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Comparison between neural mobilization and carpal bone mobilization in treating carpal tunnel syndrome

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Background: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in the upper limbs, caused by compression of the median nerve at the wrist. Objective: The study aimed at comparing between the effectiveness of neural mobilization (NM) and carpal bone mobilization (CBM) in improving signs and symptoms in patients with CTS. Methods: Thirty females with CTS were selected and randomized into two equal groups; (A) and (B). Group (A) received median nerve dynamic mobilization while group (B) received carpal bone mobilization. The duration of intervention was four weeks. Outcome measurements, before and after intervention, were pain assessment, nerve conduction studies (sensory and motor latency and conduction velocity) and finally, hand grip strength. Results: A statistically significant improvement was revealed in pain, nerve conduction parameters (sensory and motor distal latency and sensory conduction velocity) and grip strength within each group ($p<0.05$). Although, there was no statistically significant difference in pain and nerve conduction parameters between both groups, a statistically significant increase in grip strength was found in group (A) when compared to that of group (B) ($p<0.05$). Conclusion: It was concluded that both median nerve and carpal bone mobilizations were effective in improving signs and symptoms of CTS in favor to neural mobilization.

Keywords: Carpal tunnel syndrome, Neurodynamics, Carpal bone mobilization, Pain, Grip strength, Nerve conduction study.

INTRODUCTION

Carpal tunnel syndrome is an entrapment neuropathy in the upper extremity where the median nerve is compressed within the carpal tunnel. This tunnel is located between the transverse carpal ligament and the carpal bone at the wrist. It is estimated to occur in 3 - 6% of the general population between the ages of 30-60 years old. Women are three times more likely to have CTS than men, and the prevalence and severity increase with age (Atroshi et al., 2011 and Martins and Siqueira, 2017).

Patients with CTS have symptoms such as pain, numbness, para esthesia, and tingling of the first three fingers as well as radial side of the ring finger, which may cause nocturnal awakening and interference with daily activities. Thenar muscles atrophy and weakness may be found in severe cases (Le Blanc and Cestia, 2011 and Singh et al., 2016).

Most cases of CTS are idiopathic (Marshall, 2001) but work-related activities that require a high degree of repetition and force or use of hand operated vibratory tools significantly increase the risk of CTS (Kozak et al., 2015). A large prospective cohort study found that forceful hand exertion was the most important factor in the development of CTS in workers (Harris et al., 2015). Additional risk factors include family history and personal history of diabetes mellitus, obesity, hypothyroidism, pregnancy, and rheumatoid arthritis (Spinner et al., 1989).

Carpal tunnel syndrome diagnosis is based on medical history, physical exams (complaints, joint mobility testing, hand muscles strength and special tests such as Phalen's maneuver) and is confirmed by electro diagnostic tests, which objectively reveals median nerve dysfunction (Kohara, 2007).

Empirical evidence indicated that many patients with mild to moderate CTS respond to non-operative conservative treatments, including rest, modification of physical behaviors, splinting, and electrotherapy with ultrasound or laser, nerve gliding exercises, manual therapy techniques, and anti-inflammatory medications (Viera, 2003; Burke et a.l, 2007 and Maddali et al., 2013).

Neural mobilization is an intervention aims to restore the homeostasis in and around the nervous system, by mobilization of the nervous system itself or the structures that surround it (Coppieters and Nee, 2015). Recently, several studies reported optimum results with the use of neurodynamic mobilization as a conservative treatment, with neural slipping helping nerve mobilization in relation to musculoskeletal tissues (Mulleret al., 2004 and Duymaz et al., 2012).

At the same time, number of researchers have turned their attention to managing CTS through carpal bone mobilization, which results in less tissue adhesion and increased wrist mobility with improving the CTS signs and symptoms (Gunay and Alp, 2015 and Vikranth et al., 2015). One of the carpal mobilization techniques is dorsal (posterior) glide and volar (anterior) glide intermittently; it may be more effective than other techniques (Tal- Akabi and Rushton, 2000).

Aim of the study

The purpose of the study was to compare between the effectiveness of NM and CPM in improving signs and symptoms of CTS.

MATERIALS AND METHODS

Subjects

Thirty patients with CTS were selected from ShebinElkom Educational Hospital, Menoufia, Egypt. The study was conducted from October 2018 to March 2019.

