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The Effect of Long-Distance Bicycling on Ulnar and Median Nerves

An Electrophysiologic Evaluation of Cyclist Palsy

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Background: Distal ulnar neuropathies have been identified in cyclists because of prolonged grip pressures on handlebars. The so-called cyclist palsy has been postulated to be an entrapment neuropathy of the ulnar nerve in the Guyon canal of the wrist. Previous studies utilizing nerve conduction studies have typically been either case reports or small case series.

Hypothesis: Electrophysiologic changes will be present in the ulnar and median nerves after a long-distance multiday cycling event.

Study Design: Cohort study; Level of evidence, 2.

Methods: A total of 28 adult hands from 14 subjects underwent median and ulnar motor and sensory nerve conductions, which were performed on both hands before and after a 6-day, 420-mile bike tour. A ride questionnaire was also administered after the ride, evaluating the experience level of the cyclist, equipment issues, hand position, and symptoms during the ride.

Results: Distal motor latencies of the deep branch of the ulnar nerve to the first dorsal interosseous were significantly prolonged after the long-distance cycling event. The median motor and sensory studies as well as the ulnar sensory and motor studies of the abductor digiti minimi did not change significantly. Electrophysiologic and symptomatic worsening of carpal tunnel syndrome was observed in 3 hands, with the onset of carpal tunnel syndrome in 1 hand after the ride.

Conclusion: Long-distance cycling may promote physiologic changes in the deep branch of the ulnar nerve and exacerbate symptoms of carpal tunnel syndrome.

Keywords: electrodiagnostics; ulnar neuropathy; cycling; nerve entrapment

Focal entrapment neuropathies of the ulnar nerve may occur at the wrist. Often the compression occurs as the ulnar nerve passes through the Guyon canal formed between the hook of the hamate and the pisiform bones of the wrist. Cyclist palsy, ulnar nerve compression in the Guyon canal, is postulated to occur from prolonged grip pressures on bicycle handlebars.

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Cyclist palsy has been described in the literature since the first case was reported in 1896 by Destot.[11] Over the years, several European articles subsequently followed, noting the problem.[2,15,18,20,23] Beginning in the 1970s, with the increased interest in cycling, reports in American journals began to surface.[6,8,13,25]

Ulnar neuropathy at the wrist may result in dysesthesia of the little and ring fingers as well as intrinsic hand muscle weakness. As the ulnar nerve approaches the wrist, it has 2 sensory branches: the palmar cutaneous branch, which provides sensation to the hypothenar region, and the dorsal ulnar cutaneous branch, which provides sensation to the dorsal aspect of the hand. The ulnar nerve then enters the hand via the ulnar tunnel, commonly called the Guyon canal.

The Guyon canal is formed between the pisiform bone and the flexor carpi ulnaris (FCU) tendon ulnarly and the

