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Effect of spinal mobilization with arm movements on kinesthetic awareness in patient with chronic cervical radiculopathy: Randomized controlled trial

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Abstract

Background. Cervical radiculopathy (CR) is known as a severe neuromusculoskeletal condition which causes pain and physical disorders that both impair employment and quality of life. Spinal mobilization with arm movements (SMWAMs) is one of the methods in Mulligan's techniques while residual discomfort is assumed to originate from the spine. Objective. This study aimed to assess the effect of SMWAMs on cervical proprioception and functional abilities in patient with cervical radiculopathy. Methods. Forty subjects of both sexes with chronic unilateral CR participated in the study, they were randomly assigned into two equal groups, Group A (experimental group): received SMWAMs in addition to a guide line protocol, group B (control group): received the guide line protocol, over four consecutive weeks, all subjects received 12 sessions. Outcome assessments included cervical proprioception using the cervical range of motion (CROM) and functional abilities using the cervical disability index (NDI) were assessed at baseline and 4 weeks' post-intervention. Results. There was a statistical significant improvement in the experimental and control groups 4 weeks post-treatment for cervical proprioception and functional performance ($p < 0.05$). Concerning groups there was a significant difference between both groups regarding all measured variables in favor to the experimental group ($p < 0.05$). Conclusion. SMWAMs provides an additional effect in the management of chronic Cervical radiculopathy patients as it proprioception and functional performance.

Key words:

Cervical radiculopathy, Cervical proprioception, functional abilities, Mulligan, Spinal mobilization with arm movement

摘要

关键词：

Introduction

Cervical radiculopathy (CR) represents pain on either or both upper extremities, associated with neck pain, which is secondary to neural compression or irritation in the cervical spinal cord [1], triggering pain, limiting functional abilities and leading to a considerable reduction in quality of life [2]. Pain, numbness and/or tingling symptoms may be mild, but motor weakness is associated with cervical radiculopathy in serious cases; cervical joint dysfunction may hinder the sensorimotor response that may impair the proprioception of the neck [3]. 1 out of every 1000 individuals suffers from cervical radiculopathy, CR commonly affects middle-aged to elderly individuals [3, 4]; mainly triggering C7 and C6 nerve root [4]. United States study in 2013 revealed that neck associated pain and radicular pain were accounted to spend USD $87.6 billion per year, as 10.2 million visits were the reported average of clinical visits to health care facilities leading to more sick leave which has a negative impact on the productivity [5].

Mulligan Technique or mobilization with movements (MWMs) is considered a new era of manual therapy techniques employed by the physiotherapists in treating patients with CR. The use of the Mulligan concept in the context of other therapeutic procedures such as neural mobilization seems to be an effective option in treating patients, resulting in immediately range of motion and pain refinements [6, 7]. Spinal mobilization with arm movements (SMWAMs) can give a better result rather than a single treatment procedure, reducing the nerve mechanosensitivity, restoring function and treating the patient's manifestation [8, 9]. SMWAMs procedure is used when the residual discomfort or sense of tingling is assumed to be redirected from the affected cervical spine, mobilization should be sustained in conjunction with extremity motion [10].

During the last few decades several studies have investigated the connection between proprioceptive deficits and cervical problems, and it was found that the people with cervical problem have limited either active or passive cervical range of motion, decreased movement speed and affected accuracy of head repositioning with disturbance in the information of cervical proprioception [11]. Consequently, these limited cervical motions impair the quality of the neck joint position sense (JPS) when compared with normal ones without neck disabilities [12]; JPS is the ability of a person to replicate and interpret the predetermined location or range of motion of a specific joint and this is a key part of proprioception measures [13].

Aim

The aim of the proprioception is to sensitize position and kinesthesia; and kinesthesia and to control posture and movements with the sensorimotor function [14]. Following successful active head movements, the ability to reposition the head in a neutral position was used to determine implicitly loss in sensorimotor control arising from the neck; Larger than normal head repositioning accuracy (HRA) have been recorded for people suffering from cervical dysfunctions [13-15].

Even though varied procedures were suggested to show promising clinical results for Mobilization with Movements (MWMs), maximizing neck movements and decreasing neck pain; there is a paucity of evidence assessing the neurophysiological effects of SMWAM on CR, all the researches were directed toward the mechanical impact and pain management of MWM techniques [5,7-10], although it was stated that kinaesthetic awareness is totally affected with CR [11], there is no previous that studied the effect of SMWAM on it before, and thus, the aim of the current study was to compare SMWAM and the conventional physical therapy programme with respect to cervical proprioception measuring HRA, and functional abilities in patients with CR.

