志成

前骨間神經綜合症又稱Kiloh-Nevin綜合症，表現為前骨間神經支配的肌肉無力；前骨間神經是正中神經的一個分支，支配拇長屈肌、食指和中指的指深屈肌以及旋前方肌。臨床方面，患者受影響部位的肌力減弱，拇指與食指不能捏成「O」字。傳統上，病症診斷視乎臨床病歷、體檢及電學診斷檢查。雖然磁共振不能清楚顯示前骨間神經，但可以辨認去神經後有關肌肉的信號改變，以及偵測是否有腫塊病灶壓迫神經，幫助前骨間神經綜合症的確診。大部分前骨間神經綜合症患者無需接受手術也可以病情好轉。在保守治療期間，可用磁共振監察患者的情況。有關前骨間神經綜合症的治療方法及進行手術的最佳時機現仍存有爭議。本文報告一名前骨間神經綜合症患者的臨床及磁共振典型特徵。

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Submitted: 21 Feb 2011; Accepted: 28 Mar 2011.

## INTRODUCTION

Anterior interosseous nerve syndrome is a condition characterised by weakness of the muscles supplied by the anterior interosseous nerve, including the flexor pollicis longus (FPL), the flexor digitorum profundus (FDP) of the index and middle fingers, and the pronator quadratus (PQ).<sup>1</sup> It was first described by Kiloh and Nevin in 1952, which is also known as Kiloh-Nevin syndrome.<sup>2</sup> There are various causes of the syndrome including trauma, fracture, or entrapment of the nerve.<sup>1-3</sup> Besides the characteristic clinical presentation, magnetic resonance imaging (MRI) can be useful in confirming the clinical diagnosis, identifying any underlying causes and monitoring the effects of therapy, particularly the effects of conservative management.<sup>1-5</sup>

## CASE REPORT

A 62-year-old woman with a history of hypertension, presented with inability to pinch her left thumb and index finger in July 2010. She sustained an injury while lifting up two heavy bags about two weeks ago, but could not recall the exact mechanism of injury. She had tried herbal medication, but without improvement. Subsequently, she was referred to an orthopedic surgeon for further management.

On physical examination, the patient was unable to actively flex the interphalangeal joint of left thumb. Only weak active flexion of distal interphalangeal joints of left index and middle fingers and weakness of forearm pronation (in extension) were noted; pronation in flexion was slightly better. The patient could not make a 'circle' using the left thumb and index finger. Active flexion of the distal interphalangeal joint of left ring finger was normal. There was no sensory loss.

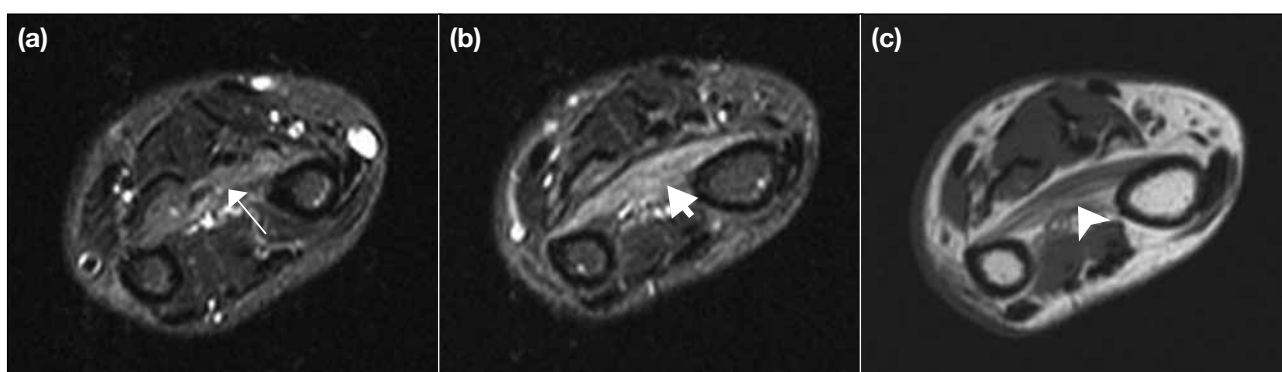
Radiography of the left forearm and elbow did not show any fracture. Nerve conduction test performed by a neurologist suggested anterior interosseous nerve syndrome.

