Ulnar-Nerve Compression Syndromes at and below the Wrist

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There are many potential sites of injury to the ulnar nerve between the brachial plexus and the hand, and the region of the wrist appears to be the most difficult to evaluate accurately. Since 1861, when Felix Guyon 14, a French urologist, first described the narrow rigid canal through which the ulnar nerve enters the hand, many have described nerve injury within the canal. Occupational trauma involving the deep motor branch was recorded by Hunt 22,23,24,25 in the early part of this century. A peculiar form of muscle atrophy in the hands of gold polishers was reported in 1896 by Gesseler 14 who did not recognize the lesion as an ulnar neuritis. Seddon 51 reviewed sixteen cases in which a ganglion in the canal of Guyon caused an ulnar motor deficit without sensory loss. In this paper we will show that there is a char-

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This text is discussing Ulnar-Nerve Compression Syndromes at and below the Wrist. It describes the historical context of understanding ulnar nerve injuries, starting with Felix Guyon's description in 1861, and highlights the occupational trauma observed in the early part of the 20th century. It references specific cases reviewed by Seddon and discusses the conditions where ulnar nerve injury occurs within the canal of Guyon, leading to motor deficits without sensory loss. The text introduces a diagram labeled Fig. 1, which illustrates the anatomical relationships of the ulnar nerve in the wrist and hand.
acteristic variation in the motor and sensory loss, depending on where in the region of the wrist the ulnar nerve has been compressed. Because of this, an orderly classification of distal ulnar lesions is now possible, which will make available to the surgeon a single system for better preoperative evaluation and localization of lesions, regardless of their cause. Until now no such classification of ulnar-nerve compression syndromes has been published.

A review of the anatomical relationships of the ulnar nerve in the wrist and hand is presented in Figure 1 which is a composite drawing of several dissections. The ulnar nerve is derived from the eighth cervical and the first thoracic nerve roots and is the largest branch of the medial cord of the brachial plexus. About six to eight centimeters proximal to the wrist, it gives off the dorsal cutaneous branch to the hand and then it passes through the ulnar-carpal canal (canal of Guyon) to the hand. This oblique canal is bounded by the pisiform proximally and medially, by the hook of the hamate laterally and distally, by a thickening of the deep forearm fascia (volar carpal ligament) blended with the tendinous flexor carpi ulnaris insertion anteriorly, and by the medial attachment of the thick transverse carpal ligament overlying the pisotriquetral articulation posteriorly. There are no tendons or tendon sheaths in the canal and, except for the nerve and artery, it contains only a small amount of fat. In this canal, the nerve bifurcates into a superficial and a deep branch. On exit from the canal the superficial branch passes through a fat pad deep to the palmaris brevis muscle which it supplies before continuing on subcutaneously to provide sensation to the ulnar surface of the hypothenar eminence and to the ring and little fingers. The deep motor branch, in company with the artery, takes an abrupt turn about the hook of the hamate to enter the narrow interval between the origins of the abductor digiti quinti and flexor digiti quinti brevis muscles. It then penetrates the substance of the opponens digiti quinti and follows along the deep palmar arch across the interossei, dorsal to the finger flexor tendons, to terminate in the flexor pollicis brevis (32 per cent of the time) and first dorsal interosseus muscles. The several reports of variations in and anomalous innervations of the hand muscles by both median and ulnar nerves \cite{10, 11, 35, 45, 48} should be kept in mind.

Three specific types of symptom complexes or syndromes emerge based on these anatomical relations (Table I).

**Type-I Syndrome**

This involves a motor weakness of all ulnar innervated muscles in the hand as well as a sensory deficit to the palmar surfaces of the hypothenar eminence and of the ulnar two fingers. These symptoms can be caused by pressure on the nerve just proximal to the canal of Guyon or within the canal. Normal sensation on the dorsum

<table>
<thead>
<tr>
<th>Type</th>
<th>Sites and Symptoms</th>
<th>Type II</th>
<th>Type III</th>
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<tbody>
<tr>
<td>I</td>
<td>Proximal to or in canal of Guyon</td>
<td>In canal of Guyon or at hook of hamate at origin of abductor digiti quinti and flexor digiti quinti; and in opponens digiti quinti muscle</td>
<td>In canal of Guyon or at hook of hamate or in palmaris brevis</td>
</tr>
<tr>
<td>II</td>
<td>Superficial and deep</td>
<td>Deep</td>
<td>Superficial</td>
</tr>
<tr>
<td>III</td>
<td>Sensory and motor deficit</td>
<td>Motor deficit only</td>
<td>Sensory deficit</td>
</tr>
</tbody>
</table>
ULNAR-NERVE COMPRESSION SYNDROMES

