Section: Physiology

Original Research Article

NERVES IN THE ZONE: EXAMINING THE RELATIONSHIP BETWEEN ISOTONIC MUSCLE CONTRACTION AND SPEED OF NERVE CONDUCTION IN YOUNG ADULTS

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Received : 04/7/2024
Received in revised form : 22/08/2024
Accepted : 07/09/2024

Keywords:
Nerve Conduction Velocity (NCV), Isotonic Exercise, Median Nerve, Ulnar Nerve, Gender Differences, Peripheral Neuropathy, Motor and Sensory Nerve Function.

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DOI: 10.47009/jamp.2024.6.5.16

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (5); 76-94

Abstract

Background: Nerve conduction velocity (NCV) testing is a key diagnostic tool for assessing peripheral neuropathies, particularly demyelinating conditions. By measuring the speed of electrical impulses through peripheral nerves, NCV tests can distinguish between demyelinating and axonal neuropathies. Factors such as nerve fibre diameter, myelination, and internodal distance influence conduction velocity. This study explores NCV in young, healthy individuals and examines how isotonic exercise and contractions impact motor and sensory nerve function, providing insights into nerve response and potential diagnostic applications. **Materials and Methods:** This cross-sectional study was conducted at Gauhati Medical College with sixty healthy participants aged 18 to 25 years. Nerve conduction studies (NCS) were performed to measure motor and sensory nerve conduction velocities of the median and ulnar nerves. Participants underwent isotonic exercises using Mosso's ergograph. Data analysis was conducted using ANOVA and Student's t-test, with results represented through descriptive statistics and Pearson's correlation coefficients. **Result:** The findings of the tests done in 60 individuals reveals suggest that isotonic exercise does not significantly alter the distal latency, amplitude, or nerve conduction velocity for the median and ulnar nerves in healthy young adults. Additionally, gender appears to influence nerve conduction parameters, with females showing higher amplitude and NCV values than males. Hand dominance does not seem to significantly affect these parameters. The study examined the effects of isotonic exercise on the nerve conduction velocity (NCV) of the median and ulnar nerves in young adults, finding no significant changes post-exercise. Gender differences were significant, with females showing higher amplitudes and conduction velocities, while hand dominance had minimal impact on NCV parameters. **Conclusion:** The study found no significant impact of isotonic exercise on nerve conduction velocities but revealed gender-related differences in nerve conduction parameters.

INTRODUCTION

Nerve conduction velocity (NCV) testing is a critical component of nerve conduction studies (NCS), which are essential diagnostic tools for assessing peripheral neuropathies, particularly demyelinating conditions. These tests measure the speed at which electrical impulses travel along peripheral nerves, providing valuable insights into nerve function and integrity. In cases of nerve damage, particularly in demyelinating neuropathies, the conduction velocity,[1] may be significantly reduced or even absent, which can aid in distinguishing between different types of peripheral nerve diseases, such as demyelinating and axonal degenerative forms. The speed of nerve conduction is influenced by several factors, including the diameter of the nerve fibers, the degree of myelination, and the internodal distance between the nodes of Ranvier. Larger axon diameters, thicker myelin sheaths, and longer internodal distances are associated with faster conduction velocities. Consequently, healthy nerves transmit signals more robustly and rapidly than damaged ones. Typically, normal nerve fibers exhibit conduction velocities that fall within established reference ranges, and while individual variations exist, they remain within these normal limits. Nerve conduction studies primarily evaluate two key parameters: the compound muscle action potential (CMAP) and the sensory nerve action potential (SNAP).[2] These measurements are taken from accessible peripheral nerves in the upper and lower limbs, including the median, ulnar, radial, common

ISSN (O): 2687-5365; ISSN (P): 2753-6556

peroneal, tibial, and sural nerves. For testing the nerve conduction, of a nerve which supplies a muscle or a group of muscle the CMAP is recorded, analysing its onset, the latent period required, the amount of time required, and the force of contraction. In contrast, sensory nerve conduction involves stimulating sensory nerves to produce a SNAP, which is also assessed for its onset latency, amplitude, and duration. The hand, wrist, and elbow are particularly susceptible to injuries resulting from overuse and repetitive strain, often manifesting as entrapment syndromes affecting the median and ulnar nerves. Biomechanical risk factors, such as repetitive motions, force, and vibration, can contribute to these conditions. Median nerve entrapment is commonly associated with carpal tunnel syndrome (CTS),[3-7] while ulnar nerve neuropathy may occur at the elbow due to chronic pressure in the bony condylar groove or from repetitive ergonomic stress. In cases of segmental demyelination or during the myelination process, the myelin sheath may thin, and the internodal distance may shorten. This leads to increased internodal conductance and capacitance, resulting in a greater loss of local current before reaching the next node of Ranvier, which can cause conduction blocks. Research indicates that conduction velocity and latency are the most commonly affected parameters in peripheral neuropathies, such as CTS and ulnar neuropathy. Over time, the conduction velocity of the affected nerves typically decreases in response to compression or injury. The modern workplace has seen an increase in physical strain on muscles and nerves due to longer working hours and repetitive tasks.[3] Studies have shown that such repetitive stress can lead to neuropathy, which may become evident over time.[4] Symptoms often include tingling and numbness, particularly among individuals engaged in computer-related tasks, where the prevalence of work-related musculoskeletal disorders (WRMSD) is notably higher than in the general population.[5] Moreover, the rise of technology and urbanization has contributed to sedentary lifestyles, diminishing physical activity levels.[5] Interestingly, research suggests that individuals engaged in strength and muscle-powered activities tend to exhibit higher motor nerve conduction velocities (MNCV) compared to endurance athletes. Although the differences are not always statistically significant, trained individuals generally demonstrate greater MNCV than untrained or injured counterparts, indicating that regular exercise may enhance peripheral nerve functionality. Demographic factors, including gender, height, and body mass index (BMI), can also influence NCV parameters.[6] Studies have shown that females tend to exhibit higher conduction velocities than males, potentially due to variations in body composition, limb length, and subcutaneous tissue density.[8,9] The increased body fat percentage in females may correlate with better myelination of neural axons, contributing to these differences.[9,10] Muscle contractions can be classified into two primary types: isometric and isotonic contractions. Isometric contractions occur when muscle length remains unchanged while tension increases, producing heat without external movement. In contrast, isotonic contractions involve muscle shortening while maintaining constant tension, allowing for external work to be performed. Activities such as running, walking, and lifting weights exemplify isotonic contractions.[11] To summarise, the NCV test serves as a vital tool in diagnosing and understanding various peripheral nerve conditions. By measuring the speed of electrical impulses through the nerves, healthcare professionals can identify nerve damage and differentiate between different types of neuropathies. The interplay of factors such as nerve diameter, myelination, and demographic variations underscores the complexity of nerve conduction and its implications for health and function.

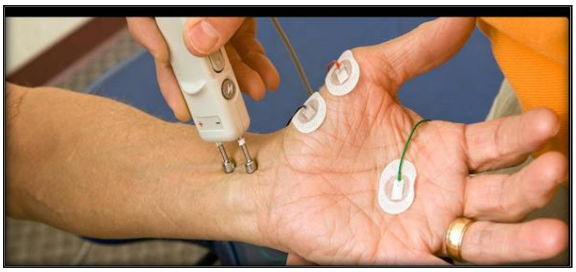

Image 1: Depicting the placement of Electrodes for stimulating the opponens pollicis muscle

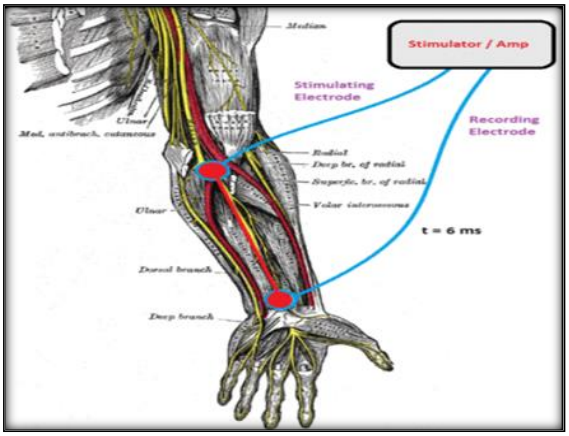

Image 2: Depicting the course of median nerve and stimulation in the elbow

This section of the article provides an overview of the history, anatomy, physiology, and current understanding of nerve conduction velocity (NCV), focusing on its clinical and diagnostic significance, particularly concerning motor and sensory nerves. The review also examines the relationship between NCV and various types of muscle contractions, including isotonic exercise, and its implications in clinical practice.

Brief Background on the History of Development of Nerve Conduction Velocity

The development of clinical neurophysiology is deeply intertwined with the history of electricity.

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Starting in the late 18th and early 19th centuries, discoveries in electrical conduction laid the groundwork for understanding nerve function. Key figures during this period include Pieter Van Musschenbroek, Benjamin Franklin, and Luigi Galvani.[10]

- Benjamin Franklin (1752) conducted the famous kite experiment, leading to the discovery of electrostatic induction and the concept of positive and negative electrical forces.[11]
- Luigi Galvani built upon Franklin's work, discovering that nerves conduct electricity, leading to the concept of "animal electricity.[12]
- Francois Magendie (early 19th century) divided the anterior and posterior spinal roots, discovering that stimulation of the posterior root elicited pain, while the anterior root produced motor effects, establishing the foundation for understanding peripheral nerves.[13]
- DuBois-Raymond (mid-19th century) recorded muscle action potentials using liquid-filled jars as electrodes, laying the groundwork for action potential research.[14]
- Hermann von Helmholtz (1850) measured the conduction velocity in frog nerves, finding the median nerve velocity to be 61.0 ± 5.1 m/s.[15]
- Duchene (1833) demonstrated that muscles could be stimulated percutaneously, advancing the understanding of nerve stimulation.[16]
- Erlanger and Gasser (1922) used an oscilloscope to classify nerve fibers into three types: A (large fibers, up to 100 m/s), B (intermediate, 2-14 m/s), and C (small, up to 2 m/s), linking nerve conduction velocity to fibre diameter. They received the Nobel Prize in 1944.[17]
- Harvey and Masland (1941) demonstrated the decremental response in myasthenia gravis, applying nerve conduction studies to neuromuscular disorders.[18]

These foundational studies established the principles of NCV, leading to modern electrodiagnostic techniques used today.