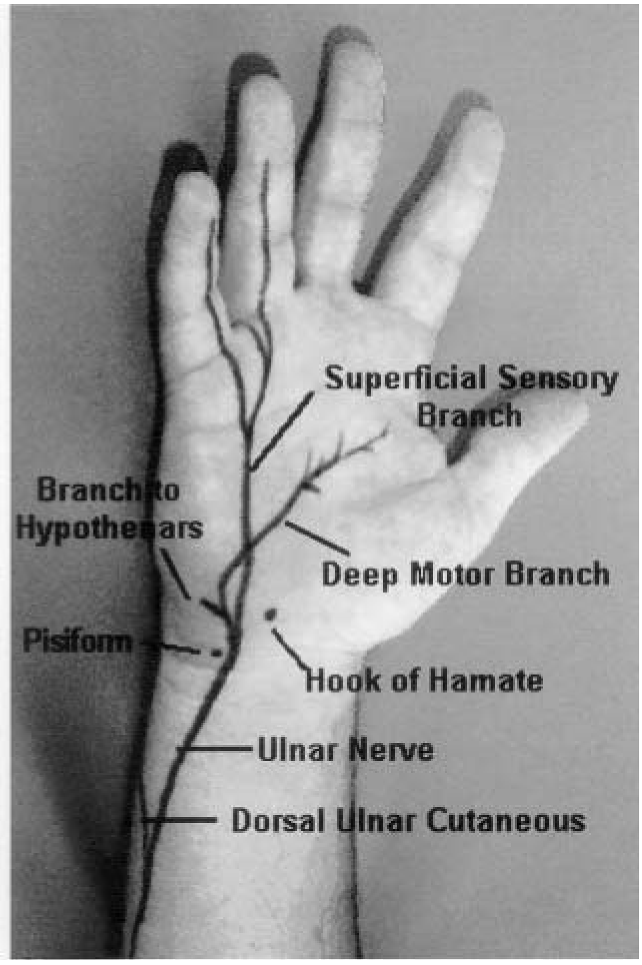

Figure 1. The ulnar nerve and its branches at the level of the wrist.

hook of the hamate radially. The pisohamate ligament forms the distal floor of the canal. The palmar carpal ligament (an aponeurotic extension of the FCU) and the palmaris brevis muscle form the roof.[10]

Either within or just distal to the canal, the ulnar nerve branches to the palmaris brevis muscle and then bifurcates to its superficial sensory division and pure motor division. This motor division further bifurcates into the branch to the hypothenar region and the deep palmar branch. Ulnar nerve compressive lesions may occur as injuries to the ulnar nerve proper or its respective branches (Figure 1).

No previous study has electrophysiologically tested the ulnar nerve, the median nerve, and their respective branches in cyclists. In particular, there has been a dearth of literature correlating cyclist palsy to electrophysiologic changes. Jackson[17] performed nerve conduction studies on the sensory and motor components of both the median and ulnar nerves of long-distance cyclists but did not study the deep ulnar motor branch. Wilmarth and Nelson[31] examined only the ulnar sensory nerve conduction studies. In both studies, the results of all nerve conductions were normal, even in cyclists experiencing symptoms. Wilmarth and Nelson[31] showed that the sensory nerve conduction studies for the ulnar nerve, although within normal values, varied significantly from the control group of noncyclists. These studies may not have shown significant changes in ulnar and median nerve conductions because not all branches of the ulnar nerve were tested adequately.

A novel electrophysiologic technique to test the ulnar nerve has emerged to isolate the deep branch of the ulnar nerve.[7] Our study aims to examine prospectively the electrophysiologic changes of the ulnar and median nerves and their respective branches across the wrist before and after a long-distance multiday cycling event.

PATIENTS AND METHODS

Design

A prospective cohort study of bicyclists riding in a multiday event was designed to assess electrophysiologic changes to the ulnar and median nerves. A follow-up questionnaire was also given to attempt to correlate changes to cyclists' habits.

Subjects

Approval from the Institutional Review Board was obtained. All subjects signed informed consent forms. Subjects were recruited by word of mouth from an adult recreational bicycling club. Not all club members participated in this study. Nerve conduction studies before and after the endurance bicycling event were used to test 28 hands from 14 adult subjects. There were 7 men and 7 women tested. The average age was 52.1 years, with a range of 41 to 64 years. No subjects reported symptoms before the study. Subjects had a varied amount of training, but they typically had about 500 miles of training during the previous 3 months.

A long-distance endurance bicycling event acted as the intervention. The bike tour totaled 420 miles over 6 days. All subjects completed the tour and did not drop out of any part of the tour. All cyclists wore gloves and, with 1 exception, used padded handlebars.

Outcome Measures

Nerve conduction parameters acted as outcome measures. Testing of nerve conduction using standard parameters was performed before and after the bike tour. A single physician who was board-certified in electrodiagnostic medicine performed all testing.

Instrumentation

A Nicolet Viking Quest electrodiagnostic machine (Nicolet Biomedical, Madison, Wis) was used for all nerve conduction studies (Figure 2).

