Compression of the Medial Half of the Deep Branch of the Ulnar Nerve by an Anomalous Origin of the Flexor Digiti Minimi. A Case Report

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Compression of the Medial Half of the Deep Branch of the Ulnar Nerve by an Anomalous Origin of the Flexor Digiti Minimi

A CASE REPORT*

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We describe the case of a patient who had compression of the medial half of the deep branch of the ulnar nerve by an anomalous penetrating tendinous structure, resulting in an unusual pattern of ulnar neuropathy. When the patient was first seen, she had isolated weakness of the intrinsic muscles of the ring and little fingers as well as some of the hypothenar muscles, without evidence of additional ulnar innervated motor or sensory abnormality. To our knowledge, this lesion has not been reported previously.

Case Report

A twenty-year-old woman who worked in the retail industry had a one-year history of a deformity involving the right, dominant hand. She recalled no episode of trauma and related the onset of the problem to lifting hangers with heavy clothing. She had no sensory abnormality or symptoms referable to problems elsewhere in the limb or cervical area and was otherwise healthy.

Before the patient was seen by the senior one of us (M. S.), a number of investigations had been performed. The findings on standard radiographs as well as a magnetic resonance image of the hand and wrist were considered within normal limits. No abnormalities were identified on two sets of nerve-conduction and electromyographic studies that had been performed two months apart. Non-invasive vascular studies demonstrated a congenitally small ulnar artery, which was confirmed by magnetic resonance angiography. Despite immobilization, avoidance of exacerbating activities, and use of non-steroidal anti-inflammatory agents, no improvement was noted.

On examination, a claw deformity of the ring and little fingers was observed. The deformity was passively correctable. Atrophy of the intrinsic muscles was visible in the intermetacarpal region between the third and fourth web spaces. Testing of muscle strength against the hand of the examiner demonstrated intrinsic weakness in the third and fourth dorsal interossei, second and third palmar interossei, third and fourth lumbrical muscles, flexor digiti minimi, and opponens digiti minimi. The other intrinsic muscles that are typically innervated by the ulnar nerve (including the abductor digiti minimi, adductor pollicis[7], first and second dorsal interossei, and first palmar interosseous) were normal, and the extrinsic muscles that are innervated by the ulnar nerve (the flexor carpi ulnaris and flexor digitorum profundus to the ring and little fingers) had normal tone and strength. The flexor pollicis brevis (innervated by the median and ulnar nerves), first and second lumbrical muscles, abductor pollicis brevis, and opponens pollicis (innervated by the median nerve) were normal. With digital extension, the little finger was noted to be abducted away from the ring finger (a positive Wartenberg sign[29]). The findings of two-point discrimination and Semmes-Weinstein monofilament testing were within normal limits. Tenderness was elicited with percussion of the ulnar nerve at the wrist, but it was not elicited in the cubital tunnel. The Allen test revealed filling in the radial artery bilaterally at two seconds after release of compression, in the right ulnar artery at five seconds, and in the left ulnar artery at four seconds. Pulp-to-pulp or so-called tip-pinch dynamometry with the Preston pinch gauge (J. A. Preston, Jackson, Mississippi) revealed values of 8.4 kilograms in the right hand and 7.2 kilograms in the left.

A third electrodiagnostic study was done six months after the second, with specific attention to the intrinsic muscles. The findings revealed denervation and fibrillation potentials in the third and fourth dorsal interossei, second and third palmar interossei, third and fourth lumbrical muscles, opponens digiti minimi, and flexor digiti minimi. The remaining intrinsic and thenar muscles were normal on electrical testing. In addition, stimulation of the median nerve produced palmar abduction of the thumb.