Materials and Methods

Trial design

A randomized controlled trial was held on the outpatient clinic faculty of Physical Therapy, Cairo University, during the period of twelve months from April 2017 to April 2018. The research protocol was registered at the Pan African Clinical Trial Registry (RegistryIDPACTR201611001851413) and approved by the research ethical committee of the school of physical therapy (NO: P.T.REC/012/001472).

Participants

This study was attended by 40 subjects (33 females and 7 males). Their ages ranged between 31 to 55 years old (mean age of 46.23 ± 6.85 years), their height varied from 1.44 to 1.73 m (mean height of 1.6 ± 0.065 m), their weight ranged from 67.5 to 110 kg (mean weight of 83.11 ± 10.54 kg) and their body mass index (BMI) varied between 25.15 to 40.99 kg/m² (mean BMI of 32.42 ± 3.81 kg/m²). This study included patients who fulfilled the following criteria: a) presence of pathological spinal lesion (C5-C6 and/ or C6-C7) confirmed by MRI, b) lateral arm and forearm pain that persists for more than three months, c) a positive result for a total of 3 out of the following tests (1- cervical distraction test, 2- upper limb tension test (ULTT), 3- Spurling test, and 4- ipsilateral cervical rotation reduced by more than 60°) [16].

The medical records were reviewed and patients were ruled out if they took part in another procedure or operation within 3 months before the experiment; any related upper cervical or upper limb diseases, such as referred costotransversal joint pain, rotator cuff tendonitis, cervical rib syndrome, and entrapment neuropathy, which may cause inconsistency with clinical results [17].

The study was informed by the participants both orally and in writing, and according to Helsinki law, the participants were informed. The agreeing subjects were randomly assigned in two equal-number groups.

Randomization

The randomization took place by another person using a random generator and permuted blocks of the same size. Group (A) study group: 20 subjects were included in this group receiving a guide line protocol combined with SMWAMs. Group (B) control group: 20 subjects were included in this group receiving a guide line protocol. The pro-

gram has been run for four consecutive weeks for three sessions per week. HRA using CROM and functional abilities using NDI were assessed before starting and after the end of the treatment sessions. A flowchart demonstrates the assignment of participants into groups (Figure 1).

Interventions

The guide line protocol was given to both groups (study and control), including hot pad for 20 minutes over the patient's neck, myofascial release, ROM, stretching and strengthening of neck muscles [18-20].