Wrist and Hand

As Type III

hook of In canal of Guyon or
ductor at hook of hamate
digitii or in palmaris
subscapularis brevis

Superficial
Sensory deficit

...ing on where in the region cause of this, an orderly will make available to the and localization of lesions, of ulnar-nerve compression...s nerve in the wrist and; of several dissections. The st thoracic nerve roots and plexus. About six to eight...cutaneous branch to the nail of Guyon) to the hand, and medially, by the hook of the deep forearm fascia...carpi ulnaris insertion transverse carpal ligament. There are no tendons or tendons, it contains only a small...peripheral and a deep branch...ough a fat pad deep to the...n the artery, takes an arrow interval between the inti brevis muscles. It then and follows along the deep...sor tendons, to terminate...first dorsal interosseus muscle, and the hypothenar eminence. There was diminished...sensation to pin prick along the medial border of the palm and in the ring and little fingers only on their palmar surfaces. A definite fullness was noted at the volar medial aspect of the wrist. Examination of the cervical spine, left shoulder, and elbow was normal. Electromyograms and nerve-conduction studies were normal. No abnormalities were noted in roentgenograms of the left wrist and hand. At surgery, the ulnar nerve was explored from the distal third of the forearm to beyond the canal of Guyon. A ganglion was found to be arising from the underlying carpus, compressing both branches of the ulnar nerve in the canal of Guyon. This was excised. Normal sensation returned within six to eight weeks followed by full motor recovery in four to six months.

Type-II Syndrome

Here, there is normal sensation in the hand, but there is motor weakness of those muscles innervated by the deep branch of the ulnar nerve. The superficial sensory branch thus has been spared while the deep motor branch is injured. The pressure on the nerve may occur where it exits from the canal of Guyon in the region...
of the hook of hamate between the origins of the abductor digiti quinti and flexor digiti quinti muscles or during its passage through the substance of the opponens digiti quinti muscle, or as it crosses the palm deep to the flexor tendons and volar to the metacarpals. Obviously the number of muscles involved depends on the site of compression along the deep branch (Fig. 3).

The following case is an example of the Type-II syndrome.

R. S., a thirty-six-year-old white metal worker, lifted heavy pieces of metal with the palm of his right hand. He began to note progressive pain and spasms in his right ring and little fingers with associated weakness in the muscles of his hand. Past medical history and review of symptoms were negative for systemic and musculoskeletal diseases. On physical examination there was obvious atrophy of the hypothenar eminence and the first dorsal interosseus muscle. The ring and little fingers were held with the distal and proximal joints flexed and the metacarpophalangeal joints extended. Muscle testing of the right upper extremity was normal except for weakness of the ulnar-innervated intrinsic hand muscles. There was no loss of sensation in the hand. Examination of the right elbow, shoulder, and cervical spine was normal. Electromyograms and nerve-conduction studies revealed fibrillation potentials in the first dorsal interosseus and abductor digiti quinti muscles and a conduction delay at the wrist. Roentgenograms of the right hand and wrist were normal. At surgery, the motor branch of the ulnar nerve was noted to be compressed and narrowed under the volar carpal ligament in the region of the hamate hook. The nerve was decompressed from the wrist to the palm. Electromyograms two months after the surgical decompression showed voluntary motor units in the abductor digiti quinti and first dorsal interosseus muscles as well as numerous polyphasic units indicative of a regeneration process. By four months he had made a complete clinical recovery.

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**Fig. 3**

The broken line indicates the potential sites of injury to the ulnar nerve which will result in the specific signs and symptoms characteristic of Type-II ulnar-nerve-compression syndrome.
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ne flexor tendons and volar
volved depends on the site
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as noted to be compressed by
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t after the surgical decommis-
inti and first dorsal interosseous
eration process. By four months

![Image of a hand with labels indicating the location of the ulnar nerve and related structures.]

