Case Report

Dynamic Nerve Compression of Guyon Canal Secondary to Variation of the Deep Branch of the Ulnar Artery: Etiology, Diagnosis, Treatment, and Outcome

Yelena Levina, MD, * Gary M. Lourie, MD, * Robert C. Matthias Jr, MD

*Department of Orthopaedics, WellStar Atlanta Medical Center, Atlanta, GA
†Department of Orthopaedics, University of Florida, Gainesville, FL

A patient presented with an ulnar-sided left wrist injury that was sustained while batting. Advanced imaging was obtained to rule out common causes of nerve compression and evaluate the patient’s anatomy. Dynamic nerve conduction studies were necessary to confirm a diagnosis of nerve compression. Failing conservative treatments, the patient underwent exploration of Guyon canal and decompression of the ulnar nerve with complete symptom resolution. The patient presented a unique diagnostic challenge because he did not display the typical findings of chronic nerve entrapment syndromes. To the best of our knowledge, dynamic nerve compression at Guyon’s canal has not previously been described. It is important to use a systematic approach to diagnosis, eliminating all other sources of compression. With appropriate diagnostic tools, nerve decompression can result in symptom relief.

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Guyon canal, or the distal ulnar tunnel, is a region along the path of the ulnar nerve that is particularly vulnerable to compression. It was first described by French surgeon Jean Casimir Félix Guyon in 1861. Although not as common as cubital tunnel syndrome, Guyon canal is another potential site of ulnar nerve compression. This region in the wrist is approximately 4 cm long and is separated into 3 zones based on various anatomic structures, leading to differing pathologies and symptomatic manifestations of this condition. Causes of ulnar nerve compression at the wrist within Guyon canal include space-occupying lesions (including ganglion cysts and ulnar artery thromboses and aneurysms), fractures of the carpals, and anatomic variations (such as anomalous muscles and vascular structures). These pathologies all represent static compression of the ulnar nerve at Guyon canal. Dynamic ulnar nerve compression is a distinct entity that has been described at more proximal levels of the ulnar nerve; however, to the authors’ knowledge, dynamic compression within Guyon’s canal, such as that described in the case of the patient in this case report, has not previously been described in the literature.

Case Report

The study was determined to be exempt by our institutional institutional review board. The patient provided written consent for inclusion in this report.

The patient was a 19-year-old, right-handed man who was a college-level baseball player. He initially presented with a left ulnar-sided wrist injury who was batting when he felt a pop upon impact along the ulnar side of the wrist. The patient had undergone computed tomography and magnetic resonance imaging (MRI) with negative reports. He underwent treatment with placement of an orthosis and a corticosteroid injection in the ulnocarpal joint with no improvement. Upon physical examination, there was tenderness to palpation over the ulnar nerve over the hamate, sensation was intact in all distributions, and there was no numbness or tingling at rest. There was noruit or thrill, Allen test was negative, and he had a negative hook of hamate test. Upon further examination, it was noted that the patient had clawing with activity (primarily while batting), and he reported associated discomfort in the volar ulnar aspect of the hypothenar eminence, numbness and...
tingling, as well as cramping of the ulnar innervated musculature. He also reported discomfort in the ring and little finger mid-metacarpal area. He reported notable symptom resolution at rest.

Imaging and nerve studies

Initial imaging included radiographs, computed tomography, and MRI of the hand and wrist with no osseous injury or space-occupying lesion. The patient also underwent nerve conduction studies (NCS) and EMG, which were initially negative. Repeat MRI revealed extensor carpi ulnaris tenosynovitis, possible inflammation, and swelling of the ulnar nerve. There were no notable findings regarding anomalous muscular structures or ulnar artery pathology (Fig. 1).

Dynamic nerve testing

Given the findings from the imaging studies and the dynamic nature of the symptoms, the next step in evaluation was dynamic nerve testing involving pre- and post-exercise studies. To obtain a dynamic study, a baseline nerve conduction study was completed before athletic activity. The patient was then asked to participate in the provoking activity, in this case batting, until the onset of symptoms. Upon the onset of symptoms, the patient underwent repeat NCS and EMG studies. These studies were then compared with each other. The study showed a definite latency that was more delayed on the left than the right side. Specifically, the latency of the ulnar motor nerve, when stimulated at the wrist and recorded at the abductor digiti quinti (ADQ) was 3.02 ms on the left compared with 2.48 ms on the right. The latency did not change clinically after exercise and was measured at 2.88 ms on the left. However, there was decreased recruitment of musculature in the ADQ, which indicated dynamic stepoff from neural input into ulnar innervated musculature (Fig. 2). These findings indicated a change in recruitment pattern resulting from a dynamic compression.6

Surgical findings

Findings from the imaging and dynamic nerve studies as well as failure of conservative treatments indicated a need for exploration of Guyon canal, decompression of the ulnar nerve, and assessment for any anomalous musculature with subsequent excision. The patient underwent this procedure, with important findings (Fig. 1).