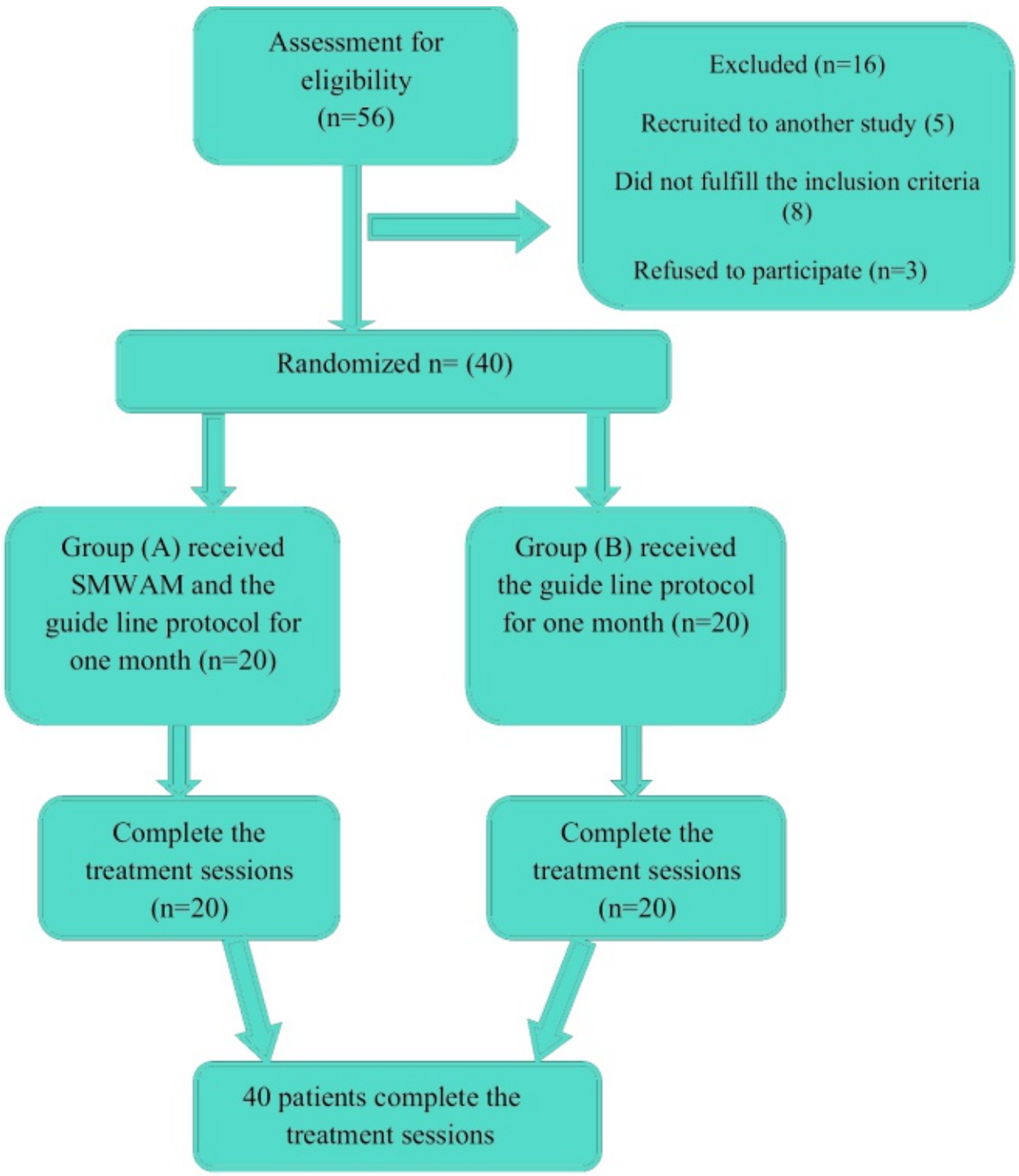

Figure 1. Flow chart of the study

The study group received a guide line protocol in conjunction with SMWAMs, utilized according to the Mulligan principal by Wayne et al. [8]. The patient was seated on a chair facing away from the therapist, transverse glide over the vertebras above and below the affected nerve root point was applied. The glide over the upward vertebra was moved away from the pain path, while the below vertebra glide was shifted in the same direction as the pain. During mobilisation, the patient was

instructed to move the upper limb in a neuro-dynamic movement actively within a painless range and return to the neutral. In the first session only three repeats were done, and in the subsequent sessions only 3 to 5 sets of 6 to 10 repetitions were expanded only if residual pain constraints were not present [8].

Outcome measures

Proprioception measure

The main outcome measure was neck joint positional sense (JPS) and HRA as a measure of cervical proprioception and kinesthetic awareness using cervical range of motion CROM device according to a proceeding protocol by Loudon et al. [21]; Participants putting on light fabric with no accessories were seated in a low back support chair with their hand on their thigh, the knees were 90° flexed and the feet were supported on the ground or support if the legs were short, following a cervical movement, the blindfolded subjects move their heads correctly with respect to the predefined target (often the neutral location of the head, and the mid-range). This test was applied 3 times in all cervical directions and the mean of the degree's variations was registered either in the neutral position or the mid-range to assess the proprioception error [2, 21, 22].

Cervical Disability Index (NDI)

The secondary outcome was to measure the level of functional abilities using neck disability index NDI, the 10-items questionnaire includes questions of the daily living activities; the numerical answer of each element is ranged from 0 (completely able) to 5 (completely disable) and these answers are added to a total score of 0 to 50 points [23].

Statistical analysis

The test of normality in Shapiro-Wilk test of data revealed normal distribution in patient's physical characteristics, functional abilities and abnormal data distribution in proprioception; (SPSS version 23) (IBM Corp, New York, United States) was used in the results analysis, physical characteristics between both groups were measured using descriptive statistics (mean and standard deviation). Paired and un paired t-test were used to compare the values of NDI within and between the tested groups. Wilcoxon signed ranks test and Mann-Whitney test were used to compare within and between both groups for cervical proprioception variables. The level of significance was set at $P \leq 0.05$.

Results

Comparing the general characteristics of the subjects between both groups revealed that there were no statistical significant differences in the mean age, body mass, height and BMI ($P > 0.05$) (Table 1).

Table 1. Descriptive statistics of the physical characteristics of both groups

Variables	Group (A) study group (Mean ± SD)	Group (B) control group (Mean ± SD)	t	P
Age [years]	46.6 ± 6.4	45.48 ± 7.4	0.342	0.734
Body mass [kg]	81.8 ± 11.55	84.4 ± 9.5	0.768	0.447
Height [cm]	161.1 ± 6.5	160 ± 6.6	0.505	0.617
BMI	31.85 ± 4.1	32.98 ± 3.47	0.932	0.357

Data are expressed as the mean ± SD, t: t-value, P-value: probability value.