TABLE 1
Comparison of Onset Latencies of the Median and Ulnar Nerves Before and After the Ride[a]

	Median		Ulnar to ADM		Ulnar to FDI		FDI to ADM	
	Before	After	Before	After	Before	After	Before	After
Average	3.70	3.45	3.1	3.0	3.5	3.7	0.45	0.6
Range	2.9-4.8	2.7-5.3	2.4-3.5	2.6-3.5	3.0-4.3	3.2-4.4	0-1.1	0.3-1.5
SD	0.45	0.62	0.29	0.25	0.27	0.39	0.219	0.26
P	.5020		.2357		.0044[b]		<.0001[b]	

[a]ADM, abductor digiti minimi; FDI, first dorsal interosseous.
[b]Statistically significant.

Figure 2. Electrodiagnostic machine used for nerve conduction studies.

Technique

The peak latency and peak-to-peak amplitude were recorded for the sensory nerve conductions. The onset latency and amplitude were recorded for the motor nerve conductions.

The following nerve conduction studies were performed on both hands of each of the cyclists before and immediately after the 420-mile bicycle ride.

Median Motor Nerve Conduction to the Abductor Pollicis Brevis. The reference electrode was placed over the carpometacarpal joint of the thumb; 8 cm was measured along the course of the median nerve from a disc electrode placed on the motor point of the abductor pollicis brevis. Stimulation was then applied to the wrist over the median nerve between the palmaris longus and flexor carpi radialis (FCR) tendon. Compound motor unit action potential responses were obtained. Onset latencies and amplitudes were recorded.

Ulnar Motor Nerve Conduction to the Abductor Digiti Minimi and First Dorsal Interosseous. Two-channel ulnar motor nerve studies were performed of the abductor digiti minimi (ADM) and the first dorsal interosseous (FDI). This 2-channel test has emerged as a method to assess the segment of the ulnar motor nerve between the hypothenar branch and the branch to the FDI.[7] The reference electrode was placed over the metacarpophalangeal joint of the little finger; 8 cm was measured from the disc electrode placed on the ADM proximally along the course of the ulnar nerve. Stimulation was then applied to either side of the FCU tendon; compound motor unit action potential responses were obtained. Onset latencies and amplitudes were recorded.

Median Sensory Nerve Conduction to the Index Finger. Ring electrodes were placed on the index finger at least 4 cm apart, and 14 cm was measured from the proximal ring electrode to the wrist along the course of the median nerve. Stimulation was then performed between the palmaris longus and the FCR tendon. A sensory nerve action potential was obtained. The peak latencies and the peak-to-peak amplitudes were recorded.

Ulnar Sensory Nerve Conduction to the Little Finger. Ring electrodes were placed on the little finger at least 4 cm apart, and 14 cm was measured from the proximal ring electrode along the course of the ulnar nerve. Stimulation was then performed on either side of the FCU tendon. A sensory nerve action potential was obtained. The peak latencies and peak-to-peak amplitudes were recorded.

Statistical Data Analysis

Data were encoded electronically using Microsoft Excel (Microsoft Corp, Redmond, Wash) and analyzed using SAS (version 8.0, SAS Institute, Cary, NC). Differences in electrodiagnostic measures for each subject were calculated by subtracting preride measures from postride measures. To test the null hypothesis that the difference was equal to zero, the Wilcoxon signed rank test was performed. *P* values less than .05 indicated that differences were significant.

RESULTS

Table 1 shows a comparison of onset motor latencies for the different nerves and nerve segments, which were tested

