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Median Nerve Conduction Velocity in Throwers, Archers, and Non-Athletes: Influence of Forearm and Elbow Joint Positions

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Amrinder Singh*, Purnima Singla, Monika Sharma

Assistant professor, M.P.T Student, Research Fellow, MYAS -GNDU Department of Sports Sciences & Medicine Guru Nanak Dev University, Amritsar, India

***Corresponding Author:** Amrinder Singh, Assistant Professor, MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India.

Abstract

Background: Engaging in athletic training not only improves cardiovascular, pulmonary, and musculoskeletal function but also has been shown to enhance neural capabilities.

Purpose: The purpose of this study was to examine how the positioning of the forearm and elbow joint affects median nerve conduction velocity (NCV) among three groups: throwers, archers, and non-athletes.

Method: This study included a total of 34 subjects of both genders, with body mass indices (BMI) ranging from 18.5 to 24.9 Kg/m^2. To measure median nerve conduction velocity (NCV) across the elbow joint at various angles (0° elbow extension, 45°, 90°, and 120° elbow flexion) and different forearm positions, NeuroStim NS2 EMG/NCV/EP System was used.

Result: Repeated Measure Analysis of Variance (RMANOVA) demonstrated a statistically significant difference in the mean values of median NCV across different angles, forearm positions, and groups ($p<0.05$).

Conclusion: The positioning of the forearm and elbow joint can significantly impact median nerve conduction velocity, particularly among athletes who engage in repetitive upper limb motions. Study showed that the archers had significantly faster NCV than throwers and non-athletes at 0° of elbow flexion.

Keywords: Angles; Joints; Motor; Peripheral nerve

Introduction

The median nerve is a vital peripheral nerve that provides motor and sensory function to the forearm and hand (Agur & Dalley, 2018). In athletes, the median nerve is susceptible to compression and tension caused by repetitive movements in the elbow and forearm. For example, athletes involved in archery may experience pronator syndrome due to repeated pronation and gripping (McCue et al., 1996; Schickendantz & Yalcin, 2020). Throwers may also experience delayed motor and sensory median NCV due to both traction and compression induced by median nerve stretching during movement (Bamac et al., 2014).

Long-term athletic training can induce changes in the neuromuscular system, including the nerves, muscles, and their interconnections, to enhance athletic performance. These changes can involve increases in axonal diameter and myelin thickness (Ross et al. 2001). Studies have shown that changes in NCV may be an indicator of nerve system adaptation due to long-term training (Revathy & Krishnan, 2022). NCV is a crucial diagnostic tool used to assess nerve function (Salerno et al., 1998). Training-induced adaptations can enhance the efficiency of nerve conduction, allowing for faster and more precise communication between the nervous system and muscles. Vernon and Mori (1992) suggest that faster NCV is associated with faster speed of processing, resulting in reduced reaction time which can ultimately enhance athletic performance. The relationship between training adaptations and NCV is complex and may vary depending on several factors, such as the type, intensity, and duration of the training (Halar et al., 1985), as well as individual differences in genetic (Li, 2015) and physiological factors (Desai et al., 2021).

Limb position can significantly impact the degree of nerve compression or tension and, therefore, affect NCV (Simon & Walker, 2017). By measuring NCV at multiple positions, clinicians can identify nerve dysfunction or compression that may be affecting athletic performance and provide appropriate management. While previous research has focused on power and endurance athletes, there is a gap in the literature when it comes to investigating athletes who rely on precise and coordinated upper extremity movements, such as archery (Sleivert et al., 1995). Our main focus in this study was to understand the impact of varying elbow and forearm position on median NCV in throwers, archers and non-athletes in response to their intense physical activity. It may provide insights into the mechanisms underlying training adaptations in athletes and help prevent or manage any median nerve injuries that may arise due to excessive and repetitive use of the elbow and forearm in various sports.

Methodology

The study recruited a total of 34 participants, including twelve throwers (age: 21.17±2.03 years, BMI: 21.78±2.21 kg/m^2), nine archers (age: 20.22±1.71 years, BMI: 21.57±2.18 kg/m^2), and thirteen non-athletes (age: 21.38±1.6 years, BMI: 21.20±1.75 kg/m^2) between the ages of 18 and 24 years from Guru Nanak Dev University, Amritsar, Punjab. Both genders were included and all participants were university-level students. At the start of the study, their age, activity level, and medical history were recorded (Patel et al., 2017). Only individuals who were right-hand dominant, as determined by the Edinburgh Handedness Inventory (Pawlak & Kaczmarek, 2010), were recruited. The exclusion criteria were no prior history or symptoms of neurological or metabolic disorders, particularly central neurological deficits, any upper limb injuries or fractures. The testing procedures was explained to the participants, and written consent was taken from them. The Institutional Ethics Committee of Guru Nanak Dev University Amritsar, Punjab, India, informed this research project.