Anatomy and Physiology of Nerves and Conduction of Impulses in Nerves

Peripheral nerves consist of multiple fascicles surrounded by connective tissue sheaths, containing Schwann cells, axons, myelin sheaths, and blood vessels. Axons vary in diameter from 1 to 20 µm and are classified based on myelination.[19]

- Myelinated fibers have a myelin sheath formed by Schwann cells, with nodes of Ranvier spaced 1-3 mm apart, facilitating saltatory conduction, where action potentials "jump" between nodes.[20]
- Unmyelinated fibers have Schwann cells that surround the axons without fully wrapping them.
- Loss of myelin leads to delayed or blocked conduction in demyelinated axons. Erlanger and Gasser classified nerve fibers based on conduction velocity, with different types serving distinct functions:[21]

Fiber	Type	Myelin sheath	Fiber Diameter (µm)	Conduction Velocity (m/s)	Spike duration (ms)	Absolute Refractory period (ms)	Function	
							Efferent	Afferent
A	α	Myelinated	12-20	70-120	0.4-0.5	0.4-1	Somatic motor	Proprioception
	β	Myelinated	5-12	30-70	0.4-0.5	0.4-1	-	Touch and when weight is applied.
	γ	Myelinated	3-6	15-30	0.4-0.5	0.4-1	Motor Muscle spindle	-
	δ	Myelinated	2-5	12-30	0.4-0.5	0.4-1	-	Pain, cold and touch
B	-	Myelinated	<3	3-15	1.2	1.2	Pre-ganglionic autonomic	-
C	-	Non – myelinated	0.4-1.2	0.5-2	2	2	Post-ganglionic autonomic	Pain, temperature, mechanoreception

Axonal Transport.[21]

- Orthograde transport (cell body to axon terminals) includes fast (400 mm/day) and slow components (0.5 to 10 mm/day).
- Retrograde transport (axon terminals to cell body) occurs along microtubules at approximately 200 mm/day.

Impulse Propagation

Nerve cells have excitable membranes that respond to stimuli, producing local non-propagated potentials or propagated action potentials. Conduction is a self-propagating process, with impulses moving at constant amplitude and velocity. The resting membrane potential of neurons is -70 mV. Action potentials occur at nodes of Ranvier in myelinated fibers (saltatory conduction) and continuously in unmyelinated fibers.[22]

Principles of Motor and Sensory Nerve Conduction

Motor Nerve Conduction

Motor nerve studies involve electrical stimulation of a nerve and recording the compound muscle action potential (CMAP) from electrodes on a muscle. Key measurements include onset latency, duration, amplitude of CMAP, and nerve conduction velocity (NCV).

Sensory Nerve Conduction

Sensory nerve action potential (SNAP) is recorded by stimulating sensory fibers and recording at a distal point. Measurements can be orthodromic (natural direction) or antidromic (opposite direction). Both methods provide similar information, though

ISSN (O): 2687-5365; ISSN (P): 2753-6556

antidromic recordings may have higher amplitudes due to proximity to recording electrodes.[23-35]

Median Nerve Anatomy and Conduction Velocity

The median nerve, a mixed nerve from the C5 to T1 roots of the brachial plexus, innervates forearm flexors and the thenar muscles, providing sensory input to the lateral palm and fingers.

Normal Median Motor Nerve Conduction Values

- Kimura (1986).[24,36]
  - Wrist: Latency 3.49 ± 0.34 ms, Amplitude 7.0 ± 3.0 µV
  - Elbow: Latency 7.39 ± 0.69 ms, Amplitude 7.0 ± 2.7 µV, NCV 57.7 ± 4.9 m/s
- Misra and Kalita (2014) [25]
  - Wrist: Latency 3.77 ± 0.40 ms, Amplitude 8.10 ± 2.62 µV
  - Elbow: Latency 7.62 ± 0.65 ms, Amplitude 7.84 ± 2.25 µV, NCV 58.52 ± 3.76 m/s

Normal Median Sensory Nerve Conduction Values (Digit to Wrist)

- Kimura (1986): Latency 2.84 ± 0.34 ms, Amplitude 38.5 ± 15.6 µV, NCV 56.2 ± 5.8 m/s.[26]
- Misra and Kalita (2014): Latency 3.06 ± 0.41 ms, Amplitude 8.91 ± 4.48 µV, NCV 45.45 ± 9.40 m/s.[1,27]

Abnormalities in Conduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy, with an incidence of 376 per 100,000 people.[28] It is more common in women and has a lifetime risk of about 10%. Autopsy studies confirm focal abnormalities in the median nerve in asymptomatic individuals. Strenuous hand use can aggravate CTS symptoms.[29]

Ulnar Nerve Anatomy and Conduction Velocity

The ulnar nerve, receiving fibers from the C7, C8, and T1 roots, travels behind the medial epicondyle at the elbow and through the cubital tunnel.

Normal Ulnar Motor Nerve Conduction Values

- Kimura (1986).[30]
  - Wrist: Latency 2.59 ± 0.39 ms, Amplitude 5.7 ± 2.0 µV
  - Below Elbow: Latency 6.1 ± 1.69 ms, Amplitude 5.5 ± 1.9 µV, NCV 58.7 ± 5.1 m/s
- Misra and Kalita (2014).[1]
  - Wrist: Latency 2.59 ± 0.40 ms, Amplitude 8.51 ± 2.03 µV
  - Below Elbow: Latency 6.13 ± 0.65 ms, Amplitude 8.07 ± 1.97 µV, NCV 61.45 ± 5.73 m/s
  - Normal Ulnar Sensory Nerve Conduction Values (Digit to Wrist).[28]
- Kimura (1986): Latency 2.54 ± 0.29 ms, Amplitude 35.0 ± 14.7

MATERIALS AND METHODS

Study Design: This cross-sectional study was conducted with sixty healthy participants at Gauhati Medical College from July 2021 to June 2022 in the Department of Physiology's neurophysiology room. The study received ethical approval from the Institutional Ethical Committee (Human) of Gauhati Medical College and Hospital.

Participants were thoroughly informed about the procedures and objectives of the study. Written informed consent in a language they can understand was taken and the procedure explained to the participants.

Inclusion Criteria

Participants were aged between 18 and 25 years. Only healthy individuals were included after a detailed clinical history was collected using a standard questionnaire and a preliminary general examination was conducted. The participants were from both the genders. No third gender participant was taken in.

Exclusion Criteria

Participants were excluded if they exhibited symptoms of peripheral sensory neural deficits, excessive muscle weakness, chronic alcohol abuse, or had a history of nerve injury to the upper limb, entrapment neuropathies, or recent fractures to the upper limb. Individuals with known thyroid disorders, neurological disorders such as poliomyelitis, or diabetes were also excluded.

Sample Size and Sampling

The study included sixty healthy subjects. Participants were selected through simple random sampling, ensuring they met the inclusion criteria. The stratification of the participants was done based on the use of the upper limb of the body which they used most and also on the basis of gender.

Data Collection Method

Nerve Conduction Studies (NCS), including Motor Nerve Conduction Velocity (MNCV) and Sensory Nerve Conduction Velocity (SNCV), were performed on both hands. The median and ulnar nerves were tested for both MNCV and SNCV. The test results recording was analysed on the basis of latent period, amplitude, and velocity of conduction of the nerve. Measurements were taken at rest, after 10 minutes of isotonic contractions using Mosso's ergograph, and after 15 minutes of isotonic exercise.

Equipment and Apparatus

- NeuroStim software (MediCaid Systems) on a computer display system
- NeuroPerfect EMG 2000 machine
- Surface disc electrodes
- Ring electrodes
- Pre-amplifier
- Medicaid system Stimulator
- Conducting/electrode jelly
- Mosso's Ergograph

Recorded Parameters

- Age/sex
- Hand dominance
- Median motor nerve conduction velocities
- Median sensory nerve conduction velocities
- Ulnar motor nerve conduction velocities
- Ulnar sensory nerve conduction velocities

Median Nerve Conduction Study and Isotonic Exercise

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Median Motor Nerve Conduction Study

The recording electrodes were placed using conducting jelly near the motor point of the abductor pollicis brevis (APB), with a reference electrode 3 cm distally at the first metacarpophalangeal joint. The placement of the ground electrode was in between the stimulating and the recording electrode. Supramaximal stimulation was applied at the wrist (3 cm proximal to the distal wrist crease) and the elbow (near the volar crease of the brachial pulse).[29]

The difference in latency between the elbow and wrist stimulation sites was measured in milliseconds (msecs) to determine the impulse travel time. The distance between these points was measured in millimetres (mm) to calculate the median motor nerve conduction velocity in meters per second (m/sec).

Isotonic Exercise Procedure

The forearm was securely fixed to the ergograph using clamps.[30] The middle finger was looped to pull a 2 kg weight, while the index and ring fingers were inserted into metal tubes. Participants performed a series of maximal contractions at regular intervals for 10 and 15 minutes without moving the shoulder, with a 5-minute rest between sessions.