An operation was performed with Bier-block anesthesia. An incision was centered on the hook of the hamate, with use of operative loupes (magnification, 5.5 times). The ulnar nerve was identified proximal to the wrist flexion crease. The deep branch and sensory branches to the third and fourth web spaces were identified. The deep branch of the ulnar nerve was traced through the hypothenar fibrotic arch (Fig. 1). A six-millimeter anomalous tendinous extension of the flexor digiti minimi, arising from the hook of the hamate, was identified and observed to penetrate the deep branch of the ulnar nerve. This resulted in a small neural loop (or a so-called ellipse[12]), by virtue of the division of the nerve into two halves (Fig. 2). The medial half of the deep motor branch was compressed distal to the branch innervating the abductor digiti minimi. When this anomalous tendinous penetration was released, the neural loop collapsed. The opponens digiti minimi was then released from its origin in order to visualize the deep branch in its entirety, passing into the depth of the mid-part of the palm. The deep branch, traced distally, appeared normal. With use of a hand-held battery-operated electrical stimulator (Xomed-Treace Pulsatron-II; Singer Medical Products, Bensenville, Illinois) that delivered 0.7 milliampere of current at eighty pulses per second, both halves of the deep branch of the ulnar nerve were examined. When the deep branch of the ulnar nerve was stimulated proximal to the site of the neural loop, there was no response in the ring and little fingers, but the thumb ad-

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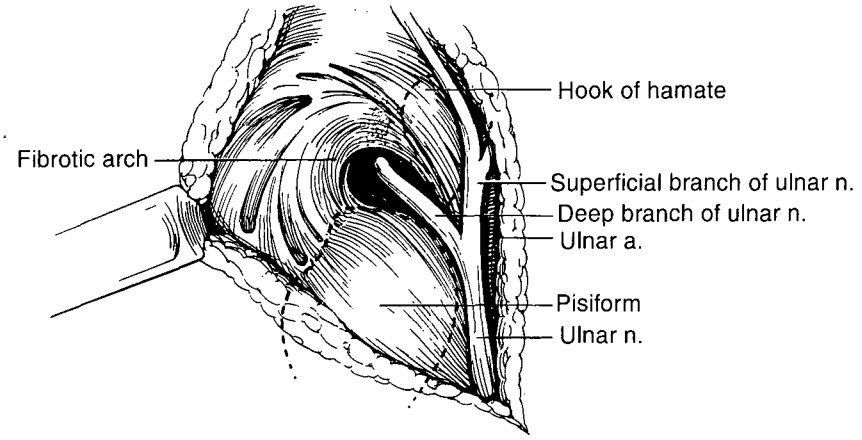

FIG. 1

Drawing showing the anatomy of the fibrotic arch and its relationship to the deep branch of the ulnar nerve.

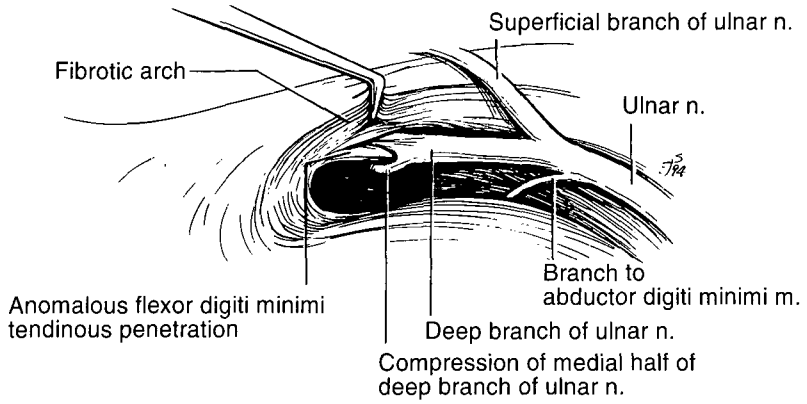

FIG. 2

Drawing showing the anomalous tendinous extension of the flexor digiti minimi penetrating the deep branch of the ulnar nerve and creating a neural loop.

ducted and the index finger abducted. Stimulation of the medial half of the deep ulnar nerve distal to the neural loop resulted in flexion of the metacarpophalangeal joint of the ring and little fingers, with simultaneous extension of the distal and proximal interphalangeal joints of these fingers as well as opposition of the ring and little fingers toward each other. When the lateral half of the deep ulnar nerve was stimulated, the thumb adducted toward the ray of the index finger.

Immediately postoperatively in the recovery room, the clawing of the hand improved. Within three months, the patient regained normal function and muscle tone in the hand. She remained asymptomatic two years postoperatively.

