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Analysis of Chronicity on Nerve Conduction Velocity of Ulnar Nerve, Median Nerve and Grip Strength in Professional Road Cyclists

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ABSTRACT

Background: Cycling as a recreation is done worldwide as well as is a major recreational sport in major leagues. Professional cyclists often tend to practice more in various terrains and use different types of cycles which have different impacts on the musculoskeletal systems. The continuous work of various parts of body, the prolonged sitting posture and the application of strong grip for prolonged durations leads to too many musculoskeletal injuries in which neuropathy in hand is most reported. We in our study wanted to study the chronic effects of prolonged duration of cycling on the nerve conduction velocity of ulnar and median nerves and on grip strength of professional road cyclists in Pune, India.

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Methods: Our study is one time cross-sectional study. Participants were selected randomly and included according to the inclusion criteria of study after explaining the study and taking a written consent. 60 adult hands of 30 subjects were assessed using NCV unit for SNCV and MNCV of ulnar and median nerve and grip strength was measured using hand held dynamometer and results were analysed using SPSS. The average age (years), BMI (kg/m^2), right hand grip strength (kg), left hand grip strength (kg), hours of practice (hour) and years of experience (years) are as follows: 34.14 ± 12.04 years, 25.35 ± 5.14 kg/m^2, 42.21 ± 17.29 kg, 38.14 ± 16.64 kg, 2.84 ± 1.06 hrs and 6.42 ± 5.22years.

1.3. Conclusion: Compression of the ulnar nerve and median nerve in road cyclists is evident resulting in prolonged distal latencies affecting the motor component more than the sensory component and also affects the grip strength with no significance to dominancy of hand; precisely it affected both the hands equally.

Keywords: Neuropathy; Nerve conduction velocity;Ulnar nerve; Road cyclists; Nerve entrapment

INTRODUCTION

Cycling is an activity generally used as a part of exercise, sport or as an aid of transport. [1] Bicycles were introduced in the 19th century and now number reaches approximately one billion worldwide2 and is used as the principal means of transportation in many parts of the world. It is an invention that provides joy and transportation to millions of people, but can also be a source of disabling injuries and death. [2] Cycling is widely regarded as an effective and efficient mode of transportation optimal for short to moderate distances and it also and part of Olympics. [3,4] There are four main Olympic cycling disciplines: road, track, mountain bike and BMX. Within some of these disciplines, there are different events that occur with different athlete types in competition (sprint, endurance and a mixture of both). There are also a huge variety of recreational cyclists. [5] Depending upon the type of landscapes, duration of cycling, body type a number of various types of cycles are available. Road cycling takes place in an open arena, for example, city streets, country roads, in which, in most cases, nothing separates the competitors from the spectators. Road racing can take place on surfaces ranging from smooth asphalt streets to brutal cobblestones. [6]

Pune being situated on the Deccan plateau, the cyclists often tend to use road bikes. Depending upon the individual's height, weight and other requirements the cycles are to be designed or set. Any fault in the pedals, handlebars, cranks, seat size tends to cause injuries to the cyclists.

Although the interaction at the pedals has received the greatest scientific attention, the impact of seat and handlebar geometry and load on wrist and hand on the performance of the rider-bicycle system cannot be ignored. [7] It is rare for cyclists not to sustain any injury due to overuse, improper technique or inadequate recovery. [6] The usual position maintained by the cyclists involves forward bending with shoulders flexed, elbows extended and wrists are gripped on to the handlebars in a cylindrical grip pattern.

Grip strength is the force applied by the hand to pull on or suspend from objects and is a specific part of hand strength. Optimum-sized objects permit the hand to wrap around a cylindrical shape with a diameter from one to three inches. [8] Chronic overuse injuries primarily affecting the median and ulnar nerves can lead to significant loss of grip strength in cyclists and can cause significant morbidity 10 as they are more prone to entrapment in cyclists. [9] . Individuals who do road cycling as a routine fitness regime or at a competition level on a regular basis are prone to injuries caused due to the prolonged postures or repetitive traumas.