The median motor nerve conduction velocity was recorded at rest, after 10 minutes, and after 15 minutes of isotonic exercise.

Median Sensory Nerve Conduction Study

Orthodromic conduction recording was employed.[31] The recording electrode was placed 3 cm proximal to the distal wrist crease, with the reference electrode 3 cm further proximal. Ring electrodes were used to stimulate the nerve at the second or third digit, with the cathode at the proximal interphalangeal joint. The placement of the ground electrode was in between the stimulating and recording electrodes.

Supramaximal stimulation was applied at the ring electrodes. Latency onset and the distance between electrodes were recorded to calculate median sensory nerve conduction velocity.

Ulnar Nerve Conduction Study and Isotonic Exercise

Ulnar Motor Nerve Conduction Study:

Using conducting jelly, the recording electrode was placed on the hypothenar eminence of the abductor digiti minimi, with the reference electrode 3 cm distally at the fifth metacarpophalangeal joint. The placement of the ground electrode was in between the stimulating and recording electrodes Stimulation by the stimulators were given more than the maximum (Supramaximal) and the stimulation was delivered at the wrist with approximate distance of 3cms from the wrist fold or crease. Similar type of stimulation by the stimulating electrodes was given in the forearm (with the electrodes placed at about 3cms from the medial epicondyle) with the elbow flexed at 90 to 130 degrees.[46]

Latency differences between the elbow and wrist were measured to determine the ulnar motor nerve conduction velocity.

Isotonic Exercise Procedure

The procedure followed the same steps as described for the median nerve.

Ulnar Sensory Nerve Conduction Study

Orthodromic recording was used, with the recording electrode placed 3 cm proximal to the distal wrist crease (slightly medially) and the reference electrode 3 cm further proximal. Ring electrodes were placed at the fifth digit, with the cathode at the proximal interphalangeal joint, and the ground electrode positioned between the stimulating and recording electrodes.

Supramaximal stimulation was applied at the ring electrodes, with latency onset and electrode distance recorded to calculate the ulnar sensory nerve conduction velocity.

Note: Surface disc and ring electrodes were used. Antidromic stimulation for sensory conduction could also be employed but orthodromic readings were taken for convenience. Mosso's ergograph was used to simulate isotonic contraction effects.

Statistical Analysis

Data were presented as percentages and means ± standard deviation. Bar and pie diagrams were used for visual representation. Comparative investigation was performed utilizing ANOVA single calculate and Student's unpaired t-test, with a p-value of less than 0.05 considered to be important as regards statistical evaluation of the data concerned.

The correlation of NCS parameters between dominant and non-dominant hands, males and females, and during isotonic exercise at rest, 10, and 15 minutes was assessed using Pearson's correlation

ISSN (O): 2687-5365; ISSN (P): 2753-6556

coefficient (r), represented graphically with scatter diagrams.

RESULTS

The tests for doing the research were conducted from July 2021 to June 2022. A total of 60 individuals of age group from 18 to 25 years from both genders were selected randomly after a proper clinical history and examination. The results and observations and relevant data were analysed using the Microsoft Excel, 2016. Data have been represented in Mean & Standard Deviation (SD) wherever applicable and p value calculated. The results and observations of the study groups have been expressed in the form of tables complemented by Pie diagrams, Bar diagrams, Columns, Graphs, Scatter diagrams etc. as per requirement.

Demographic Profiles:

The participants were divided accordingly to their gender as shown in the [Table 1 and Figure 1].

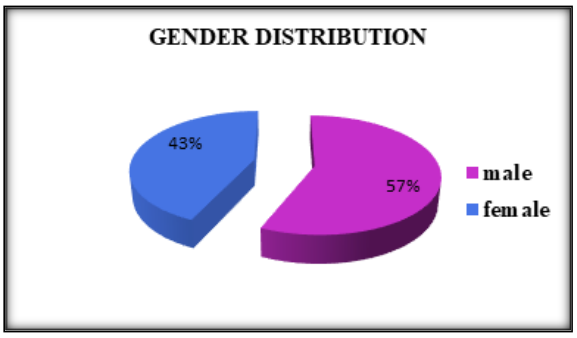

Figure 1: Pie diagram showing percentage gender distribution

Interpretation: [Table 1 and Figure 1] shows that out of 60 participants 34 were male participants accounting for 57% and 26 were female participants accounting for 43%. They were found to fulfill the inclusion criteria necessary for the study.

The Mean of the Age Distribution in years of the participants for both genders were seen to be as Shown in [Table 2 and Figure 2]

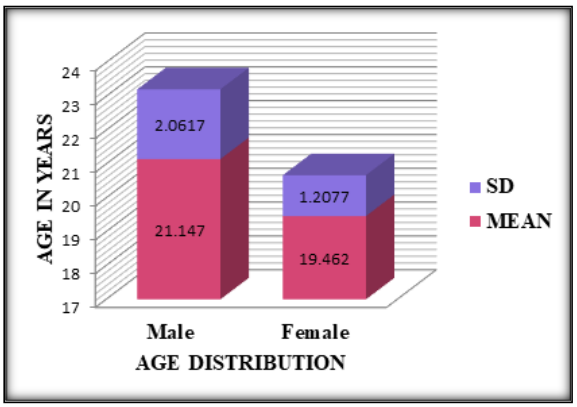

Figure 2: Bar diagram showing mean age distribution for gender

Interpretation: [Table 2 and Figure 2] shows that the mean age of male participants were 21.147 ± 2.0617 years and that of female participants was 19.462 ± 1.2077 years. Young healthy college going individuals were preferably sought from the age group of 18 to 25 years.

The Hand Dominance Pattern of the individuals irrespective of the age and gender are shown in [Table 3 and Figure 3].

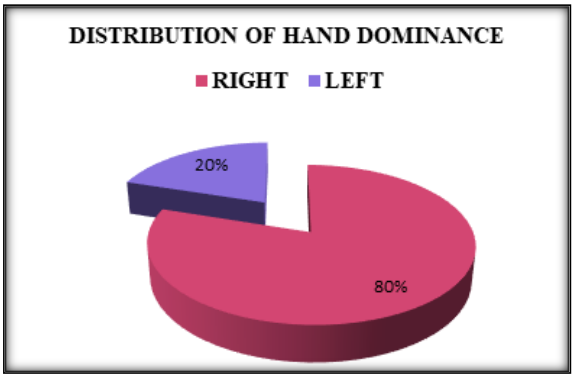

Figure 3: Pie diagram showing hand dominance pattern

Interpretation: [Table 3 and Figure 3] shows the distribution pattern for upper limb hand dominance indicated by right and left hand dominance. It was found that out of 60 participants fulfilling the inclusion criteria for the study, almost 48 individuals, i.e. 80%, were found to be right handed dominant and only 12 individuals, accounting for 20%, were found to be left handed dominant. The selection of the dominant pattern of hand was randomly done from among the study group irrespective of their age and gender.

Median MNCV in connection to Isotonic work out

Interpretation: [Table 4] shows the Distal latency in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Median MNCV, at rest DL was found to be 3.83 ± 0.512, after 10 minutes it was 3.814 ± 0.496 and then after 15 minutes DL was found to be 3.806 ± 0.493 respectively. For Left Median MNCV, at rest the DL was found to be 3.841 ± 0.485, after 10 minutes it was 3.828 ± 0.482 and then after 15 minutes DL was found to be 3.827 ± 0.494 respectively.

The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Interpretation: [Table 5] shows the Amplitude in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Median MNCV, at rest the amplitude was found to be 6.902 ± 0.529, after 10 minutes it was 6.88 ± 0.531 and then after 15 minutes amplitude was found to be 6.89 ± 0.532 respectively. For Left Median MNCV, at rest amplitude was found to be 6.909 ± 0.5022, after 10 minutes it was 6.9155 ± 0.5062 and then after 15

ISSN (O): 2687-5365; ISSN (P): 2753-6556

minutes amplitude was found to be 6.909 ± 0.5277 respectively.

The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Interpretation: [Table 6] shows the NCV in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right sided median nerve MNCV, at rest NCV was found to be 55.014 ± 4.178, after 10 minutes it was 55.201 ± 4.128 and then after 15 minutes NCV was found to be 55.298 ± 4.219 respectively. For the left sided median nerve MNCV, at rest NCV was found to be 54.778 ± 3.951, after 10 minutes it was 55.003 ± 3.918 and then after 15 minutes NCV was found to be 55.239 ± 4.037 respectively.