Experimental Procedure

To prepare the skin for measurement, the area to be stimulated was cleaned with alcohol, and any metal objects on the arm were removed. The motor median NCV was measured for each participant in supine position with their forearm supported on a plinth. Measurements were taken at four different elbow positions (0° elbow extension, 45°, 90°, and 120° elbow flexion) at the elbow level. Additionally, measurements were taken in two forearm positions, supination and pronation, for each degree of elbow flexion. A range of motion elbow brace was used to lock the elbow in the prescribed position. The distance between the proximal and distal stimulation points was measured with a tape to calculate the conduction velocity of the median nerve (Ralph et al., 2006).

Statistical Methods

The collected data was analyzed for statistical significance using the IBM 26 SPSS software. The Shapiro-Wilk test was used to assess the normality of the NCV data. Two-way repeated measures ANOVA was performed for median NCV, with two within factors (elbow and forearm position) and one between factor (sports). When significant effects were observed, a least significance difference post hoc test was employed. The significance level was set at $p < 0.05$.

Results

	Control (Mean ± SD)	*Throwers (Mean ± SD)*	*Archers (Mean ± SD)*
Age (years)	21.38±1.6	21.17±2.03	20.22±1.71
Height (cm)	162.62±7.28	171.19±11.70	167.66±8.30
Weight (kg)	56.31±8.21	63.83±8.65	60.89±9.42
BMI (kg/m^2)	21.20±1.75	21.78±2.21	21.57±2.18

Abbreviations: cm, centimeter; kg, kilogram; kg/m^2 kilogram per meter square.

Table 1: Descriptive characteristics of the participants.

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*p value*	*Partial Eta Squared*
Forearm positions	11.85	1	11.85	0.78	.38	0.02
Forearm positions * Groups	73.26	2	36.63	2.43	.104	0.13
Angles	1792.10	3	597.36	19.36	.000*	0.38
Angles * Groups	291.96	6	48.66	1.57	.16	0.09
Forearm positions * Angles	56.98	3	18.99	1.61	.19	0.05
Forearm positions * Angles * Groups	75.56	6	12.59	1.07	.38	0.06

Table 2: Showed tests of within subject factors i.e., forearm, angle and sports.

Groups	*Forearm Position*	*(I) Angle*	*(J) Angle*	*Mean Difference (I-J)*	*Std. Error*	*p value*	*95% Confidence Interval for Difference*	
							Lower Bound	*Upper Bound*
Non-Athletes	Supination	0°	120°	4.75*	1.82	.014	1.02	8.48
		45°	120°	2.65*	1.05	.017	0.50	4.79
		90°	120°	2.60*	0.71	.001	1.15	4.05
	Pronation	0°	120°	6.65*	2.20	.005	2.15	11.15
		45°	90°	5.15*	1.91	.011	1.24	9.06
		45°	120°	7.26*	1.87	.001	3.44	11.07
		90°	120°	2.10*	0.75	.009	0.57	3.64
Archers	Supination	0°	45°	8.87*	2.29	.001	4.19	13.56
		0°	90°	9.22*	2.35	.000	4.42	14.02
		0°	120°	10.79*	2.19	.000	6.27	15.23
	Pronation	0°	90°	5.86*	2.72	.039	0.30	11.41
		0°	120°	8.96*	2.64	.002	3.55	14.36
		90°	120°	3.10*	0.90	.002	1.25	4.94
Throwers	Supination	0°	120°	6.12*	1.90	.003	2.24	10.00
		45°	120°	3.03*	1.09	.009	0.80	5.26
		90°	120°	3.98*	0.74	.000	2.47	5.49
	Pronation	0°	120°	6.38*	2.29	.009	1.70	11.06
		90°	120°	3.23*	0.78	.000	1.63	4.83

Table 3: Showed comparison between the different elbow flexion angles in supination and pronation in median nerve.