MRI of the left forearm was arranged to rule out any underlying mass lesion causing nerve entrapment. Six sets of images of the left forearm were obtained with a 1.5T MRI unit (Magnetom, Symphony; Siemens, Erlangen, Germany) using a six-channel body coil (axial T1 SE, axial short T1 inversion recovery [STIR], coronal T1 SE, coronal STIR and post-gadolinium T1 SE with fat suppression in axial and coronal planes). The STIR and T2-weighted images with fat suppression revealed hyperintense signals in the left FDP, FPL (Figure a) and PQ muscles (Figure b). Mild fatty infiltration of the left PQ was also noted on T1-weighted images (Figure c). No focal mass lesion or abnormal enhancement was evident along the course of anterior interosseous nerve and there was no abnormal marrow signal or fracture.

The patient is now receiving conservative treatment and being followed up by the orthopaedic surgeon. The symptoms have slowly recovered over about two months since the MRI; power in the FPL and FDP muscles of left index finger has now improved to grade 3/5.

## DISCUSSION

The anterior interosseous nerve is a major motor branch of median nerve, which arises 2 to 8 cm below the humeral medial epicondyle.<sup>2,6</sup> It travels with the anterior interosseous artery, along the anterior surface of the interosseous membrane.<sup>1,2,6</sup>



**Figure.** (a) An axial short T1 inversion recovery (STIR) magnetic resonance image (MRI) of the left forearm shows increased signal intensity over the flexor pollicis longus and flexor digitorum profundus muscles (long arrow). (b) An axial STIR MRI of the left forearm at a more distal level shows increased signal intensity of the pronator quadratus muscle (short arrow). (c) An axial T1-weighted MRI at the same level as (b) depicts mild fatty infiltration of the pronator quadratus muscle (arrowhead).

The most frequent causes of anterior interosseous nerve syndrome are direct traumatic damage and external compression.<sup>1,3</sup> External compression could result from midshaft radial fractures, poorly applied casts, soft tissue masses including an enlarged bicipital bursa, and repetitive heavy lifting.<sup>1,3</sup> In many instances the syndrome appears to occur spontaneously.<sup>1</sup> Anatomic abnormalities including an accessory head of the FPL muscle (Gantzer muscle), bulky tendinous origin of the ulnar head of the pronator teres muscle, and vascular abnormalities could also be the causes.<sup>1,3</sup> In our patient, since there was no structural abnormality detected on MRI, the episode of heavy lifting and injury to her elbow about two weeks before presentation was likely the cause.

Clinically, patients with anterior interosseous nerve syndrome are not able to form an 'O' with the thumb and index finger, which is called the circle sign,<sup>1,3</sup> and is due to lack of innervation of the FPL or FDP muscles.<sup>3,5</sup> Muscle strength and forearm circumference may be decreased in the affected arm when compared to the normal side.<sup>3</sup> At the onset of the paralysis, patients may present with pain in the region of elbow.<sup>7</sup> They may also complain of a dull aching volar wrist pain because some sensory fibres from wrist joint travel with the anterior interosseous nerve.<sup>2</sup>

In typical acute or subacute anterior interosseous nerve syndrome, the innervated muscles show diffuse, homogeneous increased signal intensity on T2-weighted fat-suppressed or STIR images.<sup>1,3</sup> The adjacent subcutaneous fat and fascial layers are typically normal.<sup>4</sup> In contrast, traumatic, inflammatory and neoplastic causes of altered muscle signal intensity cause signal changes not only in the involved muscles but also in the subcutaneous fat and fascial layers.<sup>4</sup> This sign helps differentiate complete muscle denervation from other causes of abnormal signals in muscles.<sup>4</sup> Since the fourth and fifth fingers are not typically innervated by the anterior interosseous nerve, the MR signal intensity of the corresponding flexor muscles is normal.<sup>3</sup> In chronic complete muscle denervation, the T1-weighted images show reversible atrophy and fatty infiltration of affected muscles.<sup>4</sup> Therefore, in cases with possible muscle denervation, STIR images and T1-weighted images are recommended for assessment and to reveal the time course of the neuropathy.