Due to long distance and long duration of road cycling, individuals tend to put on their complete upper body weight on the handlebars through cylindrical grips exerting their wrists. Grips form a major component of the hand. [10] The type of grip on the cycle handlebar is cylindrical grip. Patterson, et al. [11] in their study ulnar and median nerve palsy in long-distance cyclists: A prospective study, found out that motor and sensory symptoms for ulnar and median nerves were equally distributed between road bike riders and mountain bike riders and riders of various experience levels. Many individuals (cyclists) that we assessed during an extension activity and community rehab we found the same and related complaints were also obtained such as tingling sensations in the 4th and 5th finger which led to our question, even though many injuries have been reported including ulnar neuritis, it's prevalence is mostly given in mountain cyclists. In most of the studies they have used a pre and post ride evaluation of nerves but the chronic effects are not studied leading to the aim of the study to study the chronic effects of cycling on nerve conduction velocity of ulnar and median nerve and grip strength in professional cyclists. [11-12]

4. MATERIALS and METHODOLOGY

Materials

EMG-NCV setup with proper grounding, wooden high plinth with pillows, sanitisers, pen, paper, case record sheets, patient consent form, Michigan hand outcome questionnaire, Hand held dynamometer.

Methodology

It is a onetime cross-sectional study including evaluation and assessment of 60 adult hands of 30 participants, selected randomly and included according to the inclusion criteria. This study was conducted in the Tilak Maharashtra Vidyapeeth's Department of Physiotherapy in Pune (India). The study was explained and a written consent was obtained from all the participants. The NCV was done and hand grip strength was measured from both the hands and data was analysed statistically. All ethical needs were taken care according to the declaration of Helsinki and written consent was obtained from each individual. (Testing of individual nerves is mentioned below). A full night's rest was advised before the NCV testing.

Inclusion criteria

Road cyclists since at least 6 months, cycling since the past 6 months for 4 days a week, both male and female and cycling for a period of 240kms per week.

Exclusion criteria

Patient not willing to participate, recent history of musculoskeletal disorder, any previously diagnosed respiratory/cardiovascular condition, recent surgery or any other major medical condition, neurological condition affecting balance agility and motor control and neuropathy of metabolic origin or due spinal nerve involvement.

To examine nerve conduction velocity of ulnar and median nerves

1. For ulnar nerve, the MNCV was taken by attaching the ground electrode at the mid forearm level, the button electrodes were placed along the muscle length of Abductor digiti minimi. The nerve was stimulated at two points, one at the wrist medial to palmaris longus tendon and second at the posterior aspect of the medial epicondyle of the humerus, with cathode closet to recording electrode.
2. For ulnar nerve, the SNCV was taken with the help of ring electrodes placed in the 4th digit and the ground electrode placed at the palm.
3. For median nerve, the MNCV was taken along the Abductor pollicis brevis muscle where the recording electrode was placed at the muscle belly and reference electrode was 3 cm to 4cm distal to this, ground electrode was at the mid forearm level. The nerve was stimulated at the wrist lateral to palmaris longus tendon and on the anterior aspect of the elbow, with cathode being closest to recording electrode.
4. For median nerve, the SNCV was taken with the help of ring electrodes placed around the 3rd digit and ground electrode at the palm.

Hand held dynamometer was used to check the grip strength and best of three attempts was noted for analysis. Michigan hand outcome questionnaire was filled by participants to compute functional ability of hand.

Preparation of participants

• Instructions given to the participants were as follows:-

1. Eat your normal meal on the day of the test and continue any medication you are taking.
2. Have a good sleep on the previous night of the test.
3. Take a shower or bath before the test in order to remove oils from your skin. Do not apply creams/ lotions/ oils on hands, arms, legs and feet. Remove all jewellery (rings or bracelets) and wrist watch.
4. Wear loose clothing.

•Nerve conduction velocity studies were done.

Figure 1: Placement for testing ulnar nerve MNCV.