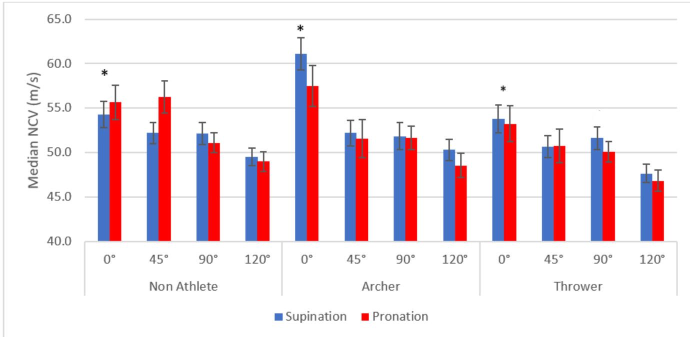

Figure 1: Showed median NCV of Non-athletes, Archers and Throwers in different elbow and forearm positions.

Discussion

The objective of the study was to examine the influence of forearm and elbow joint positions on median NCV in throwers, archers, and non-athletes and to determine how these positions might affect nerve function and the risk of injury.

The study showed that, the conduction velocity of median nerve is affected by changes in elbow position in all groups i.e., throwers, archers and non-athletes. In all three groups, the conduction velocity of the median nerve decreases as the elbow moves from full extension to 120° of flexion. We found no significant differences in the forearm positions (supination & pronation) in median NCV of any of the three groups. This showed that effect of elbow position on median NCV is dependent on the specific angle of elbow flexion or extension. Kleinrensink et al., (1995) found in their study that there is more tension in median nerve when elbow is flexed as compared to extended.

According to this study for median nerve, the best position for elbow joint is 0° to 45° for throwers, archers and non-athletes in both supination and pronation. The nerve is most compressed at 120° of elbow flexion in all the three groups. These positions showed the most significant decrease in median NCV and therefore it may increase the possibility of neuropathies (Rayan, 1992).

The findings of the present study also demonstrated that there is a significant increase in the median NCV of archers as compared to throwers and non-athletes at 0° of elbow flexion. At 0° supination, archers have greater NCV than non-athletes ($p = 0.028$) and throwers ($p = 0.020$). There are several potential reasons why median nerve conduction velocity (NCV) may be increased in archers. One possible reason is that archery requires significant use of the muscles and tendons in the forearm and hand, which may lead to increased strength and endurance of those muscles. This could result in faster conduction of signals along the median nerve, which innervates many of these muscles (Häger-Ross & Schieber, 2000). Additionally, the repetitive and precise movements involved in archery may lead to increased neural adaptation and plasticity, potentially resulting in faster NCV (Rossini & Rossi, 1998). Another potential reason is that archery requires significant mental focus and concentration, and previous research has suggested that cognitive processes can influence nerve conduction (Bera et al., 2021). Spitzer et al., (1988) found that visual attention can increase median NCV. It is possible that the mental focus required in archery may have similar effects on NCV.

In this study we found no significant change in median NCV among non-athletes and throwers. (Bamac et al., 2014) on the contrary, found significant decrease in median NCV in basketball players. This shows that the exact angles at which median NCV is affected may vary depending on the specific study, the population being studied and their training adaptations. There is a scarcity of studies that examine median NCV, which suggests a potential area for further research. It would be beneficial to recruit athletes from different sports and training ages and evaluate their nerve conduction to investigate whether median NCV varies based on the type of sport played and training intensity. By recruiting athletes from different sports and training backgrounds, it would be possible to gain a more comprehensive understanding of how median NCV varies across populations and develop targeted interventions to improve nerve function and reduce the risk of injury. Additionally, using median NCV to diagnose subclinical neuropathies in athletes could be valuable. These measurements could also provide an objective analysis of skill and coordination in sports training, making them a useful tool for athletes and trainers alike.

Conclusion

The forearm and elbow positions can have a significant impact on median NCV, especially in athletes who perform repetitive upper limb motions. This study showed that the archers had significantly faster NCV than throwers and non-athletes at 0° of elbow flexion. This indicates that the unique movements and positions used in archery may have a positive impact on median nerve function. However, while these findings are informative, further research is needed to fully understand the mechanisms underlying the observed differences in median NCV and to identify effective interventions to improve nerve function and prevent injuries. It is essential to consider the impact of repetitive upper limb motions on nerve function and to develop strategies to mitigate the potential risks associated with these activities.

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