The deep branch of the ulnar artery traveled between the motor branch and the superficial branch, running volar to the deep motor branch and dorsal to the superficial branch. As the deep branch of the ulnar artery went volar to the deep motor branch, it wrapped around to continue its normal course to contribute to the deep arch, but also completely wrapped around the deep branch of the ulnar nerve. In addition to the anomalous course of the deep branch of the ulnar artery, we observed considerable thickening of the pisohamate ligament, and the confluence of the flexor digiti minimi and the opponens digiti minimi off the hamate and the abductor digiti minimi off of the pisiform, leading to additional compression of the deep motor branch of the ulnar nerve. The deep motor branch of the ulnar nerve thus appeared to have 2 constrictions: one was the deep branch of the ulnar artery wrapping around it, and more volar to this was the thickened, hypertrophied pisohamate arch. The canal was decompressed with arteriolyis of the aberrant course of the deep branch of the ulnar artery with ligation and release of the hypertrophied pisohamate arch (Fig. 3).

Outcome

The patient underwent a strict postoperative rehabilitation period. At 2 weeks, he was allowed to begin gentle active range of motion (ROM) exercises. At 4 weeks, he began passive ROM, and at 6 weeks, he began strengthening. This protocol is notably extended compared with a standard rehabilitation protocol after Guyon canal decompression. However, from the surgeon’s experience with high-level athletes, especially in the setting of baseball and batting, the limiting factor hindering return to sport is pain and tenderness related to the scar. We thus prefer a longer immobilization protocol for high-level athletes to protect the soft tissues. The patient was gradually released back to batting, and at 4 months after surgery, he made a full recovery and returned to sport at the same performance level without reports of pain. At the patient’s last follow-up 1 year after surgery, he demonstrated full ROM of the wrist and digits and symmetric grip and pinch strength compared with the contralateral hand, and was able to complete all activities of daily living with difficulty.

Discussion

Dynamic compression

Dynamic compression of the ulnar nerve at the elbow was previously described in a case series.7 Those patients presented with various neuropathies in the elbow, including dynamic compressive neuropathies of the lateral antebrachial cutaneous nerve, ulnar nerve, and posterior interosseous nerve based on physical examination and associated symptoms. The patients were given an appropriate diagnosis using dynamic nerve conduction studies and then typically treated with surgical decompression, which resulted in resolution of symptoms and return to sport. In this study, the patient presented a unique diagnostic challenge because he did not display typical findings of chronic nerve entrapment syndromes. Our case report was different from the case series with more proximal compression in that the current patient’s dynamic compression was generated from pathology in the wrist as opposed to that of the elbow.

Figure 1. Magnetic resonance imaging T2-weighted axial image of left hand of patient in case report, demonstrating ulnar nerve and artery within Guyon canal with no obvious pathology.
The anatomic course of the ulnar artery and its branches can vary substantially. However, there are some common patterns. In zone I of the canal, the ulnar artery and nerve travel together with the artery radial to the nerve. The nerve bifurcates approximately 11 mm distal to the proximal edge of pisiform, and 3 to 7 mm distal to the bifurcation of the nerve is the location of the arterial bifurcation. The larger superficial branch travels with the superficial artery into zone II and becomes the superficial palmar arch. The smaller deep branch travels with the deep motor branch of the ulnar nerve into zone III and become the deep palmar arch. In both instances, the arteries remain superficial and radial to the nerves.

In this patient, the deep branch of the artery passed superficially over the deep motor branch of the ulnar nerve and deep to the superficial ulnar nerve branch. The artery then proceeded to wrap back around deep and dorsal to the deep ulnar nerve branch, leading to a point of constriction around the deep ulnar nerve, which likely worsened with batting or any activity that causes increased blood flow.