The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Median MNCV between male and female:

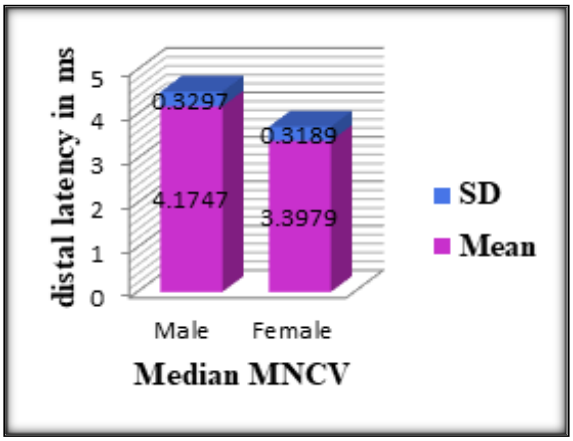

Figure 4: Bar diagram of distal latency in mean ± SD in males and females

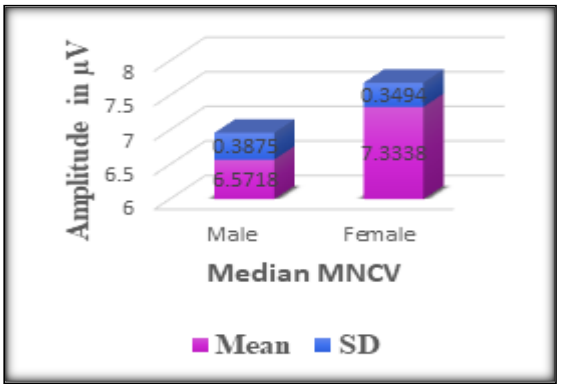

Figure 5: Bar diagram of amplitude in mean ± SD in males and females

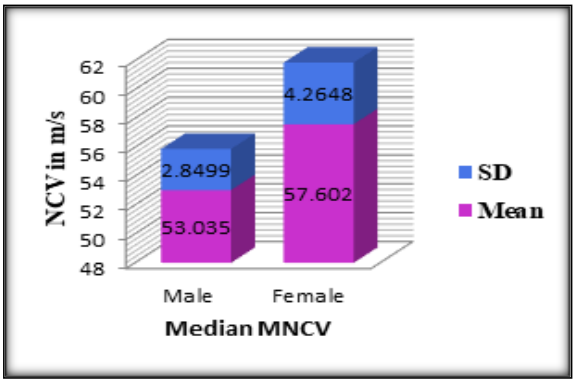

Fig 6: Bar diagram of conduction velocity in mean ± SD in males and females

Interpretation: [Table 7, Figure 4-6] shows the Median MNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Males, the distal latency was found to be 4.1747 ± 0.3297, the amplitude was 6.5718 ± 0.3875 and the NCV was found to be 53.035 ± 2.8499 respectively. For Females, the distal latency was found to be 3.3979 ± 0.3189, the amplitude was 7.3338 ± 0.3494 and the NCV was found to be 57.602 ± 4.2648 respectively. The df (degrees of freedom) was found to be 53 for the latency, 54 for the amplitude and 39 for the NCV respectively. In all the three comparisons for the p value, it was found to be <0.05 and hence was considered significant.

The distal latency in case for males was found to be significantly higher than the females whereas amplitude and NCV parameters were significantly higher in females than in males.

Median MNCV on the basis of hand dominance:

Interpretation: [Table 8] shows the Median MNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Right handed dominance, the distal latency was found to be 3.8669 ± 0.5306, the amplitude was 6.888 ± 0.538 and the NCV was found to be 55.149 ± 4.373 respectively. For Left hand, the distal latency was found to be 3.6825 ± 0.4152, the amplitude was 7.0375 ± 0.491 and the NCV was found to be 54.473 ± 3.392 respectively. The df (degrees of freedom) was found to be 18 for distal latency and NCV and 16 for the amplitude respectively. However, in all the three comparisons for the p value, it was found to be >0.05 and hence was considered not significant.

Median SNCV in relation to isotonic exercise/ contractions:

Interpretation: [Table 9] shows the Distal latency in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Median SNCV, at rest DL was found to be 2.8387 ± 0.5076, after 10 minutes it was 2.831 ± 0.5073 and then after 15 minutes DL was found to be 2.8248 ± 0.4988 respectively. For Left Median SNCV, at rest the DL was found to be 2.831 ± 0.5073, after 10 minutes it

ISSN (O): 2687-5365; ISSN (P): 2753-6556

was 2.8122 ± 0.5288 and then after 15 minutes DL was found to be 2.8387 ± 0.5076 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.
Interpretation: [Table 10] shows the Amplitude in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Median SNCV, at rest the amplitude was found to be 5.694 ± 0.5059, after 10 minutes it was 5.6875 ± 0.5083 and then after 15 minutes amplitude was found to be 5.6895 ± 0.5102 respectively. For Left Median SNCV, at rest amplitude was found to be 5.7992 ± 0.5428, after 10 minutes it was 5.7902 ± 0.5952 and then after 15 minutes amplitude was found to be 5.7593 ± 0.6383 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.
Interpretation: [Table 11] shows the NCV in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Median SNCV, at rest NCV was found to be 46.612 ± 4.3569, after 10 minutes it was 46.687 ± 4.3183 and then after 15 minutes NCV was found to be 46.747 ± 4.2586 respectively. For Left Median SNCV, at rest NCV was found to be 46.687 ± 4.3183, after 10 minutes it was 47.314 ± 5.379 and then after 15 minutes NCV was found to be 46.612 ± 4.3569 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

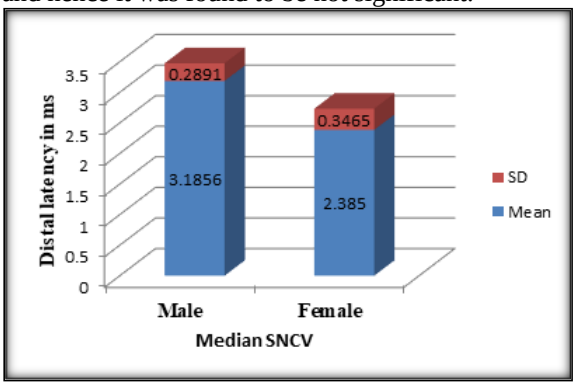

Figure 7: Bar diagram of distal latency in mean ± SD in males and females

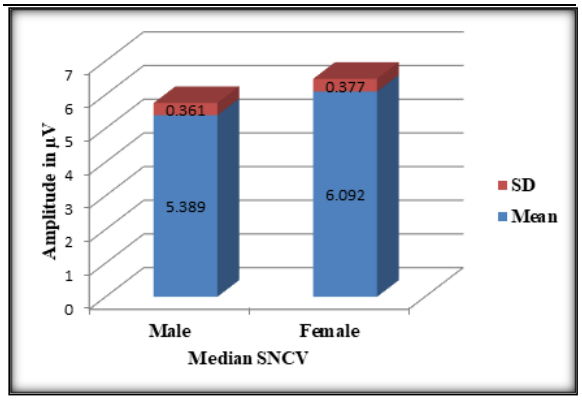

Figure 8: Bar diagram of amplitude in mean ± SD in males and females

Interpretation: [Table 12, Figure 7 and 8] shows the Median SNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Males, the distal latency was found to be 3.1856 ± 0.2891, the amplitude was 5.389 ± 0.361 and the NCV was found to be 45.856 ± 4.1418 respectively. For Females, the distal latency was found to be 2.385 ± 0.3465, the amplitude was 6.092 ± 0.377 and the NCV was found to be 47.6 ± 4.5124 respectively. The df (degrees of freedom) was found to be 46 for latency, 51 for amplitude and NCV respectively. The p value for NCV was found to be >0.05 and therefore was considered as not significant. Whereas, the p value for Distal latency and Amplitude for Median SNCV was found to be <0.05 and therefore was considered significant. The Distal latency was significantly higher in males as compared to females. However, amplitude was found to be significantly higher in females as compared to males

Median SNCV on the basis of hand dominance:

Interpretation: [Table 13] shows the Median SNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Right handed dominance, the distal latency was found to be 2.8821 ± 0.5221, the amplitude was 5.635 ± 0.5189 and the NCV was found to be 46.712 ± 4.3203 respectively. For Left hand, the distal latency was found to be 2.665 ± 0.42, the amplitude was 5.85 ± 0.4344 and the NCV was found to be 46.213 ± 4.6744 respectively. The df (degrees of freedom) was found to be 17 for distal latency and amplitude and 16 for the NCV respectively. In all the three comparisons for the p value, it was found to be >0.05 and hence was considered not significant.

Ulnar MNCV in relation to isotonic exercise/ contractions:

Interpretation: [Table 14] shows the Distal latency in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar MNCV, at rest DL was found to be 3.9055 ± 0.4478, after 10 minutes it was 3.8918 ± 0.45 and then after 15 minutes DL was found to be 3.8823 ± 0.4474 respectively. For Left Ulnar MNCV, at rest the DL was found to be 3.8918 ± 0.45, after 10 minutes it was 3.9055 ± 0.4478 and then after 15 minutes DL was found to be 3.8847 ± 0.448 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.
Interpretation: [Table 15] shows the Amplitude in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar MNCV, at rest the amplitude was found to be 5.989 ± 0.4974, after 10 minutes it was 5.987 ± 0.5168 and then after 15 minutes amplitude was found to be 6.008 ± 0.5062 respectively. For Left Ulnar MNCV, at rest amplitude was found to be 6.016 ± 0.5087, after 10 minutes it was 6.008 ± 0.5062 and then after 15 minutes'

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amplitude was found to be 6.018 ± 0.5059 respectively.

The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Interpretation: [Table 16] shows the NCV in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar MNCV, at rest NCV was found to be 56.239 ± 2.5048, after 10 minutes it was 56.44 ± 2.4393 and then after 15 minutes NCV was found to be 56.464 ± 2.4393 respectively. For Left Ulnar MNCV, at rest NCV was found to be 56.44 ± 2.4393, after 10 minutes it was 56.239 ± 2.5048 and then after 15 minutes NCV was found to be 56.58 ± 2.5716 respectively.

