Effect of SNAGS Mulligan Technique on Chronic Cervical Radiculopathy: A Randomized Clinical Trial

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Abstract

**Background:** Cervical radiculopathy is a disease of pain and/or sensorimotor deficits due to compression of a cervical nerve root and it can be a debilitating disease that is manifested with significant impairment.

**Purpose:** The purpose of this study was to investigate the effect of sustained natural accessory apophyseal glides on dermatomal somatosensory evoked potential in chronic cervical radiculopathy patients.

**Design:** Randomized controlled clinical trial.

**Material and Methods:** Fifty patients of both genders with unilateral cervical radiculopathy at level of C5/C6 and/or C6/C7, in chronic stage, and BMI ranged from 25 to 30 kg/m². Their ages ranged from 40 to 55 years old were recruited from Abo-Queir Health Insurance Association Hospital North West Delta Branch. Patients were randomly distributed by flipping a coin into two groups; control group (A) received conventional physical therapy program and study group (B) received the same conventional physical therapy program in addition to sustained natural accessory apophyseal glides (mulligan technique). Each group received the program three sessions/week for four weeks. Patients were evaluated for their dermatomal somatosensory evoked potential (latency and amplitude) by computerized electromyography before and after treatment period (four weeks) of administration of program.

**Results:** 2 X 2 mixed design MANOVA revealed that there was significant decrease of dermatomal somatosensory evoked potential latency and increase amplitude in group B compared with group A ($p<0.05$).

**Conclusion:** Mulligan technique provides an additional effect in treatment of chronic cervical radiculopathy patients as it improves dermatomal somatosensory evoked potential than conventional physical therapy program alone.

**Clinical Rehabilitation Impact:** This finding may help physiotherapists in designing a more effective rehabilitation program for patients suffering from chronic cervical radiculopathy.

**Key Words:** Sustained natural accessory apophyseal glides – Dermatomal somatosensory evoked potential – Cervical radiculopathy.

Introduction

CERVICAL radiculopathy is a neurologic condition characterized by dysfunction of a cervical spinal nerve, the roots of the nerve or both. Radiculopathy usually presents with pain in the neck and one arm, with a combination of sensory loss, loss of motor function, or reflex changes in the affected nerve-root distribution [1]. The most common cause of cervical radiculopathy in 70 to 75 percent of cases is foraminal encroachment of the spinal nerve due to a combination of factors, including decreased disc height and degenerative changes of the intervertebral joints anteriorly and zygapophyseal joints posteriorly. It is generally agreed that involvement of the C6 and C7 nerve roots secondary to lesion of the C5/C6 and C6/C7 vertebra are the most common. Cervical disc herniation and cervical spondylosis have been attributed as the main causes of cervical radiculopathy [2]. Mulligan concept includes the mobilization of the spine whilst the spine is in a weight bearing position and directing the mobilization parallel to the spinal facet planes. Mulligan has described some techniques for mobilizing cervical spine but based on a pilot study and improvement in cervical lesion resulting in pain and other signs below elbow. There is paucity and clinical observation of research evidence supporting its efficacy and are dominated by case report publication [3].

Mulligan techniques are used for both an increase in range of motion and the relief of pain, by joint mobilization. Mulligan techniques claim to improve the signs and symptoms. The use of
manual therapy highlights the value of movement in maintaining health and strength of collagenous, muscular and bony tissue. Mulligan’s principle techniques are natural apophyseal accessory glides (NAGS) and sustained natural apophyseal accessory glides (SNAGS). In SNAGS the patient attempts to actively move a painful or stiff joint through its range of motion whilst the therapist overlays an accessory glide parallel to the treatment plane [4].

Somatosensory Evoked Potential testing (SSEP) has been successfully utilized in clinical medicine for the past twenty years. Evoked potentials are used to evaluate the functioning of the sensory neural pathways. The validity, reliability and sensitivity of SSEP exams have been well documented [5]. These tests are often used in the operating room to monitor the functional integrity of the neurological pathways during surgical procedure and to determine the effectiveness of the surgical procedure [6].

The Dermatomal Somatosensory Evoked Potential (DSEP) study is a method for evaluating the abnormality of the somatosensory tract, which extends from the peripheral nerve to the cerebral cortex. In 1947, Dawson first reported the evoked potentials in humans. Since then, it has been reported to be effective in identifying lesions and then determining their locations in various damage sites, such as peripheral neuropathies, radiculopathies, spinal cord injuries, central nervous system disorders, and cerebral damage [7].

Mulligan technique SNAGS is a method of mobilization techniques which takes place in the management of a large numbers of muscle-skeletal disorders and up to our knowledge there was several studies of that investigated effect of Mulligan technique SNAGS on cervical pain but few studies investigated the effect of Mulligan technique SNAGS on the dermalomat somatosensory evoked potential in cervical radiculopathy. So, this study was conducted to investigate the effect of Mulligan’s techniques on DSEP in patients with cervical radiculopathy to substitute its effect on patient symptoms scientifically and objectively.