The NDI showed a statistically significant reduction within both groups ($P < 0.05$). Also, the post-treatment comparison of both groups revealed a statistically significant reduction in NDI ($P < 0.05$) in favour of group (A) (Table 2).

Table 2. Mean values of NDI in the "pre" and "post" tests of both groups

NDI	Pre treatment	Post treatment	Mean differences	alue	% of changes	anges
Group A	22.35 ± 3.36	7.1 ± 2.382	15.25	(68.23%)	21.248	0.000*
Group B	21.3 ± 4.105	11.55 ± 4.211	9.75	(45.77%)	14.503	0.000*
Mean differences	1.05	-4.45				
t value	0.885	4.113				
p value	0.382	0.000*				

Data are expressed as the mean ± SD, t: t-value, P-value: probability value, NDI: neck disability index

Table 3 represents the median and significance values of proprioception error at zero point in the "pre" and "post" tests of both groups in all cervical range of movement, Wilcoxon signed ranks test showed a statistical significant difference between pre and post treatment in both groups as ($P < 0.05$). Between the group comparisons, Mann-Whitney test revealed significant differences between the two groups as ($P < 0.05$).

Table 3. Median values of proprioception error at zero point in the "pre" and "post" tests of both groups

	Median and IQR				Pre versus Post treatment		Group (A) versus Group (B)	
	Experimental group (A)		Control group (B)					
	Pre-treatment	Post treatment	Pre-treatment	Post-treatment	Group (A)	Group (B)	Pre-treatment	Post-treatment
Flexion	4 (2)	1 (1)	5 (3)	3 (1)	Z = 3.738 P = 0.000*	Z = 3.773 P = 0.000*	Z = 0.413 P = 0.679	Z = 3.27 P = 0.001*
Extension	4 (1.75)	2 (1)	3.5 (3)	3 (1.75)	Z = 3.843 P = 0.000*	Z = 3.687 P = 0.000*	Z = 0.511 P = 0.609	Z = 2.932 P = 0.003*
Right side bending	3.5 (2)	1 (1)	3 (2)	2 (1)	Z = 3.871 P = 0.000*	Z = 3.455 P = 0.001*	Z = 1.055 P = 0.291	Z = 2.301 P = 0.021*
Left side bend	3 (1)	1 (0)	3 (2)	2 (2)	Z = 3.811 P = 0.000*	Z = 3.221 P = 0.001*	Z = 0.26 P = 0.795	Z = 2.811 P = 0.005*
Right rotation	3 (1)	1 (0)	3 (1.75)	1 (2)	Z = 3.852 P = 0.000*	Z = 3.656 P = 0.000*	Z = 0.622 P = 0.534	Z = 2.802 P = 0.005*
Left rotation	3 (1.75)	1 (0.75)	3 (2)	3 (1.75)	Z = 3.867 P = 0.000*	Z = 3.472 P = 0.001*	Z = 0.486 P = 0.627	Z = 3.085 P = 0.002*

Data are expressed as the median (IQR), Z: Z-value, P-value: probability value, IQR: Interquartile range

Table 4 represents the median and significance values of proprioception error at mid-range in the "pre" and "post" tests of both groups all cervical range of movement, Wilcoxon signed ranks test showed a statistical significant difference between pre and post treatment in both groups as ($P < 0.05$). Between the group comparisons, Mann-Whitney test revealed significant differences between the two groups as ($P < 0.05$).

Table 4. Median values of proprioception error at mid-range in the "pre" and "post" tests of both groups