The p value was found to be >0.05 in both the cases and hence it was found to be non-significant

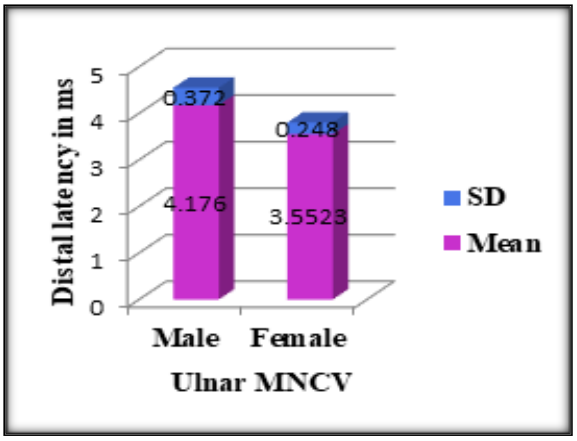

Figure 9: Bar diagram of distal latency in mean ± SD in males and females

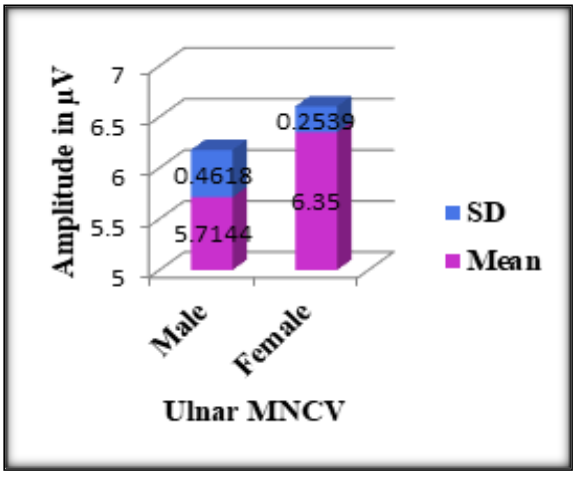

Figure 10: Bar diagram of amplitude in mean ± SD in males and females

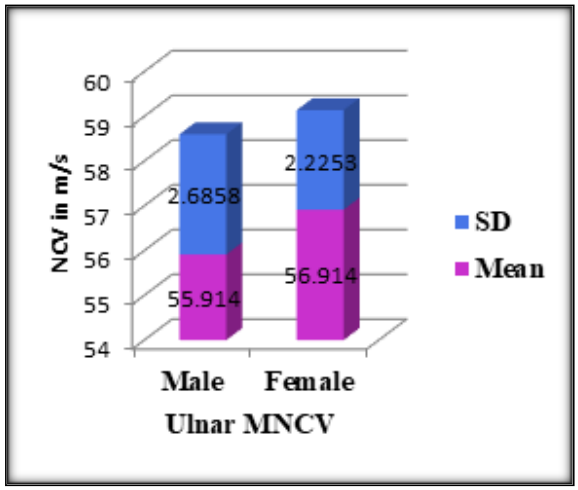

Figure 11: Bar diagram of conduction velocity in mean ± SD in males and females

Interpretation: [Table 17, Figure 9-11] shows the Ulnar MNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Males, the distal latency was found to be 4.176 ± 0.372, the amplitude was 5.7144 ± 0.4618 and the NCV was found to be 55.914 ± 2.6858 respectively. For Females, the distal latency was found to be 3.5523 ± 0.248, the amplitude was 6.35 ± 0.2539 and the NCV was found to be 56.914 ± 2.2253 respectively. The df (degrees of freedom) was found to be 55 for latency, 51 for amplitude and 56 for NCV respectively. The p value for ulnar MNCV was found to be <0.05 and therefore was considered significant. The distal latency was significantly higher for males than females and the amplitude and NCV was significantly higher for females than for males.

Ulnar MNCV on the basis of hand dominance:

Interpretation: [Table 18] shows the Ulnar MNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Right handed dominance, the distal latency was found to be 3.929 ± 0.472, the amplitude was 5.936 ± 0.525 and the NCV was found to be 56.021 ± 2.6615 respectively. For Left hand, the distal latency was found to be 3.72 ± 0.2805, the amplitude was 5.8708 ± 0.5407 and the NCV was found to be 55.072 ± 3.2669 respectively. The df (degrees of freedom) was found to be 26 for distal latency, 14 for amplitude and 13 for NCV respectively.

In all the three comparisons for the p value, it was found to be >0.05 and hence was considered non-significant.

Ulnar SNCV in relation to isotonic exercise/ contractions:

Interpretation: [Table 19] shows the Distal latency in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar SNCV, at rest DL was found to be 2.3657 ± 0.3886, after 10 minutes it was 2.3533 ± 0.3846 and then after 15 minutes DL was found to be 2.3475 ± 0.3869 respectively. For Left Ulnar SNCV, at rest the DL

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was found to be 2.3475 ± 0.3869, after 10 minutes it was 2.3372 ± 0.3864 and then after 15 minutes DL was found to be 2.3533 ± 0.3846 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Interpretation: [Table 20] shows the Amplitude in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar SNCV, at rest the amplitude was found to be 4.126 ± 0.4971, after 10 minutes it was 4.1325 ± 0.4925 and then after 15 minutes amplitude was found to be 4.1632 ± 0.5265 respectively. For Left Ulnar SNCV, at rest amplitude was found to be 4.1322 ± 0.4969, after 10 minutes it was 4.138 ± 0.4908 and then after 15 minutes amplitude was found to be 4.1325 ± 0.4925 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Interpretation: [Table 21] shows the NCV in Mean ± SD at rest, after 10 minutes of isotonic exercise and after 15 minutes of isotonic exercise respectively. Between each reading a resting time of 5 minutes was undertaken. For Right Ulnar SNCV, at rest NCV was found to be 50.871 ± 3.4319, after 10 minutes it was 51.196 ± 3.5341 and then after 15 minutes NCV was found to be 51.283 ± 3.4985 respectively. For Left Ulnar SNCV, at rest NCV was found to be 51.283 ± 3.4985, after 10 minutes it was 51.658 ± 3.74 and then after 15 minutes NCV was found to be 51.196 ± 3.5341 respectively.
The p value was found to be >0.05 in both the cases and hence it was found to be not significant.

Ulnar SNCV between male and female:

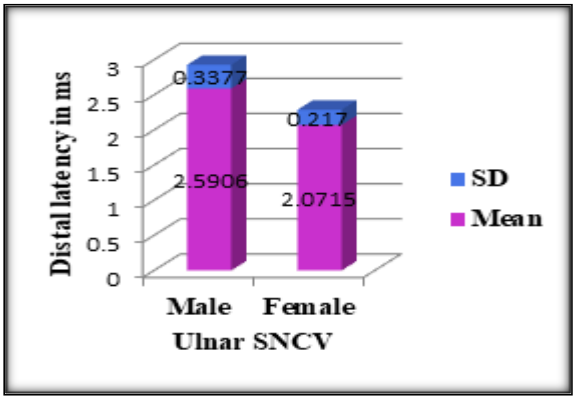

Figure 12: Bar diagram of distal latency in mean ± SD in males and females

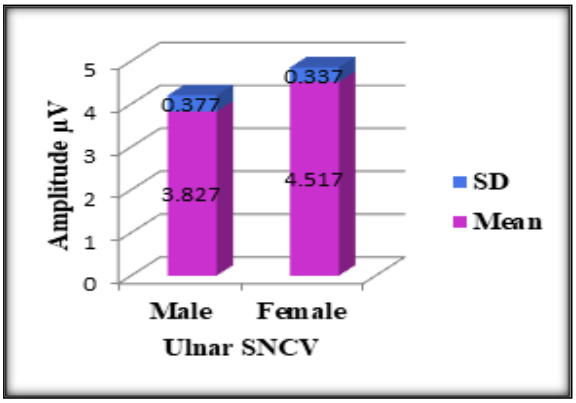

Figure 13: Bar diagram of amplitude in mean ± SD in males and females

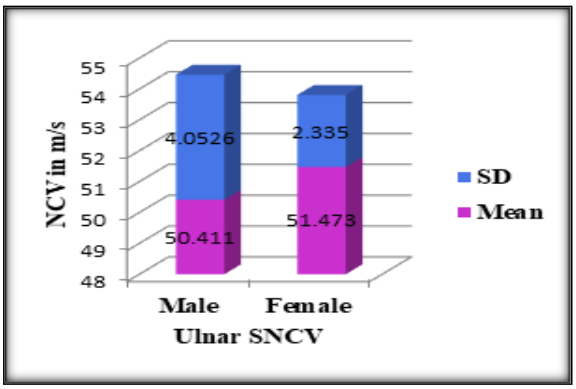

Figure 14: Bar diagram of conduction velocity in mean ± SD in males and females

Interpretation: [Table 22, Figure 12-14] shows the Ulnar SNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. For Males, the distal latency was found to be 2.5906 ± 0.3377, the amplitude was 3.827 ± 0.377 and the NCV was found to be 50.411 ± 4.0526 respectively. For Females, the distal latency was found to be 2.0715 ± 0.217, the amplitude was 4.517 ± 0.337 and the NCV was found to be 51.473 ± 2.335 respectively. The df (degrees of freedom) was found to be 55 for latency, 54 for amplitude and 53 for NCV respectively. The p value for Distal latency, Amplitude and NCV for Ulnar SNCV was found to be <0.05 and therefore was considered significant. The distal latency was significantly higher for males than females. The amplitude and NCV were significantly higher in females.

