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Action of Ultrasound Therapy in Altering Motor Nerve Conduction Velocity of Ulnar Nerve

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Ultrasound therapy is one of the commonest and most popular modality used for tissue healing, pain reduction, tissue extensibility and in inflammationby physiotherapists all around the globe.Various sensitivity tests on peripheral nerves are done with ultrasound therapy, yet conclusions are still skeptical, which makes it inconclusive in progressing the modality further into management of nerve disorders. This study aimed to analyze efficiency of therapeutic ultrasound in influencing ulnar nerve conduction velocity. To Analyze the effect of ultrasound therapy in altering motor nerve conduction velocity of ulnar nerve with two therapeutic frequencies. 40 healthy individuals were included according to the selection criteria and they were explained about safety and simplicity of procedure and informed consent was obtained. All the participants were randomly assigned into two groups as 20 in each group. Group-A was given ultrasound therapy at specific site of elbow to target the ulnar nerve with 1MHz frequency and Group–B followed the same procedure with 3MHz frequency. Pre and Post to ultrasound therapy applicationMotor Nerve Conduction Velocity (MNCV) of ulnar nerve were recorded for both the groups. The posttest mean of MNCV for forearm segment and arm segment for Group A and Group B showed statistically significant difference (P Value <0.001).The analysis done by the statistical data also revealed that the MNCV at forearm segment showed an increase in velocity compared to its pretest values, whereas the post MNCV values at arm component showed a decrease in velocity when compared to its pretest values. Among comparison the data within the groups it is evident that group A with 1 MHz of ultrasound sonification is more capable of altering the MNCV values in comparison with the 3MHz. frequency. Findings of this study conclude that ultrasound therapy can be used effectively in altering conduction velocity of a nerve and it has a potential ability to facilitate or inhibit a nerve physiological function.

Keywords: Ultrasound therapy, Motor Nerve Conduction (MNCV), Ulnar nerve Conduction. Neuropathy.

Therapeutic ultrasound is the modality of choice for physiotherapists all around the globe for its multifaceted application in the field of physiotherapy. Physiotherapists have used the modality for tissue healing, reducing pain, reducing inflammation, collagen extensibility, and scar tissue breakdown.[1]Therapeutic ultrasound (UST) utilizes sonic waves of very high non-audible frequency to produce the desired change in tissues[2]. The common commercial frequencies adopted by manufacturers are 1 MHz and 3 MHz, numerous studies have been done on this frequency to analyze its therapeutic proficiency. UST frequencies are also delivered through various modes(pulsed or continuous).[3]

Previous studies have reported the therapeutic effect of ultrasound with variable parameters and clinical conditions and have documented its therapeutic efficiency in managing various musculoskeletal disorders. Despite its remarkable therapeutic results as per literature evidence, the physiological effects of UST on altering responses of various tissue, particularly nerve function is still unclear.[4-7] Even though the influence of UST in various tissues like muscle, ligament, capsule, bone, and nerve is evident from various sources, its ability to alter the physiological function on nerve tissue is still debatable. Although nerve conduction velocity changes are documented on peripheral nerves lesions with varying modes and intensity of UST,some of the studies done in this context has identified the electrophysiological changes in nerve with variable frequency individually in different study environments, yet could not determine its significance in two different frequency parameters.[8-10] It is also noted from studies that Ultrasound treatment with an intensity ranged from 0.5 to 2 watt/cm^{2}may induce various biophysical effects within the tissues. Studies also have proved that ultrasound treatment might facilitate recovery from nerve compression and suppress pain through slowing nociceptive nerve conduction.[11-14] Various sensitivity tests on peripheral nerves are done with ultrasound therapy, yet conclusions are still skeptical, which makes it inconclusive in progressing the modality further into management of nerve disorders.

With this background, this study sets to document the difference between electrophysiological changes (nerve conduction velocity) occurring in ulnar nerve with the intensity set as 1 watt/cm^2. This study aims to analyze the role of Therapeutic ultrasound in altering ulnar nerve motor conduction velocity with 1MHz and 3 MHz frequency at two different segments of nerve recording. Thisstudy hypothesized that there would be a significant change in motor conduction velocity of ulnar nerve under controlled environment with continuous mode of ultrasound delivery between the groups. Non-continuous or pulsed duty cycles were ignored in this study since previous research on this background has proved its inefficiency in altering nerve conduction velocity.