**Material and Methods**

Fifty patients with cervical radiculopathy, their age range from 40 to 55 years old were recruited from Abo-Queir Health Insurance Association Hospital North West Delta branch in the period between Jun. 2015 and May 2016. Patients signed an informed consent form, approved by the Faculty of Physical Therapy Ethical Committee, to participate voluntarily in the study. After a brief orientation session about the nature of the study, they were randomly assigned to two groups. Study group was consisted of 25 patients (14 females and 11 males) with mean age, body mass, height, and BMI values of 47.8±4.83 years, 169.44±5.76 cm, 77.28±7.54kg, and 26.93±2.44kg/m² respectively. This group received conventional physical therapy program for chronic cervical radiculopathy in addition to Mulligan technique SNAGs.

All participants were referred from the same orthopedic surgeon who was informed of patient inclusion and exclusion criteria. Patients were included in the study if they were diagnosed as unilateral cervical radiculopathy at level of C5/C6 and/or C6/C7, in chronic stage, and BMI ranged from 25 to 30kg/m². Prior to the study patients were excluded if they have spinal canal stenosis, rheumatoid arthritis, vestibular insufficiency, medical “red flags” eg. tumor, fracture, myelopathy, osteoporosis, underwent to any cervical spine operations, peripheral neuropathy, ligaments laxity, any contra indications to manual therapy.

**Study design and randomization:**

The study was designed as a prospective randomized clinical trial in which patients were assigned randomly into two groups. Randomization was used to eliminate the researches’ bias and was carried out by a blinded and an independent research assistant who used flipping a coin method to assigned the patient randomly.

**Instrumentations:**

EMG was used to measure amplitude in micro volt and latency in mille seconds of dermatomal evoked potential latency and amplitude of DSSEP were recorded before treatment and after four weeks of treatment. DSSEP involve recording cerebral evoked responses from cutaneous stimulation of areas of known dermatomal innervation providing a pure sensory input to any level of the spinal cord [8].

**Assessment procedures:**

Careful attention was paid to cleaning and scarifying the skin before the attachment of the recording electrodes in the scalp. The hair was separated and the skin in between was thoroughly cleaned by methylated alcohol and sand paper was used to gently abrade the skin sites by removing several superficial layers of the skin and skin oils. It was generally accepted that abrasion is considered sufficient when the impedance measured across two such electrode preparation sites is between 1,000 and 5,000Ω.
Four standard landmarks are required to locate all positions necessary for DSSEPs. The nasion (bridge of the nose) and inion (posterior bony protuberance over the inferior aspect of the occiput) are two anatomic landmarks along the skull's mid sagittal plane. Those regions where the ears attach to skull just anterior to tragus form the second pair of landmarks in the frontal plane. The point at which the line extending between the two ears cross the previously defined mid-point of the sagittal line joining the nasion and inion designates the vertex of the skull constitute an electrode site called the CZ. Ten percent of the total distance between the nasion and inion, superior to nasion, constitutes and electrode site called Fpz. Twenty percent of total distance between the above two sites, nasion and inion, from CZ toward the nasion designates the 2 inches recording site C3, C4. The cortical responses were amplified, averaged and displayed using an analysis time of 150ms. Filter setting of 2Hz to 10KHz was utilized. Surface electrodes secured to the patients by filling the cub aspect of the electrode by an electrolyte paste, and then it was firmly pressed against the prepared skin. Changes in the latency and/or amplitude of the response can indicate dysfunction in the neural pathway being monitored.

The site of stimulation for C6 was about 7cm above the styloid process of the radius and for C7 between the second and third metacarpal bones. A bipolar electrode was used for stimulation with inter electrode distance of 2.5cm with the stimulation cathode placed proximally. The sensory threshold for electrical stimulation was determined by increasing the intensity of electrical current until the patient reported its sensation as tolerable and painless stimulus intensity was usually set at 2.5 times above this level. Recording was done with 9mm diameter tin/lead electrodes affixed with cream to abraded skin. The recording electrodes were placed at C3 and C4, while the reference electrode was placed at Fz and the ground electrode at Fpz.

Treatment procedures:

Both groups (control and study) received conventional physical therapy program for neck pain which include (hot pack, TENS, stretching and strengthening exercises for cervical spine) three times per week for one month [9] while the study group additionally to the traditional physical therapy program received Mulligan technique SNAGS. Electric hot pack was placed over the neck and upper part of shoulders musculature. This was being applied for ten min. Transcutaneous 2 channel Electrical Nerve Stimulation (TENS) was used with pulse width 100-150, pulse rate 60-100hz, and output adjust to the most comfortable intensity level. Patients were seated on chair during session. Two electrodes paraspinale on upper fibers of trapezius of the affected side and the other two electrodes on dermatome according of the affected level of spine C5/6 and/or C6/C7 were used. Patients received 30 minutes per session for three sessions per week for four weeks [10].