Inclusion criteria:

Female patients with right CTS were included; they were diagnosed with moderate CTS and confirmed by electro diagnostic test (EDX) (Padua et al., 1997 and Keith et al., 2009), the age ranged between 25 to 50 years of age, positive Phalen's test.

Exclusion criteria:

Patients were excluded in the following conditions: psycho-social problem, double crush syndromes, cervical or thoracic origin of symptoms, diabetes mellitus, Herpes Zoster, recent fracture crush injuries, shoulder injuries, scaphoid instability, hyper-mobile joints, shoulder painful arc syndrome, pregnancy, women under hormonal replacement therapy.

Methods

A consent form was obtained from patients after comprehensive explanation of the aim and procedures of the study. The study proposal was approved by the Research Ethical Committee of the Faculty of Physical Therapy, Cairo University.

Assessment procedures:

Nerve conduction studies were carried out following methods used by Werner and Andary(2011) by EMG apparatus (Tru Trace EMG 4ch Head box device, manufactured by deymed Diagnostic Pvt., Ltd., Czech Republic). Pain was assessed using visual analogue scale (VAS) according to Boonstra et al., (2008). Finally, hand grip strength was evaluated using jamar hand dynamometer following procedures of Roberts et al., (2011). Assessment was done before and after completion of four weeks of intervention.

Treatment procedures

Patients were randomized into two equal groups; (A) and (B). Group (A) received median nerve dynamic mobilization while group (B) received carpal bone mobilization.

Neural mobilization:

The patient was asked to lie down on a couch in supine lying position. The NM technique was performed by the researcher in the form of: Shoulder depression, Shoulder abduction, Forearm supination, Shoulder external rotation, Wrist and finger extension, and Elbow extension (Michelle and Toni, 2008 and Oskouei et al., 2014). All the movements were taken to the end of the available range or to the point where symptoms were produced. These neural stretches were held for 10 sec. and were repeated 10 times per session. The sessions were administered for three times a week.

Carpal bone mobilization:

The patient was asked to sit on a chair with the ventral aspect of the forearm on the table and the hand off the table**.** The researcher's stabilizing hand griped the distal radius with the thumb on the dorsal surface and the index finger on the ventral surface. The manipulating hand griped the scaphoid bone with the thumb on the dorsal surface and the index finger on the volar surface**.**The manipulating hand glided the scaphoid bone in antero-posterior direction on the radius with an oscillation of 30 – 40 per minute (Patterson, 1998; Sucher and Hinrichs, 1998 and Dinarvand et al, 2017) with lateral glide of proximal row of carpal bones was also given (Tal-Akabi and Rushton, 2000). Grade of mobilization and progression of treatment were decided according to the patient's irritability and severity (Joie et al., 2005).The treatment was administered three times a week for a total period of four weeks.

Statistical analysis

The obtained data was collected and statistically analyzed using the statistical SPSS package program version 20 for windows. Data was presented as means and standard deviations. Paired andunpaired t-tests were used to compare within and between groups. The level of significance (*p*- value) was ≤ 0.05.

RESULTS

Patients' general characteristics

The results revealed that in group (A), the mean age was 36.47±6.58 years. While in group B, the mean age was 36.40±7.02 years. There was no significant difference between both groups (*p*=.98). Regarding the duration of illness, there was also no significant difference between both groups (*p*=.44) (table 1).

Table 1: General characteristics of the patients in each group.

Variable	Group (A) Mean±SD	Group (B) Mean±SD	t	*p*
Age (years)	36.47±6.58	36.40±7.02	0.023	0.98 (NS)
Duration of illness (months)	4.47±1.41	4.07±1.39	0.78	0.44 (NS)

NS: Non -significant

Pain

The results revealed no significant difference between group (A) and group (B) regarding VAS score mean values neither before (7.80±1.15and 7.93±.88 respectively) nor after treatment (1.20±.94 and 1.07±.96 respectively) (*p*=.72 and .70 respectively).

On the contrary, the results revealed that there were significant decrease of VAS score mean values after treatment compared to that before treatment in both groups (A) and (B) (*p*=.000) as shown in table (2) and figure (1).

Table 2:Comparison between both groups regarding VAS scores before and after treatment.