Ulnar SNCV on the basis of hand dominance:

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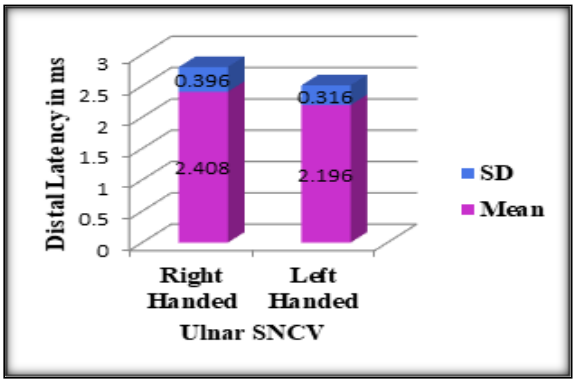


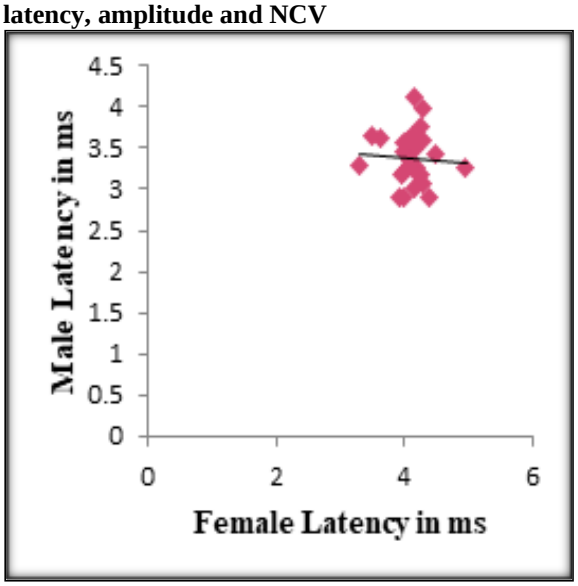
Figure 15: Bar diagram of distal latency in mean ± SD in males and females

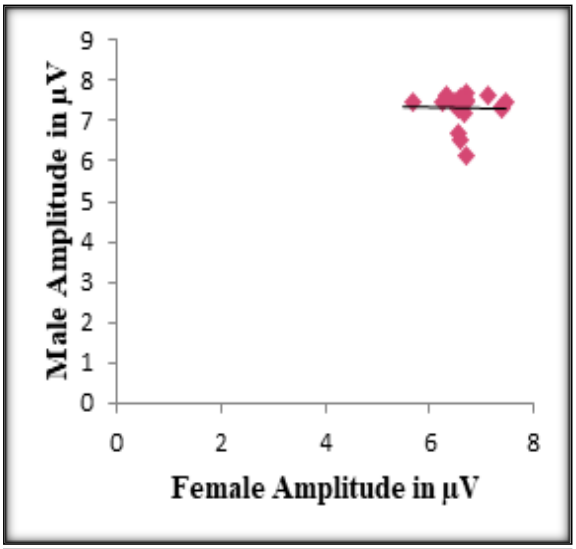
Interpretation: [Table 23] shows the Ulnar SNCV in mean ± SD for distal latency in ms, amplitude in µV and NCV m/s. Fig 15 shows the bar diagram for distal latency in right handed and left handed dominant individuals. For Right handed dominance, the distal latency was found to be 2.408 ± 0.396, the amplitude was 4.0816 ± 0.5097 and the NCV was found to be 50.625 ± 3.522 respectively. For Left hand, the distal latency was found to be 2.196 ± 0.316, the amplitude was 4.303 ± 0.415 and the NCV was found to be 51.854 ± 2.975 respectively. The df (degrees of freedom) was found to be 18 for distal latency, 17 for amplitude and 16 for NCV respectively.

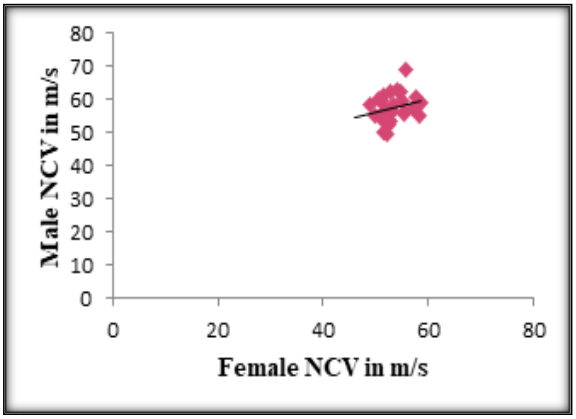
The p value was found to be >0.05 in case of amplitude and NCV and hence was considered not significant. However, p value for distal latency was found to be <0.05 and hence considered to be significant. The distal latency for Right handed dominant individuals were significantly higher than the Left handed dominant individuals whereas no such significance was found in amplitude and NCV among the Right handed and Left handed dominant individuals.

Correlations:

MEDIAN MNCV BETWEEN GENDERS: distal latency, amplitude and NCV





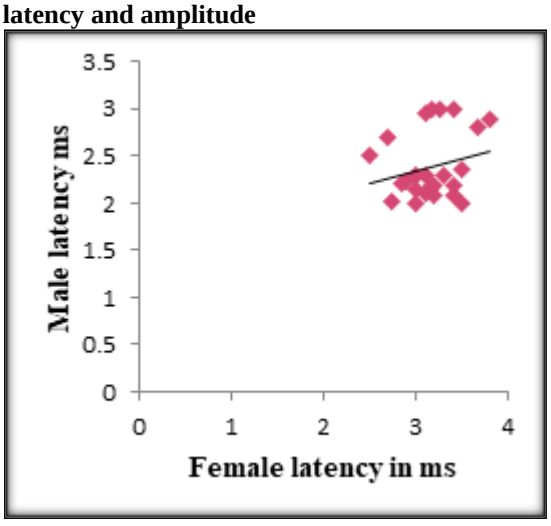


With p>0.05 and r = -0.057 by Pearson's Correlation there was no significant correlation seen between the distal latencies of females to males. With p>0.05 and r = -0.057 by Pearson's Relationship there was no positive connections seen between the distal latencies of females to guys.

With p>0.05 and r = -0.022 by Pearson's Correlation there was no significant correlation seen between the amplitudes of females to males.

With p>0.05 and r = 0.24 by Pearson's Relationship there was no positive relationship seen between the conduction velocities of nerve of females to guys.

MEDIAN SNCV BETWEEN GENDERS: distal latency and amplitude



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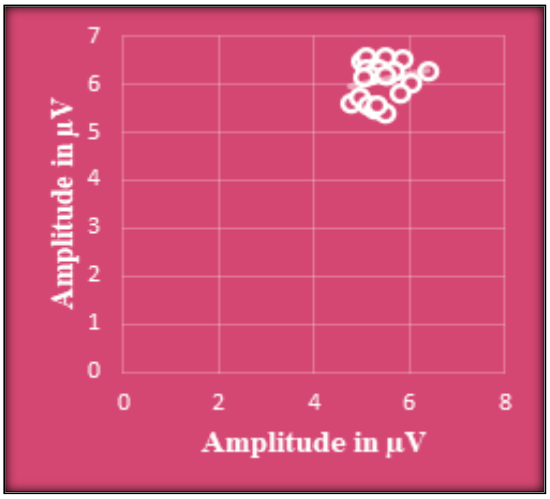
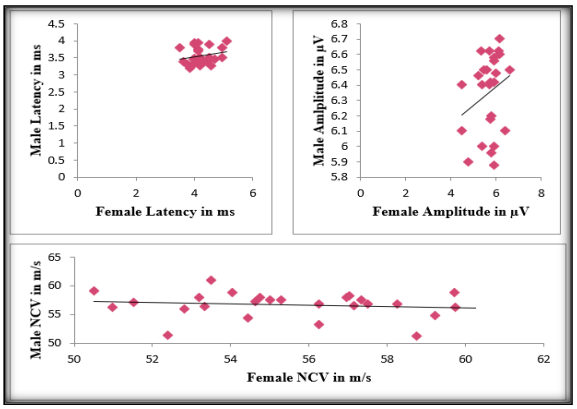


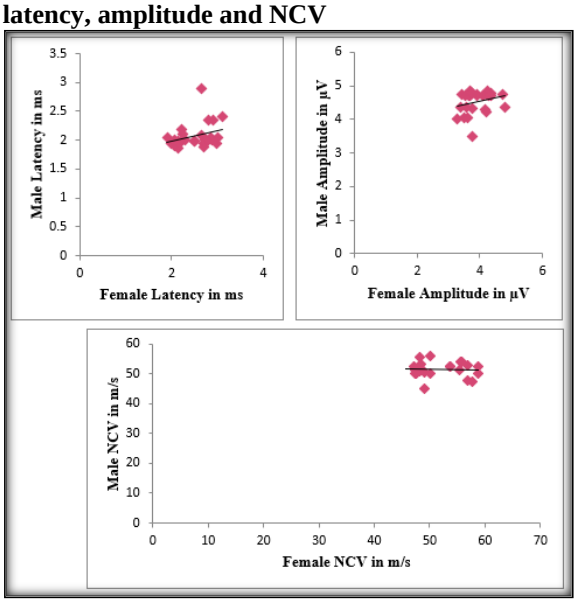
With p>0.05 and r = 0.23 by Pearson's Correlation there was no significant correlation seen between the distal latencies of females to males.
With p>0.05 and r = 0.179 by Pearson's Correlation there was no significant correlation seen between the amplitudes of females to males.

ULNAR MNCV BETWEEN GENDERS: distal latency, amplitude and NCV



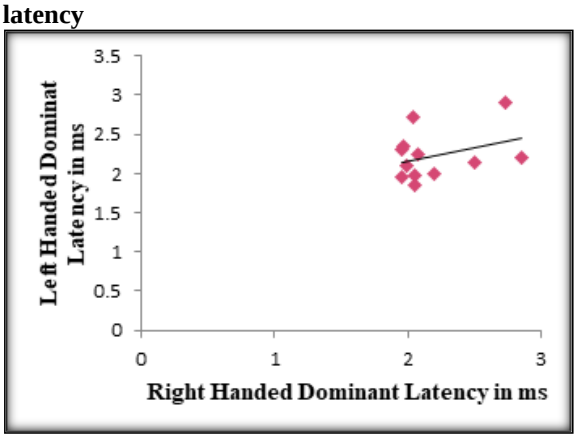
With p>0.05 and r = 0.23 by Pearson's Correlation there was no significant correlation seen between the distal latencies of females to males.
With p>0.05 and r = 0.24 by Pearson's Correlation there was no significant correlation seen between the amplitude of females to males.
With p>0.05 and r = -0.14 by Pearson's Correlation there was no significant correlation seen between the NCV of females to males.