	Median and IQR				Pre versus Post treatment		Group (A) versus Group (B)	
	Experimental group (A)		Control group (B)					
	Pre-treatment	Post treatment	Pre-treatment	Post-treatment	Group (A)	Group (B)	Pre-treatment	Post-treatment
Flexion	4 (3)	1.5 (1.75)	4.5 (3)	3 (1.75)	Z = 3.879 P = 0.000*	Z = 3.267 P = 0.001*	Z = 0.434 P = 0.664	Z = 2.882 P = 0.004*
Extension	4 (3)	1 (1)	5 (2.75)	2.5 (1.75)	Z = 3.841 P = 0.000*	Z = 3.878 P = 0.000*	Z = 0.206 P = 0.837	Z = 2.267 P = 0.023*
Right side bending	4 (1)	1 (1)	3.5 (2.75)	2 (1.75)	Z = 3.765 P = 0.000*	Z = 3.489 P = 0.000*	Z = 0.264 P = 0.792	Z = 2.945 P = 0.003*
Left side bend	3 (0.75)	1 (0)	3 (1)	2 (1)	Z = 3.744 P = 0.000*	Z = 4.011 P = 0.000*	Z = 1.309 P = 0.191	Z = 2.828 P = 0.005*
Right rotation	3 (2)	1 (1)	3 (2.75)	2.5 (2)	Z = 3.951 P = 0.000*	Z = 3.888 P = 0.000*	Z = 0.654 P = 0.513	Z = 2.871 P = 0.004*
Left rotation	3 (2)	1 (1)	3 (2)	2.5 (2)	Z = 3.872 P = 0.000*	Z = 3.446 P = 0.001*	Z = 0.142 P = 0.887	Z = 2.816 P = 0.005*

Data are expressed as the median (IQR), Z: Z-value, P-value: probability value, IQR: Interquartile range

Discussion

The primary objective of the current study was to compare the effectiveness of SMWAM and the conventional physical therapy programme with respect to cervical proprioception measuring HRA, and functional abilities in patients with CR. However, the results of this study revealed that all assessed variables were improved in both groups and SMWAMs benefited more than the control procedure.

Regarding the proprioception results; the current study is considered to be a Premier research to investigate the influence of SMWAMs on cervical proprioception in patient with CR, the possible explanation of the changes provided by SMWAMs could be related to the original theory by Mulligan based on the model of mechanical dysfunction and positional faults realignments [24], the impact of maltracking correction, as several studies concluded that the cervical joint dysfunction impedes the sensorimotors afferents and cervical Joint Position Sense (JPS) error, causing changes in the pattern of the afferent responses to the higher centers in the brain, which affecting the motor control and somatosensory response [2, 25, 26].

The restoration of natural mechanisms for the nervous system can also be the justification for the possible explanation of those findings, since the spinal impairment may change the balance of afferent input into the CNS so that this distorted adjuvant input could, with time, lead to possible maladaptive neural plastics modifications in the CNS; several researches have fallen into line with the overall concept of the current study that is alternation afferent knowledge contributes to neural and functional plastic transition [26]. Few earlier studies have shown the positive effect of SMWAMs on pain and ROM in people suffering from cervical problems [10, 27].

Furthermore, the augmented ROM and muscle functions also have a significant impact on the proprioception awareness; as the restrictions on neck movement can, on the other hand, impact neck JPS efficiency and the motor control of the head and cervical muscles [11, 28]. Also it was demonstrated that the pain in cervical spondylosis subjects could also cause altered proprioception, so that pain management may produce improvements in the muscle spindle activities and the brainstem neurons proprioceptive properties [28].

Concerning to the functional abilities, the results of the current study were consistent with Sreenivasu et al. [27] who demonstrated that both SMWAMs and McKenzie exercises with neural mobilization had a positive impact on pain and functional abilities in cervical radiculopathy subjects. Also, Jasmita and Ajit, [10] indicated that SMWAMs was more effective than a conventional exercise program, in the management of pain, disability, improvement of functional ability and cervical ROM. Additionally, the finding of this study came in agreement with Khan et al. [29] who reported that MWM along with neural mobilization improved the pain and functional performance better than MWM alone.

Furthermore, the current results are in harmonious with Sudarshan, [30] who reported immediate refinements in cervical ROM, pain and functional abilities following a simultaneous integration of sustained natural apophyseal glide and neurodynamic mobilization to 47- years old case report and these results were preserved to a four-month follow-up period. The mechanism by which SMWAM improves the functional abilities was proposed due to improving ROM which permits wider range of activities; also reducing the perception of pain positively affects the quality of life allowing painless daily activities [27].

Limitations

The major limitation of this study was the lack of blindness by the assessor; efforts were made to standardize diagnostic and evaluational procedures to minimize any possible bias caused by lack of blindness. Further studies are needed to investigate long-term effects, the ongoing results of SMWAMs on CR should be studied taking into account the researchers and patients blinding.

Conclusion

With regards to this research, SMWAMs have an added effect on chronic CR patients' treatment, as it improves proprioceptive awareness and functional abilities.

Clinical relevance for physiotherapy practice

SMWAMs seem to complement physical therapy services with CR care successfully, because the reversal of small place defects in the impaired spines not only increases the pain and ROM, but also the neurophyological activity of the nerve is affected greatly which improves the kinesthetic awareness the level of functional abilities.

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