VAS	Group (A)	Group (B)	*p*
Pre	7.80±1.15	7.93±.88	.72 (NS)
Post	1.20±.94	1.07±.96	.70 (NS)
p	.000**	.000**	

p<0.05* = significant. p<0.00** = highly significant p>0.05 = Non- significant

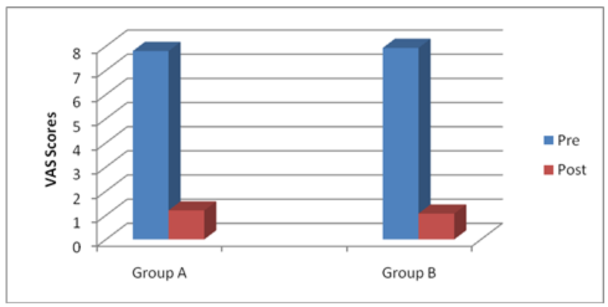

Figure 1: Mean values of VAS scores in groups (A) and (B) before and after treatment.

Hand grip strength

Before treatment,there was no significant difference between group (A) and group (B) regarding the hand grip score mean values (15.09±3.22 and 12.48 ±6.27 respectively) (*p*=.16). On the other hand, the results revealed significant difference between groups after treatment in favor to neural mobilization group (group A) (22.90±3.66 and 18.68±6.14 respectively) (*p*= .03).

Additionally, the results revealed a highly significant increase in the hand grip score mean values after treatment compared to that before treatment within groups (A) and (B) (*p*=.000) as shown in table (3) and figure (2).

Neurophysiological Findings

Sensory distal latency

The findings showed non-significant difference between group (A) and group (B) regarding sensory distal latency mean values neither before (2.80±.41and3.05 ±.49 respectively) nor after treatment (2.37±.42 and 2.58 ±.54 respectively) (*p*=.15 and .24 respectively).On the other hand, the results showed highly significant decrease in the sensory distal latency mean values after treatment compared to that before treatment within both groups (A) and (B) (*p*=.001 and .000 respectively) as shown in table (4).

Table 3: Comparison between both groups regarding hand grip score mean values before and after treatment.

Hand Grip Strength (Kg m)	Group (A)	Group (B)	*p*
Pre	15.09±3.22	12.48±6.27	0.16 (NS)
Post	22.90±3.66	18.68±6.14	0.03*
p	0.000**	0.000**	

p<0.05* = significant. p<0.00** = highly significant
P>0.05 = Non- significant.

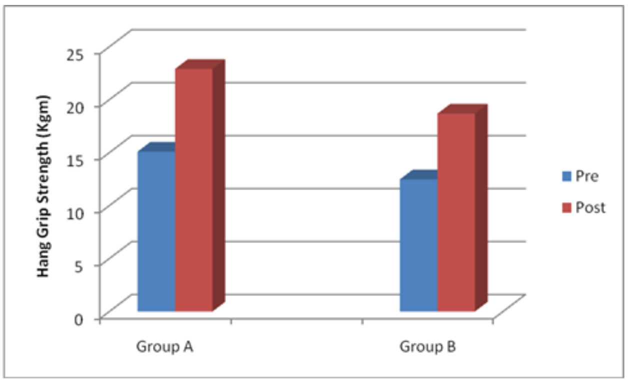

Figure 2: Mean values of hand grip strength in groups (A) and (B) before and after treatment.

Sensory conduction velocity

The results also did not show significant difference between group (A) and group (B) regarding sensory conduction velocity mean values neither before (38.27±4.57 and 37.26±3.69 respectively) nor after treatment (53.53±8.66 and 48.47±8.95 respectively) (*p*=.51 and .13 respectively).

Table 4: Comparison between both groups regarding sensory distal latency mean values before and after treatment.

SDL (ms)	Group (A)	Group (B)	*p*
Pre	2.80±.41	3.05 ±.49	0.15 (NS)
Post	2.37±.42	2.58±.54	0.24 (NS)
p	0.001**	0.000**	

p<0.05* = significant. *P*<0.00** = highly significant
p>0.05 = Non- significant

On the other hand, the results revealed highly significant increase in the sensory conduction velocity mean values after treatment compared to that before treatment within groups (A) and (B) (*p*=.000) as shown in table (5) and figure (3).