ULNAR SNCV BETWEEN GENDERS: distal latency, amplitude and NCV



With p<0.05 and r = 0.303 by Pearson's Correlation there was a positive correlation seen between the distal latencies of females to males.
With p<0.05 and r = 0.26 by Pearson's Correlation there was a positive correlation seen between the amplitude of females to males.
With p>0.05 and r = -0.02 by Pearson's Correlation there was a no significant correlation seen between the NCV of females to males.

Ulnar SNCV hand dominance relation for distal latency



With p<0.05 and r = 0.83 by Pearson's Correlation there was a strong positive correlation seen between the distal latencies of right handed dominant individuals to left handed dominant individuals.

Table 1: Showing gender distribution (Numbers in parentheses show percentage).

Gender	Counts	Total
Male	34 (57%)	60
Female	26 (43%)	

Table 2: Showing mean age distribution between genders

Gender	Age in Mean ± SD (years)
Male	21.147 ± 2.0617
Female	19.462 ± 1.2077

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Table 3: Hand dominance distribution

Hand Dominance	Count	%
Right Handed	48	80
Left handed	12	20
Total	60	100

Table 4: Distal latency (DL) in relation to Isotonic exercise/ contractions

	Right Median MNCV (ms)			Left Median MNCV (ms)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	3.83	3.814	3.806	3.841	3.828	3.827
SD	0.512	0.496	0.493	0.485	0.482	0.494
p value	0.9638			0.986		

'N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 5: Amplitude in relation to Isotonic exercise/ contractions

	Right Median MNCV (µV)			Left Median MNCV (µV)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	6.902	6.88	6.89	6.909	6.9155	6.909
SD	0.529	0.531	0.532	0.5022	0.5062	0.5277
p value	0.9845			0.9977		

N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 6: NCV in relation to Isotonic exercise/ contractions

	Right median nerve MNCV (m/s)			Left sided Median nerve MNCV (m/s)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	55.014	55.201	55.298	54.778	55.003	55.239
SD	4.178	4.128	4.219	3.951	3.918	4.037
p value	0.9309			0.81673		

N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 7: Median MNCV in Mean ± SD between male and female

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Male (n=34)	4.1747 ± 0.3297	6.5718 ± 0.3875	53.035 ± 2.8499
Female (n=26)	3.3979 ± 0.3189	7.3338 ± 0.3494	57.602 ± 4.2648
Df	53	54	39
p value	0.001	0.001	0.001

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

Table 8: Median MNCV in Mean ± SD based on Hand dominancy

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Right handed (n=48)	3.8669 ± 0.5306	6.888 ± 0.538	55.149 ± 4.373
Left handed (n=12)	3.6825 ± 0.4152	7.0375 ± 0.491	54.473 ± 3.392
Df	18	16	18
p value	0.13894	0.11872	0.35698

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

Table 9: Distal latency (DL) in relation to Isotonic exercise/ contractions

	Right Median SNCV (ms)			Left Median SNCV (ms)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	2.8387	2.831	2.8248	2.831	2.8122	2.8387
SD	0.5076	0.5073	0.4988	0.5073	0.5288	0.5076
p value	0.9898			0.9645		

N.B. p-value was calculated utilized ANOVA single figure. S.D: - Standard Deviation *p<0.05 is considered as significant

Table 10: Amplitude in relation to Isotonic exercise/ contractions

	Right Median SNCV (µV)			Left Median SNCV (µV)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	5.694	5.6875	5.6895	5.7992	5.7902	5.7593
SD	0.5059	0.5083	0.5102	0.5428	0.5952	0.6383
p value	0.9965			0.9317		

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N.B. p-value was calculated utilized ANOVA single figure. S.D: - Standard Deviation *p<0.05 is considered as significant

Table 11: NCV in relation to Isotonic exercise/ contractions

	Right Median SNCV (m/s)			Left Median SNCV (m/s)		
	At rest	**10 min**	**15 min**	**At rest**	**10 min**	**15 min**
Mean	46.612	46.687	46.747	46.687	47.314	46.612
SD	4.3569	4.3183	4.2586	4.3183	5.379	4.3569
p value	0.9873			0.6867		

N.B. p-value was calculated utilized ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 12: Median SNCV in Mean ± SD between male and female

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Male (n=34)	3.1856 ± 0.2891	5.389 ± 0.361	45.856 ± 4.1418
Female (n=26)	2.385 ± 0.3465	6.092 ± 0.377	47.6 ± 4.5124
Df	46	51	51
p value	0.001	0.001	0.11799

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant.

Table 13: Median SNCV in Mean ± SD based on Hand dominancy

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Right handed (n=48)	2.8821 ± 0.5221	5.635 ± 0.5189	46.712 ± 4.3203
Left handed (n=12)	2.665 ± 0.42	5.85 ± 0.4344	46.213 ± 4.6744
Df	17	17	16
p value	0.0869	0.1166	0.43884

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

Table 14: Distal latency in relation to Isotonic exercise/ contractions

	Right Ulnar MNCV (ms)			Left Ulnar MNCV (ms)		
	At rest	**10 min**	**15 min**	**At rest**	**10 min**	**15 min**
Mean	3.9055	3.8918	3.8823	3.8918	3.9055	3.8847
SD	0.4478	0.45	0.4474	0.45	0.4478	0.448
p value	0.96045			0.9673		

N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 15: Amplitude in relation to Isotonic exercise/ contractions

	Right Ulnar MNCV (µV)			Left Ulnar MNCV (µV)		
	At rest	**10 min**	**15 min**	**At rest**	**10 min**	**15 min**
Mean	5.989	5.987	6.008	6.016	6.008	6.018
SD	0.4974	0.5168	0.5062	0.5087	0.5062	0.5059
p value	0.96921			0.9937		

N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant

Table 16: NCV in relation to Isotonic exercise/ contractions

	Right Ulnar MNCV (m/s)			Left Ulnar MNCV (m/s)		
	At rest	**10 min**	**15 min**	**At rest**	**10 min**	**15 min**
Mean	56.239	56.44	56.464	56.44	56.239	56.58
SD	2.5048	2.4393	2.5879	2.4393	2.5048	2.5716
p value	0.8659			0.7529		

N.B. p-value was calculated utilizing ANOVA single figure. S.D: - Standard Deviation
*p<0.05 is considered as significant.

Table 17: Ulnar MNCV in Mean ± SD between male and female

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Male (n=34)	4.176 ± 0.372	5.7144 ± 0.4618	55.914 ± 2.6858
Female (n=26)	3.5523 ± 0.248	6.35 ± 0.2539	56.914 ± 2.2253
Df	55	51	56
p value	0.001	0.001	0.04526

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant.

Table 18: Ulnar MNCV in Mean ± SD based on Hand dominancy

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Right handed (n=48)	3.929 ± 0.472	5.936 ± 0.525	56.021 ± 2.6615
Left handed (n=12)	3.72 ± 0.2805	5.8708 ± 0.5407	55.072 ± 3.2669

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Df	26	14	13
p value	0.055	0.36	0.1301

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

Table 19: Distal latency in relation to Isotonic exercise/ contractions

	Right Ulnar SNCV (ms)			Left Ulnar SNCV (ms)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	2.3657	2.3533	2.3475	2.3475	2.3372	2.3533
SD	0.3886	0.3846	0.3869	0.3869	0.3864	0.3846
p value	0.966			0.9725		

N.B. p-value was calculated utilized ANOVA single factor. *p<0.05 is considered as significant

Table 20: Amplitude in relation to Isotonic exercise/ contractions

	Right Ulnar SNCV (µV)			Left Ulnar SNCV (µV)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	4.126	4.1325	4.1632	4.1322	4.138	4.1325
SD	0.4971	0.4925	0.5265	0.4969	0.4908	0.4925
p value	0.908			0.997		

N.B. p-value was calculated utilizing ANOVA single figure. *p<0.05 is considered as significant

Table 21: NCV in relation to Isotonic exercise/ contractions

	Right Ulnar SNCV (m/s)			Left Ulnar SNCV (m/s)		
	At rest	10 min	15 min	At rest	10 min	15 min
Mean	50.871	51.196	51.283	51.283	51.658	51.196
SD	3.4319	3.5341	3.4985	3.4985	3.74	3.5341
p value	0.7851			0.7395		

N.B. p-value was calculated utilizing ANOVA single factor. *p<0.05 is considered as significant

Table 22: Ulnar SNCV in Mean ± SD between male and female

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Male (n=34)	2.5906 ± 0.3377	3.827 ± 0.377	50.411 ± 4.0526
Female (n=26)	2.0715 ± 0.217	4.517 ± 0.337	51.473 ± 2.335
Df	55	54	53
p value	0.001	0.001	0.0413

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

Table 23: Ulnar SNCV in Mean ± SD based on Hand dominancy

	Distal latency (ms)	Amplitude (µV)	NCV (m/s)
Right handed (n=48)	2.408 ± 0.396	4.0816 ± 0.5097	50.625 ± 3.522
Left handed (n=12)	2.196 ± 0.316	4.303 ± 0.415	51.854 ± 2.975
Df	18	17	16
p value	0.0467	0.0805	0.0862

N.B. p-value was calculated using unpaired t-test. *p<0.05 is considered as significant

DISCUSSION

This study, titled " **EXAMINING THE RELATIONSHIP BETWEEN ISOTONIC MUSCLE CONTRACTION AND SPEED OF NERVE CONDUCTION IN YOUNG ADULTS** in the Department of Physiology, Gauhati Medical College," aimed to examine the effects of isotonic exercise on nerve conduction velocity (NCV) parameters of the upper limbs. Conducted with 60 young, healthy participants at the Department of Physiology, Gauhati Medical College, the research focused on the median and ulnar nerves, which are essential for coarse and fine movements.[42]

The primary objective was to observe any changes in NCV parameters following isotonic exercises and to provide insights into how these parameters respond to such exercises. The nerve conduction study involved taking three consecutive readings: the first at rest, the second after 10 minutes of isotonic exercise using an ergograph, and the third after 15 minutes of ergographic exercise. A five-minute rest period was included between each reading to ensure adequate muscle recovery. Additionally, variations in NCV parameters were examined in relation to gender and hand dominance.