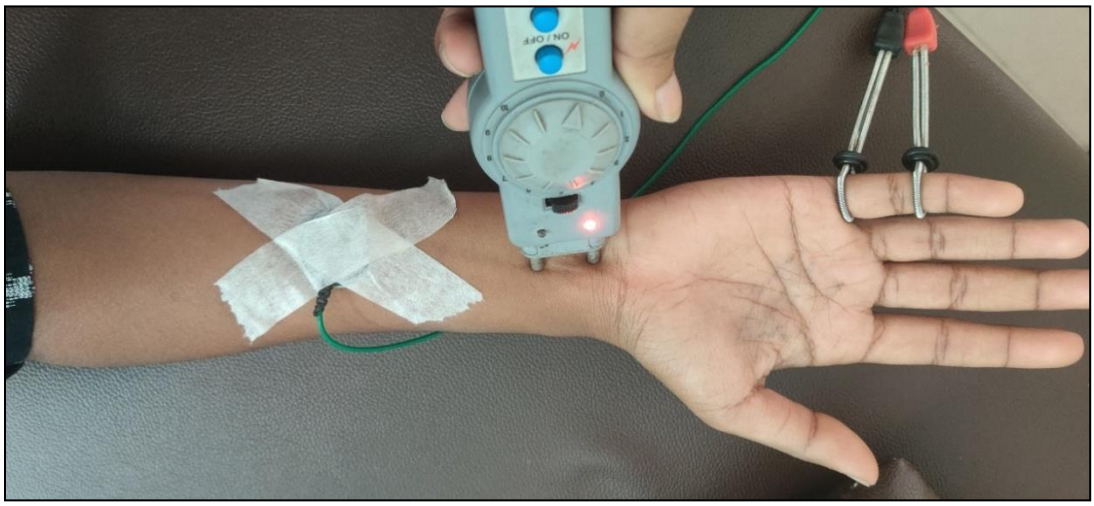

Figure 2: Placement for ulnar nerve SNCV.

Figure 3: Placement for median nerve MNCV.

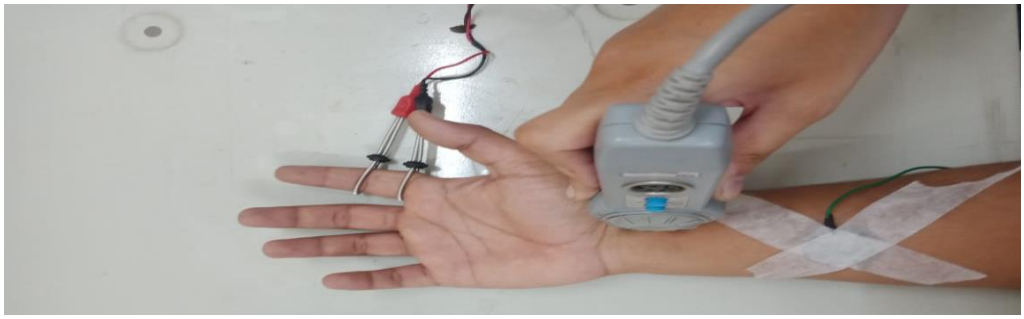

Figure 4: Placement for median nerve SNCV.

Statistical analysis

Data was analysed using SPSS version 16 in 64 bit system, the normality of the variables was checked and parametric and non-parametric tests were applied accordingly. Paired Student's t test was used for comparing the mean at p=0.05.

The mean and standard deviation of age (year), BMI (kg/m^2), Right hand grip strength (kg), Left hand grip strength (kg), Hours of practice (hrs) and Years of experience (year) are as follows 34.14 ± 12.04 years, 25.35 ±5.14 kg/m^2, 42.21 ± 17.29 kg, 38.14 ± 16.64 kg, 2.84 ±1.06 hours, 08.30±3.94 years comparable at baseline without any significant difference true to p=0.05 as shown in Table 1.

Table 1: Table showing average values of baseline demographic data of sample population (n=15)

Demographic Data	Mean ± SD
Age (years)	34.14 ± 12.04
BMI (kg/m^2)	25.35 ± 5.14
Right hand grip strength (kg)	42.21 ± 17.29
Left hand grip strength (kg)	38.14 ± 16.64
Hours of practice (hour)	2.84 ± 1.06
Years of experience (years)	6.42 ± 5.22

Table 2 suggests prolonged distal latencies for both motor and sensory components with all the other components including duration, amplitude and CV are within normal physiological ranges suggesting compression of the nerve.

Table 2: Table showing average values of MNCV and SNCV of right and left ulnar nerves.

DOMINANCY →	Right Ulnar Nerve		Left Ulnar Nerve	
Variables ↓	MNCV	SNCV	MNCV	SNCV
Latency (ms)	3.02 ± 0.26	2.78 ± 0.42	3.02 ±1.01	2.6 ± 0.25
Duration (s)	13.59 ± 2.24	2.57 ± 1.1	13.30 ± 2.23	2.71 ± 1.19
Amplitude (mV)	10.26 ± 4.13	20.08 ± 1.5	10.4 ± 4.13	19.81 ± 2.64
CV (m/s)	67.14 ± 4.84	55.69 ± 11.52	61.33 ± 8.82	52.1 ± 6.89

Table 3 suggests prolonged distal latencies for both motor and sensory components. All the other components including duration, amplitude and CV are within normal physiological ranges suggesting compression of the nerve.

Table 3: Table showing the percentage distribution of distal latencies of the MNCV and SNCV of right and left median nerve.