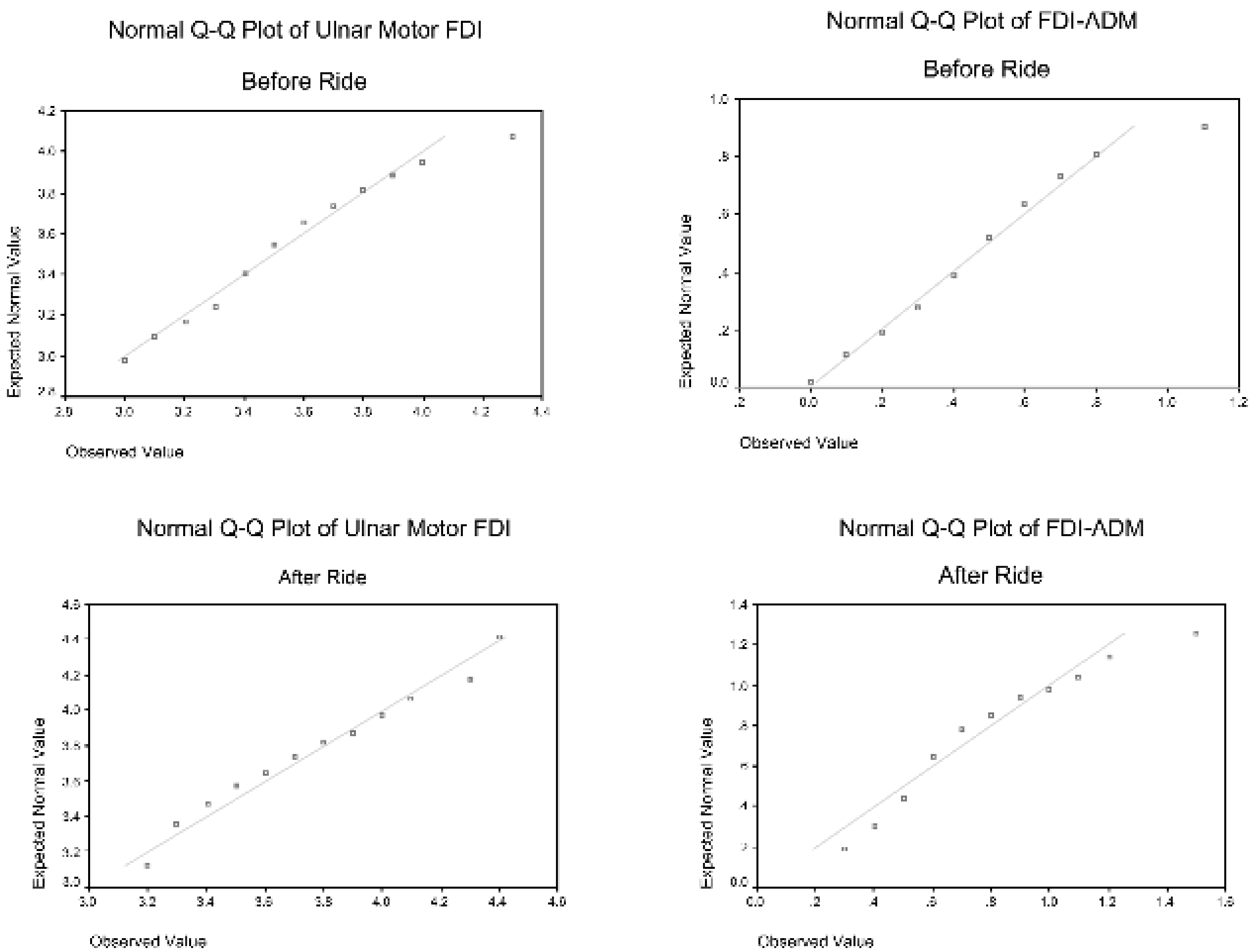

Figure 3. Normal Q-Q plots for ulnar motor nerve conduction to the abductor digiti minimi (ADM) and first dorsal interosseous (FDI).

TABLE 2
Peak Sensory Latencies of the Median and Ulnar Nerves Before and After the Ride[a]

	Median		Ulnar	
	Before	After	Before	After
Average	3.30	3.15	3.20	3.10
Range	2.7-4.1	2.7-4.1	2.7-3.5	2.7-3.5
SD	0.31	0.35	0.21	0.22
P	.7204		.6466	

[a]No statistical significance was seen.

before and after the event, including a comparison of the difference in latency between the ulnar nerve conductions to the FDI and the ADM.

The absolute onset motor latencies for the deep branch of the ulnar nerve to the FDI before and after the event were significantly different (P = .0044). The difference between the FDI and the ADM also showed slowing after completion of the event (P < .0001).

Table 2 presents the comparison data of peak latencies for the sensory nerve conduction studies before and after the event. Results of the sensory nerve conduction studies of the median sensory and ulnar sensory nerves did not show significant difference between the preride and postride peak latencies.