Motor distal latency

There was no significant difference between group A and group B regarding motor distal latency mean values neither before (4.33±.45and 4.36±.53 respectively) nor after treatment (3.97±.47 and 4.13±.51 respectively) (*p*=.88 and .40 respectively).
On the contrary, the results revealed significant decrease in motor distal latency mean values after treatment compared to that before treatment within groups A and B (p=.001 and .000 respectively) as shown in table (6).

Table 5: Comparison between both groups regarding sensory conduction velocity mean values before and after treatment.

SCV (m/sec)	Group (A)	Group (B)	*P*
Pre	38.27±4.57	37.26±3.69	0.51(NS)
Post	53.53±8.66	48.47±8.95	0.13(NS)
p	0.000**	0.000**	

p<0.05* = significant *p*=0.00** = highly significant *p*>0.05 = Non- significant

Motor conduction velocity

The results revealed no significant difference between group A and group B regarding motor conduction velocity parameters mean values neither before) 57.38±5.14 and 58.72±6.73 respectively) nor after treatment (60.93±10.17 and 60.27±8.74 respectively) (p=.55 and .85 respectively).

Table 6: Comparison between both groups regarding motor distal latency mean values before and after treatment.

MDL (ms)	Group (A)	Group (B)	*P*
Pre	4.33±.45	4.36±.53	.88 (NS)
Post	3.97±.47	4.13±.51	.40 (NS)
p	.001**	.000**	

p<0.05* = significant. p=0.00**= highly significant. p>0.05 = Non -significant.

Also, the findings revealed no significant differences regarding motor conduction velocity mean values after treatment compared to that before treatment within groups A and B (p=.10 and .28 respectively) as shown in table (7) and figure (4).

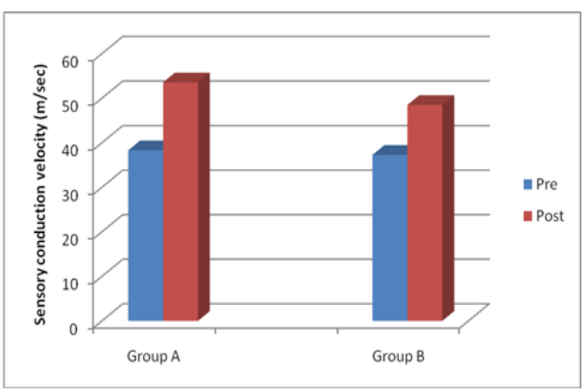

Figure. 3: Mean values of sensory conduction velocity in groups (A) and (B) before and after treatment.

Table 7: Comparison between both groups regarding motor conduction velocity mean values before and after treatment.

MCV (m/sec)	Group (A)	Group (B)	*p*
Pre	57.38±5.14	58.72±6.73	.55 (NS)
Post	60.93±10.17	60.27 ±8.7	.85 (NS)
p	.10 (NS)	.28 (NS)	

NS=Non -significant

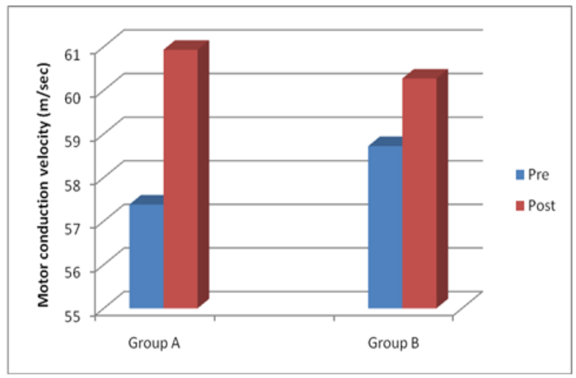

Figure 4: Mean values of motor conduction velocity in groups (A) and (B) before and after treatment.

DISCUSSION

The aim of the present work study was to compare between the effectiveness of NM and CBM in reducing pain, improving nerve conduction and grip strength and consequently improving the quality of life of CTS patients. In the current study, females only were included as women are affected up to three times more often than men (Atroshi, et a.,l 2011).

The results demonstrated no significant difference in the age between groups (A) and (B). Additionally, there were no significant differences in the score of VAS, nerve conduction study and hand grip strength between both groups before treatment. This indicates that the selection of the patients in both groups was homogenous and this facilitated the comparison between them.