Discussion

The distal ulnar tunnel is a one and one-half-inch (approximately four-centimeter) confined space, with discrete anatomical limits and boundaries. It extends from the proximal edge of the palmar ligament to the fibrous edge of the hypothenar muscles and is traversed by the ulnar nerve and artery. The tunnel has been subdivided into three zones to correlate the anatomy of the ulnar nerve and its branches with clinical symptoms[11,24]. Zone I consists of the ulnar nerve proximal to its bifurcation; zone II, the deep branch of the ulnar nerve; and zone III, the superficial branch. Although many variations occur, the deep branch of the ulnar nerve typically innervates the palmar and dorsal interossei, third and fourth lumbrical muscles, hypothenar muscles, adductor pollicis, and deep head of the flexor pollicis brevis.

Ulnar-nerve compression within Guyon's canal is most commonly within zone I. Involvement of the deep branch within zone II, which is also relatively common, is usually due to ganglia or anatomical abnormalities in the vicinity of the fibrotic arch at the origin of the hypothenar muscles[8,11]. The fibrotic arch has been demonstrated in 40 per cent of cadavera[4], and swelling or edema of the fibrotic arch plays a well recognized role in the development of compression of the deep branch[16]. When a patient has motor weakness alone, it is almost exclusively due to compression in zone II. However, posteromedial fascicular involvement of the ulnar nerve within zone I may also result in pure motor weakness[8,11].

The usual clinical presentation of pure motor involvement from compression of the ulnar nerve or its deep branch within the distal ulnar tunnel[8,11,28] includes paresis or paralysis of (1) all of the intrinsic muscles innervated by the ulnar nerve[24], (2) the intrinsic muscles innervated by the ulnar nerve except the hypothenar

muscles[13], (3) the intrinsic muscles innervated by the ulnar nerve except the abductor digiti minimi[28], or (4) the first dorsal interosseous and adductor pollicis muscles[6,22].

Dysfunction of the ulnar nerve has been associated with variations in neural anatomy either involving the ulnar nerve at a level just proximal to the wrist[17,19,25,30] or involving the deep branch of the ulnar nerve[2,6]. Loops of the deep ulnar nerve[14,18] have been previously identified in the region of the hook of the hamate in several patients[2,6,10] as well as in 9 per cent (seven) of seventy-seven cadavera in an anatomical study[20]. Although the internal topography of the deep branch of the ulnar nerve has not been fully defined, histological cross-sectional studies have demonstrated the nerve to be composed of one to six fascicles[3,9]. The innervation of the hypothenar muscles is from the medial aspect of the deep branch of the ulnar nerve[9]. The clinical presentation and intraoperative findings in our patient suggest that the medial half of the deep branch of the nerve, distal to its branches to the abductor digiti minimi, supplied the other hypothenar muscles as well as the intrinsic muscles of the third and fourth interspaces. The lateral half of the deep branch of the ulnar nerve probably supplied the muscles of the first and second web spaces.

Although it is rare, innervation of the thenar, adductor, and first dorsal muscles was identified as coming from the median nerve in 5 per cent (six) of 124 patients in one study[21]. However, the preoperative electrical studies and intraoperative stimulation of nerves eliminated the possibility of cross innervation in our patient.

The intraoperative response to stimulation of the medial half of the deep branch of the ulnar nerve after release indicated a neurapraxia and suggested that a good clinical recovery could be expected. This was confirmed by the immediate improvement in the clawing of the hand noted in the recovery room.

To our knowledge, penetration of the deep branch of the ulnar nerve by a tendinous structure has not been reported previously, although analogous neural penetration has been demonstrated elsewhere in the upper limb. One ramus of an ulnar neural loop may pass through the flexor carpi ulnaris just proximal to the wrist and entrap the ulnar nerve with resultant neuropathy[19,25,30]. An anomalous flexor digitorum superficialis tendon[1] has also been reported to split the median nerve, resulting in neural dysfunction.

Anatomical variations within Guyon's canal[5] or related to the flexor digiti minimi are common[27]. An accessory flexor digiti minimi, arising in the forearm and passing through Guyon's canal, has presented as a mass in the hypothenar region[15] or with nerve compression[23,26] at the level of the wrist, but not at the level of the fibrotic arch as was seen in our patient.

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