As a population, there was no significant difference between the hands before or after the ride for either the median motor or sensory study. However, of the 28 hands tested before the ride, 3 had an onset latency greater than 4.2 milliseconds for the median motor nerve. An onset latency of 4.2 milliseconds or greater for the median nerve has been established as indicative of a median neuropathy at the level of the wrist, that is, carpal tunnel syndrome (CTS).[12,22] After the ride, these hands experienced an increase in latency time. In addition, 1 cyclist's hand experienced a 0.9 millisecond increase from 3.9 milliseconds to 4.8 milliseconds, indicative of CTS onset. This person reported experiencing palm numbness and tingling bilaterally.

In analyzing the data for this study, an effort was made to be sure standard normal statistics would yield accurate results. To prove this, we utilized a Q-Q plot comparison.

The Q-Q plots (Figure 3) indicate the measured distribution against that of predicted normal distributions. These probability plots are generally used to determine whether the distribution of a variable matches a given distribution. If the selected variable matches the test distribution, the points cluster around a straight line, indicating that there is a normal distribution. These plots suggest that a standard normal statistical approach is acceptable.

DISCUSSION

Our objective was to examine prospectively the electrophysiologic changes of the ulnar and median nerves and their respective branches across the wrist, before and after a long-distance multiday cycling event. The onset motor latencies were significantly prolonged for the deep branch of the ulnar nerve to the FDI ($P = .0044$) after the ride. The segment between the FDI and the ADM also showed slowing after the ride ($P < .0001$). In addition, 3 hands had electrophysiologic findings suggestive of CTS before the ride, with further prolongation of the median motor latency after the ride; 1 hand showed the onset of CTS after the ride.

In this study, the nerve conduction studies of the ulnar motor branch to the ADM before and after the tour did not show a significantly increased onset latency. All nerve conduction studies of the ADM, both before the ride and after the ride, were within normal limits.[5] Thus, no conclusions can be drawn about the effects of cycling and handlebar pressure on the segment of the ulnar nerve to the ADM. However, the statistically significant findings of our study implicated changes of the onset latency to the deep branch of the ulnar nerve to the FDI. Our groups' average distal latency of 3.53 milliseconds before the ride is slightly below the population mean of 3.6 milliseconds, and our groups' average of 3.74 milliseconds after the ride is slightly above the population mean of 3.6 milliseconds.[26] All the cyclists' FDI latencies were within established normal values of a mean of 3.4 milliseconds, with a range of 2.6 to 4.4 milliseconds.[26]

To determine cyclist palsy in riders, we looked at established values for the onset latency to the ADM and the FDI. The onset latency to the ADM was not affected, whereas the onset latency to the FDI was affected, suggesting the lesion may be located in the palm, distal to the motor branch to the ADM. This pattern, therefore, would also affect the latency difference between the ADM and the FDI on the ipsilateral side. Logically, the ADM to FDI difference is also where significant differences were seen. These results indicate that subclinical changes can occur in the nerves of cyclists' hands.

Olney and Wilbourn[26] established distal motor latencies to the FDI, ipsilateral time differences for the distal motor latency between the ADM and the FDI, and side-to-side differences of the FDI latencies. Lo et al[21] established side-to-side differences to the ADM (0.394 milliseconds) and to the FDI (0.474 milliseconds).

The use of contralateral comparison of the motor nerve conductions to the ADM and the FDI may be useful for diagnosing ulnar neuropathy in a typical population; however, contralateral differences may not be sensitive enough to evaluate cyclist palsy. It is possible that contralateral comparisons may not be effective because both hands are subjected to similar forces while on the bike. Even if a cyclist commonly changes gears with only 1 hand, the time difference spent on the bars during a long ride would be negligible.

Although bicyclists may classically sustain an ulnar nerve injury, median nerve injuries in cyclists are also common.[3] In our study, 3 hands had an onset latency of the median motor nerve greater than 4.2 milliseconds, which indicates a median neuropathy at the level of the wrist, that is, CTS.[12,22] All 3 of these hands had increases (or worsening) of their latency times after the ride. Also, 1 cyclist's hand indicated the onset of CTS.