The NCV parameters analyzed included median motor nerve conduction velocity (MNCV) and sensory nerve conduction velocity (SNCV), as well as ulnar MNCV and SNCV. For MNCV, compound muscle action potential (CMAP) was recorded for distal latencies, amplitudes, and NCV, while for SNCV, sensory nerve action potential (SNAP) was recorded for the same parameters.[1]

In this study, no significant variations (increases or decreases) were observed in the NCV parameters (distal latencies, amplitudes, and NCV) for both median and ulnar nerves following 10 and 15 minutes of isotonic exercise. This was supported by a p-value greater than 0.05. These findings contrast with some previous studies, which have shown different results regarding the impact of exercise on nerve conduction. For instance, Borges et al. (2013) conducted a study in Brazil to measure the MNCV of the median and

ISSN (O): 2687-5365; ISSN (P): 2753-6556

common fibular nerves in three groups of athletes: middle-distance runners (MRG), sprint runners (SRG), and handball players (HG), compared to a control group (CG). They found significant differences between trained and untrained individuals in the SRG and MRG, with only the distal latency showing significant differences in the MRG compared to the CG.[8] Elam (1987) explained that lower body fat percentages are inversely related to MNCV, potentially enhancing neuromuscular integration and facilitating neural transmission.[89] Similarly, Wei et al. (2005) suggested that the functional overload experienced by athletes might increase nerve fiber diameter and myelin sheath thickness, resulting in higher nerve conduction velocities.[65]

In contrast, a study by Ozbek et al. (2006) on asymptomatic volleyball players found that nerve conduction velocities at the elbow segment of the motor nerve were slower compared to non-athletic controls, suggesting possible subclinical entrapment neuropathy due to strenuous elbow movements.[90] Hajimoradi et al. (2015) reported that exercise combined with gallic acid improved sensory nerve conduction velocity (SNCV) significantly in rats with sciatic nerve crush.[91] Tesfaye et al. (1992) observed a significant increase in sural nerve conduction velocity after exercise in normal subjects, though not in those with neuropathy.[92]

It is also documented that repetitive pressure and overuse can lead to injuries at nerve passage points in the hand, wrist, and elbow, potentially manifesting as entrapment syndromes and reducing nerve conduction.[3] The ulnar nerve in particular is vulnerable to damage from ergonomic stress and pressure from tools, handles, or crutches.[1,4-6]

Bonfiglioli et al. (2005) found a significant reduction in NCS parameters among workers performing repetitive jobs, associating early symptoms of carpal tunnel syndrome with such occupations.[93] Stenson et al. (1993) reported that industrial workers had significantly smaller mean median sensory amplitudes and longer motor and distal latencies compared to controls, likely due to prolonged exposure to high grip forces.[69] Similarly, Ganeriwal et al. observed decreased nerve conduction parameters in computer users compared to non-users, attributing this to repeated friction, tension, and impaired vascular perfusion.[5,73] Murata et al. found similar results in computer operators working for more than six hours daily, whereas Sanden et al. reported no significant changes in median nerve conduction velocity.[72,94]

In this study, no significant changes in nerve conduction parameters for median or ulnar nerves were observed following short-duration isotonic exercise. This may be attributed to the brief exercise exposure and lack of formal training among participants, despite their reported daily use of digital media for four to six hours.

Gender-based variations in NCV parameters were significant in this study. For the median MNCV, distal latencies were longer in males ($p<0.05$), with mean distal latency values of 4.1747 ± 0.3297 in males compared to 3.3979 ± 0.3189 in females. Conversely, amplitudes and conduction velocities were higher in females than in males ($p<0.05$). Males had a mean amplitude of 6.5718 ± 0.3875 compared to 7.3338 ± 0.3493 in females, while mean conduction velocity was 53.035 ± 2.849 in males and 57.602 ± 4.2648 in females. A similar trend was observed for median SNCV, with longer distal latencies in males and higher amplitudes in females, though conduction velocity showed no significant gender differences ($p<0.05$). Ulnar NCV parameters exhibited similar results, with longer distal latencies in males, higher amplitudes in females, and faster conduction velocities in females, except for median SNCV.

Misra and Kalita also reported shorter latencies and higher nerve conduction velocities in females, attributing higher SNAP amplitudes in females to a lower subcutaneous-to-nerve tissue ratio.[1] Gakhar et al. (2013) found longer latencies in males and higher amplitudes and faster conduction velocities in females for both median and ulnar nerves.[95] Robinson et al. noted faster conduction velocities in females across all nerves studied, with larger amplitudes in females for most sensory nerves and larger motor amplitudes in males for some nerves. Adjusting for height diminished most conduction velocity differences, but amplitude differences persisted.[78] Similar findings were reported by Samol et al., who found longer sensory distal latencies in males, higher sensory amplitudes in females, and faster motor conduction velocities in females.[79] Hennessey et al. and Huang et al. also found higher SNAP amplitudes in females in the upper limbs.[80,96] However, Stenson et al. reported no significant gender differences in their study.[74]

Regarding hand dominance, this study found no significant correlation ($p >0.05$) in motor and sensory median and ulnar NCV parameters, except for a slight variation in ulnar sensory distal latency, which was longer in right-handed individuals (mean 2.408 ± 0.396) compared to left-handed individuals (mean 2.916 ± 0.316). This aligns with Wee's (2001) study, which found no differences in median NCV parameters between dominant and non-dominant hands.[97] Jagad et al. (2013) similarly found no significant differences between dominant and non-dominant hands.[98] Tan (1993) reported higher SNCV on the left side and faster MNCV on the right in right-handed individuals.[83]

Conversely, Colak et al. found delayed sensory conduction in the dominant arms of tennis players compared to their non-dominant arms.[67] Ozbek et al. observed slower ulnar motor conduction in the dominant arms of volleyball players compared to their non-dominant arms.[90] Gupta et al. found significantly higher sensory conduction velocities in left-handed individuals for both right and left median nerves.[84] Sathiamoorthy also reported a correlation between handedness and motor nerve conduction

ISSN (O): 2687-5365; ISSN (P): 2753-6556

velocities, particularly in the median nerve,[85] the present study found no significant relationship between NCV parameters and short-term isotonic exercise. However, it did reveal significant gender differences in nerve conduction parameters and no significant relationship between hand dominance and NCV parameters, except for a longer ulnar sensory distal latency in right-handed individuals.

CONCLUSION

The present study aimed to examine the response of peripheral nerves to isotonic exercises or contractions, specifically assessing variations in nerve conduction study (NCS) parameters concerning gender and hand dominance. While the findings indicated no significant changes in NCS parameters due to isotonic exercises, notable differences were observed in relation to gender. Specifically, the study found that distal latencies were longer in males compared to females. Conversely, females exhibited higher amplitude values and faster conduction velocities, except in the case of ulnar sensory conduction, where no significant variation was noted. Additionally, regarding hand dominance, a slight but significant increase in latency was observed in right-handed individuals compared to their left-handed counterparts. The study's limitations are noteworthy, as it was a cross-sectional analysis focusing on the median and ulnar nerves in response to short durations of isotonic exercises. Several confounding factors, such as the duration of exposure to isotonic exercises, age, height, body mass index (BMI), and temperature, were not adequately controlled, potentially affecting the statistical accuracy of the results. Although cross-sectional studies can provide valuable insights into the effects of isotonic exercises on peripheral nerves, they do not allow for an assessment of changes within the same individuals over time. The sample size of 60 participants was relatively small, and the time-bound nature of the study further constrained the comprehensiveness of the findings. Thus, further research with a larger, more representative sample and longitudinal designs is essential to establish the associative changes in peripheral nerves in response to isotonic exercises. This would enable a more generalized conclusion regarding the effects observed in the present study. The estimation of basic NCS parameters holds significant clinical implications, aiding in the detection, diagnosis, prevention, and treatment of various peripheral nerve disorders. Understanding conduction velocities in peripheral nerves in relation to exercise can enhance athletic performance and facilitate recovery following peripheral nerve injuries. The long-term effects of isotonic exercises on peripheral nerve function have garnered considerable interest, warranting follow-up studies to explore these relationships further. In summary, while the current study did not find significant variations in NCS parameters due to isotonic exercises, it did reveal essential gender-related differences in nerve conduction characteristics. The findings underscore the need for more extensive research to clarify the impact of isotonic exercises on peripheral nerve function and to explore the potential benefits for clinical and athletic applications.

Acknowledgements: The author acknowledges at first all the patients who consented to take part in the study. I am thankful and indebted to the contributions of the Faculty of Gauhati Medical College and Hospital for their consent to use the Neurophysiology room and the guidance imparted by senior Faculty. The author also acknowledges the contributions of the staff of Gauhati Medical College who helped in assisting the tests to be carried out.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556