DOMINANCY →	Right Median Nerve		Left Median Nerve	
Variables ↓	MNCV	SNCV	MNCV	SNCV
Latency (ms)	3.0 ± 0.41	2.4 ± 0.6	2.7 ± 0.6	2.2 ± 0.3
Duration (s)	12.0 ± 1.7	2.5 ± 0.7	13.7 ± 1.7	3.2 ± 1.3
Amplitude (mV)	16.4 ± 5.3	15.0 ± 6.9	14.8 ± 5.8	13.0 ± 5.7
CV (m/s)	68.9 ± 5.5	48.6 ± 13.9	66.2 ± 7.1	51.9 ± 11.3

Table 4 shows that the MNCV and SNCV of conduction velocity comparison for left and right side for median nerve and ulnar nerve showed no significant differences and were comparable suggesting that conduction velocities were not affected.

Table 4: Table showing the comparison between the right and left ulnar and median nerve latency for MNCV and SNCV

NERVE/VARIABLE	SIDE	MNCV (LATENCY)	SNCV ((LATENCY)
MEDIAN NERVE P Value	RIGHT	0.08	0.2
	LEFT		
ULNAR NERVE P Value	RIGHT	0.1	0.07
	LEFT		

Table 5 shows that the MNCV and SNCV of Latency comparison for left and right side for median nerve and ulnar nerve showed significant differences suggesting compression of nerve. It also shows that hand grip strength of right and left hand have no significant difference at p =0.05.

All the above results suggested towards the compression of ulnar nerve and median nerve with no significant affection to the conduction velocity or duration or amplitude of the nerves.

Table 5: Table showing comparison between latency of MNCV and SNCV of right and left ulnar and median nerve and grip strength of the right and left side.

NERVE/VARIABLE	DOMINANCY	RIGHT	LEFT
MEDIAN NERVE P Value	MNCV (LATENCY)	0.001	0.01
	SNCV (LATENCY)		
ULNAR NERVE P Value	MNCV(LATENCY)	0.002	0.03
	SNCV(LATENCY)		
Grip Strength (in Kgs)	RIGHT	44 ± 18	0.16
	LEFT	41 ± 17	

DISCUSSION

In our study, we wanted to study the chronic effects of cycling on nerve conduction velocities of ulnar and median nerve and grip strength of professional cyclists. Our study comprised of 30 cyclists randomly selected with an average age of 34.14 ± 12.04 years and a BMI of 25.35 ± 5.14. These cyclists usually spend an average of 2.84 ± 1.06 hours daily into cycling with an experience of 6.42 ± 5.22 years (Table 1). In these subjects we found out that the MNCV and SNCV showed prolonged distal latencies for both motor and sensory components of ulnar nerve and median nerve (Table 2 and 3). Table 4 and 5 in our results suggests that the motor and sensory findings of nerve

conduction velocity comparisons shows equal affection for both median nerve and ulnar nerve, while the comparison between MNCV and SNCV shows significant affection to MNCV. In results, according to Table 5, the grip strength for the right hand was 44 kg ± 18 kg and for the left hand was 41 kg ±17 kg which was found to be mildly reduced as compared to the normal value of 49.7 kg but no significant difference was found between the left and right side leading us to the finding that the involvement is bilateral, symmetrical or not is yet to be ventured.

A cylindrical grip is to be maintained for a really long time which predisposes to the entrapment of median and ulnar nerve thus affecting the grip strength. The median nerve is a continuation of the middle and lateral cords of the brachial plexus that receives innervation from all roots of the brachial plexus (C5-T1) [13, 14] while the ulnar nerve emerges from the medial cord of the brachial plexus at the lower border of the pectoralis minor and descends the arm along the medial side of the humerus. [15] Chronic repeated trauma (especially due to stereotyped professional activities) and chronic pressure together with vibration exerted over months or years are well known extrinsic causes of a ulnar neuropathy at the wrist or the hand. [16] Ulnar neuropathy has been a common complaint amongst the cyclist as compared to median nerve compression. We in our study also noted that MNCV in right ulnar nerve was mildly affected in 7.1% of individuals, moderately in 28.5% and severely in 64.2% of individuals and SNCV right ulnar, 28.5% had mildly prolonged distal latencies, 50% of the subjects showed at a moderate level and 21.4% of the subjects showed severely prolonged distal latencies. The left ulnar nerve MNCV showed, 14.2% individual with mild prolonged distal latencies, 42.8% with moderate affection and 2.8% of the subjects with severe affection, while the SNCV showed 42.8.2% of the subjects with mild affection, 42.8% with moderate affection and 14.2% showed severe affection.

A power grip is a grip formed with the fingers and the palm of the hand in order to move or manipulate objects. This type of grip is used for grasping handles and holding smaller products such as mobile phones and remote controls. [16] During the power grip, the ulnar side of the hand works with the radial side to give stronger stability. [10] Power grip is generated through a combination of the intrinsic and extrinsic hand muscles.