MATERIALS AND METHODS

This study was designed as an experimental study with samples divided by simple random sampling method with single blinding. The study procedure was approved by institutional human ethical committee and the study was administered on normal individuals who were health science students of the same university were research was conducted. The details of the study procedure was explained to group of 117 students and out of these 73 students volunteered for the study and 40 were selected based on selection criteria to maintain homogeneity of the group (Ref. table 1).The selected participants were explained about safety and simplicity of procedure and informed consent was obtained. Upon information about the study procedure they were randomized into 2 groups. Group A and group B consisted of 20 participants each.Inclusion criteria for selection of the participants were female of age between 20-25yrs and without any nerve compression or neurological deficit, asymptomatic and pain free upper limb. Participants with Brachial plexus injury**,** cervical radiculopathiesand individuals with neuropathies**,** shoulder pain radiating to hand**,** elbow and wrist pain were excluded from the study.

Participants in Group-A was given ultrasound therapy with 1MHz frequency and Group-B was given with 3MHz frequency on to their dominant upper limb. Both the group participants were positioned in supine lying with dominant arm in slight abduction and external rotation with pillow/towel roll support at the elbow placed in 90 degree flexion.The ultrasound therapy was given by placing the transducer head in between the medial epicondyle and olecranon process. Ultrasound therapy was administered as direct method through aqueous gel coupling medium with Intensity: 1.0 w/cm^2**,** Duration: 7 minutes, Mode: continuous for both the groups. Procedure was administered for single session with Frequency: 1 MHZ for Group A and 3 MHZ for Group B.[15]

The outcome measures to determine the results were done based on motor nerve conduction velocity (MNCV) of ulnar nerve. Pre and Post ultrasound therapy Motor Nerve Conduction Velocities were recorded for both the groups.The ultrasound therapy and NCV testing was done in the same environment with procedure conducted as one time session at normal room temperature Ulnar nerve distal and proximal MNCV was recorded in both the groups at two different segments as described below.

MNCV testing procedure

The ulnar nerve motor nerve recording was performed with help of electro-physiologist who was blinded to the study. Active recording electrode was placed over the highest prominence of hypothenar muscles in between the ulnar border of distal forearm crease and distal transverse palmar crease. The inactive electrode was placed over the tendon of hypothenar at the level of metacarpophalangeal joint of the little finger. The ground electrode was fixed around the wrist on the dorsal aspect. The distal 1stsite of ulnar nerve was stimulated with probe positioned 2cm proximal to the wrist at the level of flexor carpi ulnaris tendon. The proximal 2ndstimulation site for ulnar nerve

Table 1. Anthropometric variables of the groups for homogeneity

Group –A (n=20)				Group –B(n=20)			
Age, yrs.	Ht., cm	Wt., kg	Hand Dominance	Age, yrs.	Ht., cm	Wt., kg	Hand Dominance
20.17± 1.23	153.2 ± 5.1	54.2 ± 8.32	Right- 20 Left- 0	20.53± 2.16	152.7 ± 4.7	53.2 ± 6.89	Right- 20 Left- 0

Table 2. Comparison of Pre and Post-Test MNCV Values of Group-A

Group A(n=20)		Mean m/sec	Standard deviation	't' value	significance
MNCV of Wrist – Elbow level	Pre test	53.11	2.65	11.20	<0.001
	Post test	59.49	2.57		
MNCV of Elbow- Axilla level	Pre test	55.95	2.21	9.40	<0.001
	Post test	49.47	2.91		

Table 3. Comparison of Pre and Post-Test MNCV Values of Group-B

Group B(n=20)		Mean m/sec	Standard deviation	't' value	Significance
MNCV of Wrist – Elbow level	Pre test	52.20	2.51	10.33	<0.001
	Post test	57.49	2.58		
MNCV of Elbow- Axilla level	Pre test	54.18	2.23	4.67	<0.001
	Post test	46.64	7.02		

Table 4. Comparison of post-test values between the groups

Parameter	Post Test Values					
	Group A(n=20)		Group B(n=20)			
	Mean m/sec	Standard deviation	Mean m/sec	Standard deviation	't' value	P Value
MNCV of Wrist – Elbow level	59.49	2.57	57.49	2.58	2.43	0.0188
MNCV of Elbow- Axilla level	49.47	2.91	46.40	7.02	5.24	0.0791

was fixed over the elbow just 4cm distal to the medial epicondyle. Further the 3rd stimulation site to measure MNCV of Elbow to shoulder was done approximately 4 cm proximal to medial epicondyle. The next consecutive 4thstimulation site was at axilla approximately 10 cm proximal to stimulation point 3. From these four sites the MNCV values for wrist to elbow (forearm segment) and elbow to axilla(arm segment) was measured.[16, 17]

RESULTS AND DISCUSSION

The collected data was tabulated and analyzed using descriptive and inferential statistics. Paired t-test was used to analyze significant changes between pre-test & post-test measurements (Table 2 & 3). Unpaired t-test was used to analyze significant changes between two groups (Table 4).

The data from the table 2 shows the pre-test and post-test values of MNCV stimulated at forearm and arm levelsin Group-A participants.