**Fig. 4**

The broken line indicates the potential sites of injury to the ulnar nerve which will result in the specific signs and symptoms characteristic of Type-III ulnar-nerve-compression syndrome.

**Type-III Syndrome**

This involves sensory deficits in the volar surface of the hypothenar eminence and in the ring and little fingers, from pressure on the superficial branch of the ulnar nerve. There is no associated muscle weakness or atrophy. In this syndrome, a compressive lesion in or just at the end of the canal of Guyon may spare the deep branch of the ulnar nerve. The sensory branch can also be traumatized directly in its superficial course along the ulnar border of the hand. The dorsum of the hand retains normal sensation (Fig. 4).

The following case illustrates a typical Type-III syndrome.

D. B., a forty-seven-year-old white male steel worker, fell eight years before admission, striking the volar surface of his right hand with the wrist hyperextended. He had pain in the wrist, more severe on the radial than on the ulnar side. The pain persisted and roentgenograms were interpreted as showing degenerative changes in the articulations between the radius, navicular, and greater multangular. Two years before admission, a ganglion was removed from the volar radial aspect of the wrist overlying the involved joints. Postoperatively, he continued to complain of pain and numbness along the ulnar side of the hand, ring, and little fingers. He had no complaints of muscle weakness in the hand. A review of systems and past medical history was negative.

On physical examination, there was decreased sensation to pin prick over the volar surface of the ring and little fingers and hypothenar eminence of the right hand. Tinel's sign was elicited at the region of the canal of Guyon. There was full active motion of all fingers with no muscle weakness or atrophy. Examination of the cervical spine, right shoulder, and elbow was normal. Electromyograms and nerve-conduction studies were normal. Routine anteroposterior, lateral, and
TABLE II
REPORTED LESIONS CAUSING Ulnar-Nerve-Compression Syndromes At And Below The Wrist

<table>
<thead>
<tr>
<th>Lesion</th>
<th>No. of Cases</th>
<th>Total (Per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganglion</td>
<td>39</td>
<td>28.7</td>
</tr>
<tr>
<td>Occupational neuritis</td>
<td>32</td>
<td>23.5</td>
</tr>
<tr>
<td>Laceration</td>
<td>14</td>
<td>10.3</td>
</tr>
<tr>
<td>Ulnar-artery disease (arteritis, thromboangiitis)</td>
<td>11</td>
<td>8.1</td>
</tr>
<tr>
<td>Fracture of carpal bones</td>
<td>8</td>
<td>5.9</td>
</tr>
<tr>
<td>Scar-tissue contracture</td>
<td>6</td>
<td>4.4</td>
</tr>
<tr>
<td>Fracture of metacarpal</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>Fracture of radius</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>Aberrant muscles</td>
<td>4</td>
<td>2.9</td>
</tr>
<tr>
<td>Tumor, neurilemma</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Anomalous relationship of nerve to carpal bones (pisiform, hamate)</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Bursitis, pisiform</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Osteo-arthritis, carpus</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Accessory ossicle</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Dislocation of distal end of ulna</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Lipoma</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Hemihyphenal cyst</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Dislocation of pisiform</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Rheumatoid arthritis (no specific cases reported)</td>
<td>136</td>
<td></td>
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</tbody>
</table>

oblique roentgenograms of the hand and wrist revealed osteo-arthritis, and a tunnel view demonstrated an ununited fracture of the hook of the hamate bone.

At surgery, the ununited volar bone fragment, which was compressing the sensory branch, was excised and the nerve was decompressed from the canal of Guyon to the palm. Within five weeks the patient noted complete relief of symptoms and return of normal sensation in the hand.

Discussion
A review of the literature and our own experience indicated at least nineteen different causative lesions for compression of the ulnar nerve in the wrist and hand. These are listed in Table II in the order of reported frequency. It seems odd, therefore, that some current orthopaedic textbooks only mention the ganglion as a cause. On the basis of the recorded histories and physical findings it was possible to differentiate and type each case specifically according to our classification. Of a total of 136 cases, including seven personal cases, forty-one (30 per cent) were Type I, seventy-one (52 per cent) were Type II, and twenty-four (18 per cent) were Type III. No particular lesion was consistently associated with any particular type of syndrome with the possible exception of arteritis of the ulnar artery. The majority of these lesions were Type III and responded to resection of the involved segment of the artery. Most Type-II lesions were caused by nerve compression in the canal of Guyon or at the hook of the hamate but a few showed the nerve compressed in the palm. This indicates the necessity for systemized thorough operative exploration.