Among all the riders in whom nerve conduction studies were obtained, 50% noted symptoms in their hands, characterized as pain, numbness, or tingling. Of interest, the symptoms covered both ulnar and median sensory branch territory and could not be correlated to abnormalities of the sensory conduction studies. None of the riders complained of any weakness. Prior literature has also found nerve conduction studies to be within normal limits, even when symptoms occurred.[13,16,17,31] Needle electromyography can be a useful component in the testing of severe cases of ulnar and median nerve injury. Our study did not evaluate needle electromyographic changes.

Theoretically, the prolonged pressure on the median and ulnar nerves during a bicycle ride can affect nerve physiology. Yet no conclusion can be drawn about the exact cause of nerve physiologic change, as all cyclists wore gloves and, with 1 exception, used padded handlebars (Figure 4). The use of gloves and padded handlebars has often been postulated to prevent cyclist palsy.[4,14,19,24,28] However, subclinical changes may occur.

Several studies assessing the incidence of both acute and overuse injuries in cyclists have been conducted. These studies focused either on the general populace or on specific groups of cyclists involved in large-scale bicycling tours.[1,9,19,30] The studies indicate that 19% to 36% of participants experienced symptoms in their hands or wrists during long-distance multiday riding events. Patterson et al[27] found that 92% (23 of 25) of cyclists had either motor or sensory symptoms, or both, when interviewed and examined after a 600-km bicycle ride.

Eckman et al[13] were the first in the literature to correlate clinical symptoms with electrodiagnostic studies. They reported on 3 cases of cyclist palsy, using nerve conduction studies, and discussed localizing the lesion using the difference in latency between the conduction of the FDI and the ADM.

Shea and McClain[29] first classified ulnar compression syndromes of the wrist and hand into 3 categories (Table 3). In 1985, Wu et al[32] reclassified the syndromes into 5 categories (Table 3).

Our electrodiagnostic study has shown that changes do occur to the deep branch of the ulnar nerve, even with typical preventive measures. Whether the increased onset