In patients with distal ulnar nerve compression, it is important to be mindful of vascular malformations and pathology, because ulnar artery thromboses are a known cause of distal ulnar nerve compression. The current patient’s vascular physical examination was noted as normal with no palpable bruit or thrill and a negative Allen test indicating a patent ulnar artery. However, other methods can be employed to evaluate for a vascular anomaly, including

### Table 1: Nerve Conduction Studies (Pre-Exercise)

| Nerve       | Stimulation Site | Recording Site | Latency (msec) | Amplitude (mV) | Conduction Velocity (M/s) |
|-------------|------------------|----------------|---------------|----------------|---------------------------|
| L. Median/Motor | Wrist            | APB            | 3.04          | 8              |                           |
| L. Ulnar/Motor  | Wrist            | “              | 2.88          | 8              |                           |
| “            | Below Elbow      | “              | 7.36          | 8              |                           |
| “            | Above Elbow      | “              | 9.4           | 10             |                           |
| R. Ulnar/Motor  | Wrist            | ADMQ           | 2.48          | 8              |                           |

### Table 2: Nerve Conduction Studies (Post-Exercise)

| Nerve       | Stimulation Site | Recording Site | Latency (msec) | Amplitude (mV) | Conduction Velocity (M/s) |
|-------------|------------------|----------------|---------------|----------------|---------------------------|
| L. Ulnar/Motor  | Wrist            | ADMQ           | 2.88          | 8              |                           |

### Figure 2. Nerve conduction study demonstrating that at baseline, left ulnar motor latency was increased compared with right ulnar motor latency. Although latency before and after exercise was unchanged, the EMG study shows that the left ADQ (L ADMQ) recruitment was decreased. APB, abductor pollicis brevis.

### Figure 3. Intraoperative photograph at the time of nerve decompression. Dissection scissors point to the deep branch of the ulnar artery as it encircles the deep motor branch of the ulnar nerve. The freer points to the superficial branch of the ulnar artery. The forceps move the superficial branch of the ulnar nerve ulnarly to demonstrate a clearer view.

### Electromyography

| Muscle       | Insertional Activity | Fibs | Fasc | Recruitment | Voluntary Motor Unit Potentials |
|--------------|----------------------|------|------|-------------|---------------------------------|
| L. 1st Dorsal Interosseus | Normal               | 0    | 0    | Normal      | Normal                          |
| L. ADMQ      | Normal               | 0    | 0    | Decreased   | Normal                          |

Vascular variation

The anatomic course of the ulnar artery and its branches can vary substantially. However, there are some common patterns. In zone I of the canal, the ulnar artery and nerve travel together with the artery radial to the nerve. The nerve bifurcates approximately 11 mm distal to the proximal edge of pisiform, and 3 to 7 mm distal to the bifurcation of the nerve is the location of the arterial bifurcation. The larger superficial branch travels with the superficial artery into zone II and becomes the superficial palmar arch. The smaller deep branch travels with the deep motor branch of the ulnar nerve into zone III and become the deep palmar arch. In both instances, the arteries remain superficial and radial to the nerves.
Doppler examination to assess further for bruit or thrill that would indicate aneurysmal dilation. Arteriography could also be appropriate if a vascular pathology is suspected. Ultrasound imaging has also been shown to be a useful modality to evaluate Guyon canal in terms of the ulnar nerve and the surrounding soft tissues, including the ulnar artery. Ultrasound is noninvasive and cost-effective and can be used in static and dynamic settings to aid in evaluating ulnar nerve and ulnar artery pathologies.

Conclusion

This patient represents a unique case of dynamic nerve compression of Guyon canal. Accurate diagnosis of this approach involves many steps beginning with a history that suggests dynamic entrapment of a specific nerve. Physical examination is benign at rest; however, an examination after the provocative activity will elicit more classical physical findings. Steroid injections, therapy, bracing, and rest were not successful in eliminating the patient’s symptoms. Radiographic and advanced imaging were necessary to rule out other common causes of compression and evaluate the patient’s anatomy. Finally, a dynamic NCS was necessary to confirm the diagnosis. It is important to use a systematic approach to eliminate all other sources of potential compression and to employ appropriate diagnostic tools to provide an accurate diagnosis. Once a diagnosis is suspected, surgical exploration and decompression can lead to symptom resolution and return to sport or regular activities.

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