Twenty-one of the sixty-one peripheral ulnar-nerve lesions reported by Vanderpool and co-workers were located at the wrist. Ganglions were the causative lesions in 63 per cent (thirteen in twenty-one cases) of their series, but our review shows that, of all reported lesions, 28.7 per cent were caused by ganglions. Our review showed no correlation with age or sex. In the majority of cases, the injury to the nerve was essentially a reversible neuropraxia amenable to surgical decompression or to change in occupation.
The ulnar-carpal canal differs from the more familiar median-carpal tunnel in several ways. It lies more superficial and medial and is roofed by a much thinner ligament. Although the walls of both canals are rigid and osseous, their contents are quite different. In Guyon's canal there are no tendons or tendon sheaths which might cause symptoms through swelling. Both canals contain nerves, but there is no major artery or vein accompanying the median nerve as in the case of the ulnar nerve. The bifurcation of the ulnar nerve in the canal of Guyon separates the sensory and motor functions at a constant, vulnerable anatomical site.

Compression syndromes involving the ulnar nerve are much less frequent than those involving the median nerve probably because the absence of the motion of tendons and tendon sheaths may spare the ulnar nerve when there is synovial involvement in generalized disorders. Occasionally, however, the underlying carpal bones are involved by rheumatoid disease with local expansion into the canal. Generally, in each case, the onset of symptoms seems to be gradual. The thinner ulnar-canal roof is more elastic and yielding than the dense sharp-edged transverse carpal ligament of the median tunnel. Thus, transient crowding of the canal's contents may not cause symptoms. Moreover, gradual, partial loss of motor control of the intrinsic muscles with an intact median-innervated thumb and normal sensation is not severely incapacitating. The extrinsic hand and wrist muscles continue to function. Therefore, some patients whose occupations do not require manual dexterity may not recognize the motor deficit.

In a patient with complaints suggestive of a distal ulnar-nerve lesion a proper evaluation follows a logical sequence. As always, an accurate history is taken including details about unusual vocations, for example, gold polishers, oyster openers, and cutlery workers. Unusual avocations may also be discovered, such as motorcycling. If there has been an injury, that is, a laceration or fracture, this should be recorded. Generalized disorders, such as rheumatoid arthritis, seleroderma, and diabetes mellitus, are sought for. The possibility of an abnormality of the cervical spine, shoulder, and elbow must be excluded. A detailed sensory examination will help to distinguish nerve compression at the elbow from wrist and hand involvement. Intact sensation on the dorsal ulnar border of the hand localizes the injury distal to the origin of the dorsal sensory branch. A detailed muscle examination is essential because, as mentioned, intrinsic muscle weakness may not be symptomatic or grossly evident. Electromyographic and nerve-conduction studies complement the muscle testing. Roentgenograms of the hand and wrist including the carpal-canal views are necessary to demonstrate possible fractures and bone displacement. The surgeon should be aware that acute pain and swelling occurs in the wrist in patients with calcification in the flexor carpi ulnaris tendon, but usually without ulnar-nerve compression.

The treatment of the compression syndromes involving the ulnar nerve is usually surgical decompression and exploration of the nerve and its branches until the preoperatively indicated lesion is found. An initial trial of conservative therapy by immobilization, discontinuance of traumatic habits, and local injection of cortisone may be tried. Regardless of the cause, the resulting symptom-complex depends on the specific site of involvement. The severity of nerve compression, as well as the site, will influence symptoms. Finally, it should be noted that median-nerve compression in the carpal tunnel may exist simultaneously with ulnar-nerve compression syndrome at or below the wrist.

Summary

A classification of three specific syndromes of ulnar-nerve compression at the wrist and hand with representative cases is presented and reported cases have been
classified according to the location of compression. In Type I (proximal lesion), there is sensory loss in the ulnar distribution as well as some distal loss. In Types II and III (distal lesions), there is, respectively, only pure motor or pure sensory deficit. An outline of preoperative evaluation is suggested for more accurate localization of the site of the injury. Surgical decompression of the usual reversible ulnar neuropathia is the suggested treatment.

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