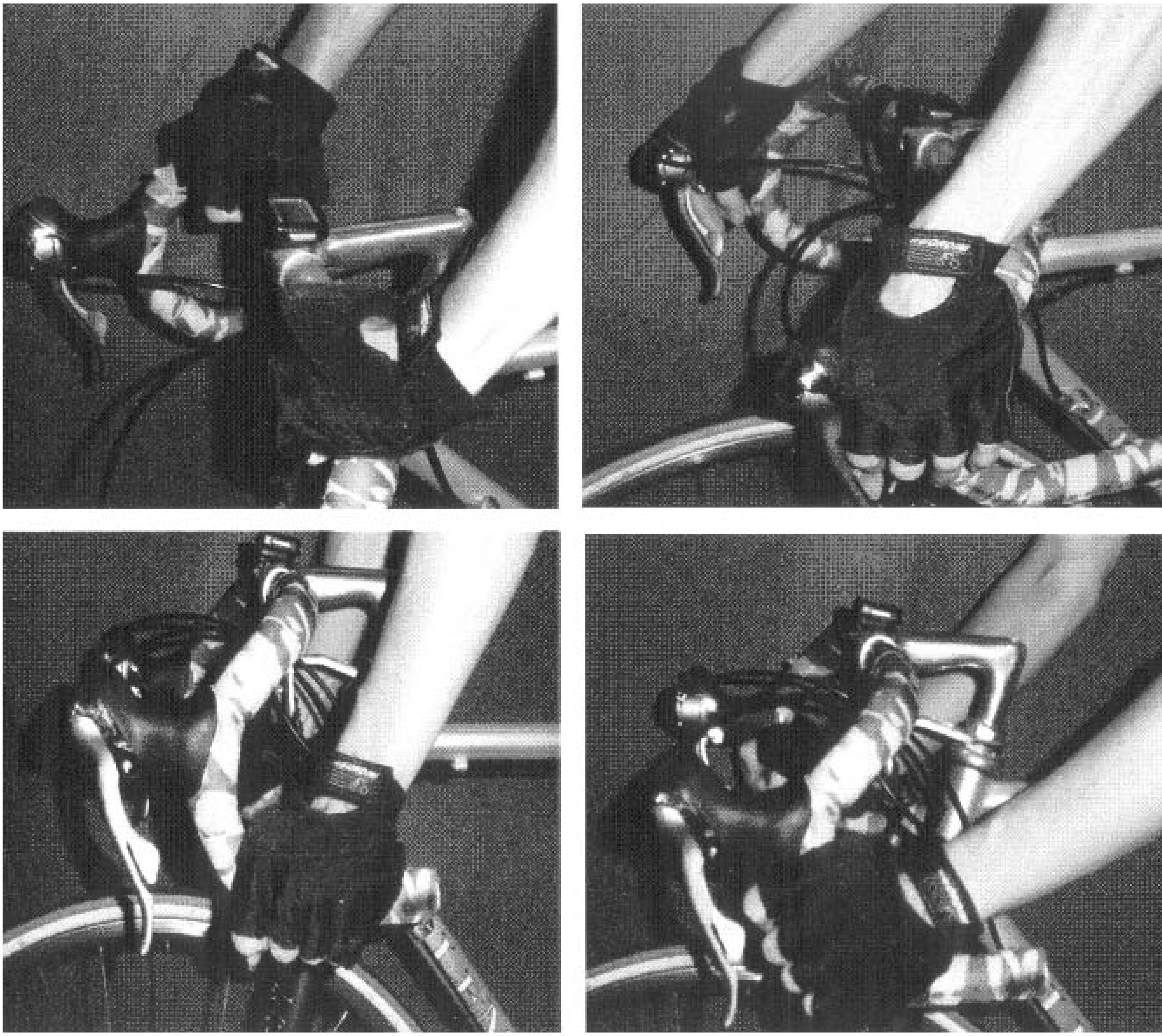

Figure 4. A variety of hand positions available for road cycling.

TABLE 3
Comparison of Classification Systems of Ulnar Nerve Compression at the Wrist

Shea and McClain[29] Type	Wu et al[32] Type		Location
I	I	Mixed	Proximal to or within the Guyon canal
III	II	Sensory	At the wrist, just distal to the branch to the palmaris brevis muscle
II	III	Motor	Proximal to the branch to the hypothenar muscles
	IV	Motor	Distal to the branch to the hypothenar muscles
	V	Motor	Proximal to the branches to the first dorsal interosseous and adductor pollicis muscles

latency times are because of the cyclist's position on the bike or other factors is unknown. Further studies could include a larger number of participants and could establish the exact position and distribution of weight on the bicycle. Also, a study employing needle electromyography as well as nerve conduction studies could add clarity to the exact pathophysiological injury to the ulnar and median nerves. Our study shows descriptively that preexisting nerve palsies may be exacerbated both pathophysiologically and symptomatically with long-distance bicycling.

There are several limitations to our study. These limitations include the small number of our sample size and the lack of a temperature measurement. Many other technical errors may have occurred, including measurement error, submaximal stimulation, inconsistencies in the distance from the motor point, and differences in interelectrode distance.[12] However, the same experienced electromyographer performed all tests in a similar fashion.

Every attempt was made to perform all measurements at the same time of day and in a similar ambient temperature. All subjects were measured within 3 hours of completing the cycling tour. Therefore, no significant delay occurred between the testing of the subjects and the end of the cycling tour. A variety of factors have been shown to affect nerve conduction studies, such as age, gender, weight, and temperature. There have been no studies which have shown any effect on nerve conductions in regard to fitness level or hydration status.[12] The average age of our subjects was 52.1 years. Our sample size was not large enough to evaluate the effects of age and riding history and how these factors may have affected the nerve conduction studies.

In conclusion, our study demonstrates that long-distance cycling may cause electrophysiologic changes in the deep motor branch of the ulnar nerve and may exacerbate symptoms of CTS because of changes to the median nerve.

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