As the results revealed, both groups showed improvement in pain and hand grip strength. Also, there was a significant improvement in the sensory and motor distal latencies and sensory conduction velocity after intervention. This indicated an effectiveness of both treatment methods (NM and CBM) in favor to neural mobilization as indicated by the improvement of hand grip strength in NM group more than CBM group.

The results of present study were in agreement with previous study conducted by Tal-Akabi and Rushton (2000) who studied the effects of two manual therapy techniques, CBM and median NM in patients with CTS. They found a significant improvement in VAS and wrist range of motion scores within each group when compared with the control one. However, no statistically significant difference was observed between CBM and median NM.

Another study done by Vikranth et al., (2015) was carried out to compare between the effectiveness of CBM and NM. The duration of intervention was only two weeks, five times per week. The researchers concluded that median NM and CBM were also effective in improving pain, functional status and symptom severity in the treatment of CTS patients. However there was no significant difference in improvements obtained between the NM and CBM.

Regarding neural mobilization, the results of present study were in agreement with those studies conducted by Pinar et al (2005) and Akalin et al (2002) who reported improved grip and pinch strength, significant reduction of pain and improved Phalen's and Tinel's signs after tendon and nerve gliding in patients with CTS.

Also, Baysal et al., (2006) found an improvement in sensory distal latency that remained four to eight weeks as follow up after nerve and tendon gliding exercises in CTS patients.This finding was considered the most objective measure supporting the beneficial effects of the neurodynamic approach.

Additionally, the positive findings of the current research were supported by a research done by Bialosky et al., (2009) which included 40 CTS females treated with neurodynamic mobilization technique for three weeks. They reported greater and faster pain relief and improvement of functions such as grip strength in addition to reduction of temporal summation, suggesting the potential of a favorable neurophysiological effect.

In the same line, Goyal et al., (2016) investigated the effect of NM on the motor nerve conduction velocity and function in CTS patients. They found significant improvement in latency and velocity of the median nerve, in addition to reduction of pain and improvement of functional status after treatment. Also, other authors performed median nerve mobilization for CTS patients and reported that it reduces pressure in carpal tunnel, improves conduction velocity, grip strength, and alleviated pain Ha et al., (2012).

Improvement in neural mobilization group may be explained by studies conducted on human and animals which revealed that NM reduced intraneural edema (Schmid et al., 2012), improved intraneural fluid dispersion (Gilbert et al., 2015) and reduced hyperalgesia (thermal and mechanical) (Song et al., 2006) thus promoting optimum physiologic function. Also, previous study has investigated the effects of nervous system mobilization on nerve entrapment problems reporting that NM was helpful in improving axonal transport and improved nerve conduction (Michelle and Toni, 2008).

Regarding carpal bone mobilization, the results of current study came in agreement with a study conducted by Gunay and Alp (2015) who studied the efficacy of carpal bone mobilization in combination with wrist splint compared to wrist splint. Group of intervention received CBM three times a week, total of 10 times, and used neutral volar wrist splint at night for three weeks. The study showed significant improvement in function, strength, symptom severity, sensory distal latency, and amplitude of the intervention group at the end of study and after three months.

Moreover, the results of present study are in agreement with a study conducted by Dinarvand et al., (2017) which involved 18 females with mild and moderate CTS treated by scaphoid and hamate bone mobilization in combination with wrist splint. They found improved pain, symptom severity and functional status as well as median nerve conduction study in both mobilization and control groups after eight weeks of treatment. Although there was no significant difference between the groups regarding median nerve sensory and motor distal latency, the improvement was higher for pain and symptom severity as well as functional status in mobilization group.

CONCLUSION

It was concluded that both median nerve and carpal bone mobilizations were effective in improving signs and symptoms of CTS in favor to neural mobilization.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT
Great thanks for all the participants of the study.

AUTHOR CONTRIBUTIONS

FS carried out the clinical practice of the study, collected data and contributed in writing the paper.EE designed the study frame work, contributed in the writing process and editing, contributed in analyzing and presenting data.

YE revised the manuscript and contributed in data interpretation AE diagnosed the patients and contributed in the study general design

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