In some patients, variations in the muscles supplied by the anterior interosseous nerve result in MRI

signal intensity changes that may not follow the typical presentation and cause diagnostic confusion.<sup>2</sup> Anomalous communication (known as Martin-Gruber anastomosis) between the median nerve or proximal anterior interosseous nerve and the ulnar nerve in the forearm is found in up to 40% of individuals.<sup>1</sup> Atypical MRI findings of anterior interosseous nerve syndrome, including additional involvement of the flexor carpi radialis muscle and absence of signal changes of the FPL and FDP of the index finger, have also been found.<sup>2</sup> Therefore, radiologists need to be aware of these possible anatomic variations, which do not preclude the diagnosis of anterior interosseous nerve syndrome.<sup>2</sup>

Although the diagnosis of peripheral neuropathy can be made from the clinical history, physical examination and electrodiagnostic testing, imaging provides anatomical information regarding the nerve, its innervated structures and surrounding structures. High-resolution ultrasonography (USG) provides a quick, low-cost and dynamic assessment of peripheral neuropathies.<sup>2</sup> However, assessment is often limited to superficial nerves.<sup>2</sup> The anterior interosseous nerve is usually too small and too deep to be visualised by USG. Moreover, USG is less sensitive than MRI for detecting changes due to muscle denervation.<sup>8</sup>

Since MRI achieves high contrast resolution, it can identify nerves and allow assessment of possible primary abnormalities, such as a mass compressing the nerve.<sup>1,3</sup> In some patients, direct visualisation of primary nerve abnormality or compressive anatomic structures may not be possible with MRI or USG.<sup>3,8</sup> In these instances, mapping out denervated muscles by MRI can diagnose and localise entrapment or compressive neuropathies.<sup>2,3,8</sup> The normal anterior interosseous nerve itself is usually not readily identified on MRI, for which reason diagnosis of the syndrome relies on the recognition of signal changes in the denervated muscles that are supplied by the anterior interosseous nerve.<sup>8</sup> In contrast to this syndrome, the pronator syndrome (another well-known entrapment disturbance of the median nerve) also shows altered signals in the pronator teres, flexor carpi radialis, palmaris longus and flexor digitorum superficialis muscles.<sup>3</sup> Therefore, knowledge of muscle denervation pattern aids in differentiating syndromes due to median nerve entrapment.

Electrophysiological studies, including electromyography and nerve conduction tests, are useful in the diagnosis of nerve injury.<sup>1</sup> However,

there are several limitations, including inability to determine structural cause and failure to provide spatial information.<sup>1</sup> For anterior interosseous nerve syndrome, accurate positioning of the electrodes can be difficult in the PQ, which is a thin deep muscle.<sup>2</sup> Moreover, electromyography is invasive, while MRI is a non-invasive procedure and more likely to be more acceptable to patients.<sup>2</sup> MRI also has a potential advantage over electromyography by showing increased signal intensity on STIR images, before changes in denervation become detectable by electromyography (i.e. about 2 to 3 weeks after denervation).<sup>1-3</sup>

Most patients with anterior interosseous nerve syndrome improve without surgical intervention.<sup>9</sup> Therefore, once diagnosed, non-surgical treatment should be offered first, and includes rest, splinting, and observation.<sup>9</sup> MRI is useful for monitoring the effects of conservative management.<sup>3</sup> However, controversy about the treatment of anterior interosseous nerve syndrome and when surgical treatment is appropriate still persists.<sup>9</sup> In symptomatic patients, Vrieling et al<sup>10</sup> suggested that the observation period should be eight months to a year, while Sood and Burke<sup>7</sup> recommended exploration after six months when there is no evidence of recovery. Further studies are needed to determine the optimal management for patients with anterior interosseous nerve syndrome.

In conclusion, MRI is a useful imaging tool to confirm clinical diagnosis of anterior interosseous nerve syndrome, to identify possible underlying causes and to monitor the progress of conservative treatment.

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