The intrinsic muscles of the hand consist of the interossei (4 dorsal and 3 palmar), the adductor pollicis muscle, the hypothenar muscles (opponens digiti quinti, flexor digiti quinti, abductor digiti quinti), the thenar muscles (abductor pollicis brevis, flexor pollicis brevis, opponens pollicis), and the lumbricals. [17] The median and ulnar nerves control the performance of the intrinsic muscles. The ulnar nerve supplies the interossei, adductor pollicis, hypothenar muscles, medial 2 lumbricals, and deep portion of the flexor pollicis brevis. Sensory innervation from the ulnar nerve covers the small finger and the ulnar half of the ring finger.[18] Injury to the ulnar nerve results in significant loss of power grip, pinch strength, and hand dexterity. [19] Motor involvement varies and can include weakness of the hypothenar, interosseous, and thumb adductor musculature. [20,21] Sensory involvement most frequently manifests in the hypothenar eminence, little finger, and ulnar portion of the ring finger. [22] Prolonged pressure on the ulnar palm associated with cycling [22] and weightlifting can be a cause of ulnar tunnel syndrome.[23,24] Ambient temperatures

can affect hand function. Manual dexterity is reduced in colder environments, making it more difficult to perform manual tasks with products. Often cyclists are exposed to harsh climates and environments especially on expedition and professional tours which may add on to the prolonged latencies and decrease in grip strength as found in our study. The flexibility and sensitivity of the fingers may also decrease in these circumstances.[25]

In a study titled neuromuscular ultrasound in electrically non-localizable ulnar neuropathy in 2018, David et al.suggested that, out of normal cyclists, [16] nine of them reported symptoms of neuropathy extending to wrist, [22] these cyclists attributed their discomfort to prolonged riding without changing hand position, especially on rough road surfaces. They also reported that their symptoms diminished after they modified their cycling technique and adjusted their bicycle to better fit their body dimensions. There are various reasons for the compression of the ulnar nerve. According to Assmus et al. in their study, titled distal ulnar nerve compression at the wrist published in 1977 mainly pressure and occupational trauma are the reasons, the distal type compression is almost exclusively the result of extra-neural ganglion cysts. [16] An accurate diagnosis is made possible by electromyography and nerve conduction studies. The sensory nerve action potentials, distal motor latency to the hypothenar and adductor pollicis muscles, and the corresponding muscle action potentials after nerve stimulation are pathologically altered, according to the type of lesion. Although spontaneous recovery may occur, operation is the treatment of choice, provided that simple pressure palsy is eliminated. [12] In another study by Megan et al., named ulnar and median nerve palsy in long-distance cyclists: A prospective study published in 2003 it was found that no significant difference in the incidence of motor symptoms was found among cyclists of various experience levels or based on handlebar types (mountain bike *vs.* road bike). [25] Venu et al. his study named “The effect of long-distance bicycling on ulnar and median nerves: an electrophysiologic evaluation of cyclist palsy that long-distance cycling” published in 2005 proved that cycling may promote physiologic changes in the deep branch of the ulnar nerve and exacerbate symptoms of carpal tunnel syndrome. [26] A variety of other 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. [27]

In our study we found our results aligned with various studies that may have resulted in decreased grip strength and prolonged distal latencies but we also found out that both median and ulnar nerve showed equal involvement in terms of affection and a further study is warranted to find out if the reason may have a proximal source owing to the fact that the position of cyclists is mostly stooped which not only put pressure on the wrist joint with the wrist mostly kept in neutral to extension but also puts a good amount of strain on the trapezius muscle,[13-27] a hypertrophy or inflamed trapezius may also give rise to similar symptoms which needs to be ruled out, even though individuals with any complaint of neck pain or pre diagnosed cases of cervical neuropathy were excluded but asymptomatic patients may have been enrolled leading to a bias in the study. Some limitations to the study includes less sample

size, lack of temperature monitoring while testing for NCV, measurement error, submaximal stimulation, inconsistencies in the distance from the motor point, and differences in inter electrode distance.

CONCLUSION

Compression of the ulnar nerve and median nerve in road cyclists is evident resulting in prolonged distal latencies affecting the motor component more than the sensory component and also affects the grip strength with no significance to dominancy of hand; precisely it affected both the hands equally.

NEW FINDINGS

Dominancy and gender doesn't seem to have an effect or nerve entrapment in professional cyclist has no role to play and the motor component of the nerves is more affected. Even though the findings suggest the following it raises some concerns regarding if the entrapment was more central or has arisen from the peripheral pathway.

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