The pre-test mean value of MNCV at forearm level is 53.11 m/second (SD 2.65) and the post-test mean value is 59.49 m/second (SD 2.57). This shows that test scores of MNCV at forearm level is increasing gradually with evident of p value <0.001.

The pre-test mean value of MNCV at elbow level is 55.95 m/seconds (SD 2.21) and post-test mean value is 49.47 m/seconds (SD 2.91) this shows that MNCV at arm level isdecreasing gradually with evident of p value <0.001.

The data from the table 3 shows the pre-test and post-test values of MNCV stimulated at forearmand arm level in Group-B participants.

The pre-test mean value of MNCV at forearm level is 52.20 m/seconds (SD 2.51) and the post-test mean value is 57.49 m/seconds (SD 2.58). This shows that test scores of MNCV at forearm level is increasing gradually with evident of p value <0.001.

The pre-test mean value of MNCV at arm level is 54.18 m/second (SD 2.23) and post-test mean value is 46.64 m/second (SD 7.02) this shows that MNCV at arm level isdecreasing gradually with evident of p value <0.001..

The data from table 4 shows the post-test values of MNCV at forearmandarm level in comparison with Group-A and Group-B.

The post-test mean value of MNCV at forearm level in Group-A is 59.49 m/second (SD 2.57) and post-test mean value of MNCV at forearm level in Group-B is 57.49 m/second (SD 2.58)with the P value (0.0188). It shows that there exists a significant difference between post-test values between the groups at forearm level

The post-test mean value of MNCV at arm level in Group-A is 49.47 m/second (SD 2.91) and post-test mean value of MNCV at arm level in Group-B is 46.40 m/second (SD 7.02) with the P value (0.0791). It shows that there does not exist a significant difference between post-test values between the groups at arm level.

Statistical analysis of MNCV results revealed that there is statistically significant difference evident within and between Group A and Group B. Further both the frequency parameters significantly increased the MNCV of the groups, and among comparison within the groups it is evident that group A with 1MHz. of ultrasound sonificationis more capable of altering the MNCV values in comparison with the 3MHz. frequency. Further the findings also reveal that ultrasound therapy administered nerve shows considerable increase in conduction velocity at the distal (forearm)when compared to the proximal (arm) site were the post MNCV findings were deteriorated. This is an important finding to standardize the site of therapy in a clinical scenario involving peripheral nerve.

The strength of the study includes specificity of standardized protocols used in ultrasound therapy. The outcome analysis was done with MNCV values for ulnar nerve, which is also considered as golden standard to analyze nerve function. Similarly, the homogeneity of the groups was also maintained to prevent bias between groups. The assessor was also blinded about the group allocation. The weakness of the study includes nonperforming sensory nerve testing. Since many studies were done on ulnar sensory nerve conduction velocity (SNCV) testing to analyze the pain relieving effects, SNCV testing was not selected as an outcome measure for this study.[7]

Previous studies done on therapeutic ultrasound and nerve conduction recorded the thermal changes in soft tissues. Moore J H et al conducted a study onalterations in healthy nerves latencies from ultrasound application and concluded that latency changes appeared to be related to temperature changes induced by ultrasound's thermal effects and not by non-thermal effects.[13] This particular finding and results of similar findings made the investigators to select continuous mode ultrasound, which is used globally for deeper tissue heating.[15, 17-20]

The results of this study reveal that ultrasound therapy with 1MHz (Group A) is more effective than ultrasound therapy with 3MHz (Group B) in altering motor nerve conduction velocity. This finding can be of greater importance in concluding the effect of ultrasound therapy in improving motor function through effective alteration of motor conduction velocities. Moreover, the effects of ultrasound therapy targeted over the nerve is more effective in increasing its distal conduction connections rather than the proximal site.This finding also suggest that proximal nerve zone has to be sonified to generate a significant beneficial effect while targeting distal motor units. The disparity in proximal and distal segment MNCV values were recorded in a study conducted by Onguna et al stated that the dissimilarities in the both values might be due to temporal dispersion and phase cancellation happening due to desynchronized conduction during nerve stimulation.[21]Ulnar nerve entrapment is the second most common type of nerve entrapment.[22] Pain reduction and early suppression of inflammation is essential in such cases, regeneration of the nerve can also be a facilitator for early recovery. Regeneration and inflammatory signs responses study on peripheral neuropathy has been documented in various other modalities used in Physiotherapy practice.[23-25]. The results of ultrasound application in this study significantly altered the MNCV values, which is an important finding to conclude that ultrasound therapy can be used effectively in altering conduction velocity of a nerve and it has a potential ability to facilitate or inhibit a nerve physiological function. The findings of this study can be further applied with ultrasound therapy in case of peripheral nerve lesions and neuropathies to analyze its recovery and further standardization may be done to analyze it with long term follow up trials.

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