Stretching exercises for neck muscles:

Upper trapezius muscles stretching: The patient sat on a stool in an erect position. The therapist stood behind the patient with one hand on the patient's shoulder for stabilization, while the other was on the side of the patient's head. The stretching was applied by moving the head in side bending with holding for 30 seconds and rest for 30 seconds and repeated three times to both sides.

Stretching exercises for neck rotators: The patient was seated on a stool. The therapist stood behind the patient with one hand on patient's shoulder while the other on head laterally.

Stretching exercise was applied by application of passive full neck rotation toward right and left directions as much as possible but within limit of pain. The patient was asked to hold for 30 seconds, rest for 30 seconds and repeated three times.

Isometric strengthening exercises for neck muscles (the exercise was repeated for ten repetitions per session).

Isometric strengthening exercises for neck extensors: The patient sits on a stool in an erect position. The therapist stands behind the patient with one hand on the patient's shoulder, while the other on the occipit. The patient asked to push the therapist hand, while the therapist resisted the movement, so there was no neck movement.

Isometric strengthening exercises for neck rotators: The patient sat on a stool in an erect position. The therapist stands behind the patient with one hand on the patient's shoulder, while the other was on the side of the head. The patient asked to push the therapist hand backwards and try to rotate the head to right and left, while the therapist resisted the movement without neck movement.

Isometric strengthening exercises for neck side bending muscles: The patient sits on a stool in an erect position. The therapist stands behind the patient with one hand on the patient's shoulder, while the other was on the occipit. The patient asked to push the therapist hand and try to side
bend the neck to right and left, while the therapist resisted the movement without neck movement.

**Mulligan technique SNAGS for rotation:**

A pilot study was conducted on five patients and revealed that rotation Mulligan technique SNAGS was more effective than extension, flexion and side bending Mulligan techniques SNAGs. So in the current study rotation Mulligan technique for C5/C6 and/or C6/C7 was conducted accordingly.

The patient seated comfortably on a stool. The therapist stood behind the patient and the medial border of one thumb's distal phalanx is placed on the articular pillar on the chosen side of the suspected site of lesion. The thumb nail slope at approximately 45 degree in the direction of the patient's eyeball. Therapist's other thumb reinforced this. This means if the patient has lesion at cervical C5/C6 so the therapist's thumb was on the cervical 5th articular pillar. However when “SNAGGING” on the right, the right thumb placed on the right pillar and push up with the left. When “Snagging” on the left the left thumb would be on the left pillar [3].

The therapist's other fingers comfortably placed laterally on each side of the neck or upper anterolateral thorax to prevent the neck from flexing. While the facet is being maintained, the patient was asked to turn his head slowly in the restricted painful direction. As the head rotates, the therapist follow with his hands to ensure that the mobilization take place with the movement then get the patient to apply sustained overpressure for few seconds at approximately 45 degree in the direction of the eyeball. Mobilizations was repeated six times and the movements was reassessed [4]. Finally, a home program is performed between treatment sessions utilizing the SNAGS principles and a towel to impart the glide component to maintain gains achieved during treatment.

**Statistical analysis:**

Statistical analysis was conducted using SPSS for windows, Version 18 (SPSS, Inc., Chicago, IL). The current test involved two independent variables. The first one was the (tested group); between subject factors which had two levels (control group received conventional physical therapy program for chronic cervical radiculopathy and study group received the same conventional physical therapy program in addition to SNAGS Mulligan technique; the second one was the (measuring periods); within subject factor which had two levels (pre, post). In addition, this test involved two tested dependent variables (DSEP latency and DSEP amplitude). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference.

Descriptive analysis using histograms with the normal distribution curve showed that DSEP latency and amplitude was normally distributed and not violates the parametric assumption for the measured dependent variable. Additionally, testing for the homogeneity of covariance revealed that there was no significant difference with \( p \)-values of >0.05. The box and whiskers plots of the tested variable were done. Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed for DSEP latency and DSEP amplitude. All these findings allowed the researchers to conduct parametric analysis. So, 2 X 2 mixed design MANOVA was used to compare the tested variables of interest at different tested groups and measuring periods. With the initial alpha level set at 0.05.

**Results**

**Baseline and demographic data:**

There were no statistically significant differences \( (p>0.05) \) between subjects in both groups concerning age, body mass, height, and BMI (Table 1).

**DSEP latency and DSEP amplitude:**

Statistical analysis revealed that there were significant within subject effect \( (F=113.996, \ p=0.0001) \) and treatment* time effect \( (F=45.979, \ p=0.0001) \) but there were no significant between subject effect \( (F=2.569, \ p=0.08) \). Table (2) represents the mean \( \pm \) SD and multiple pairwise comparisons for all dependent variables in both groups in different measuring periods. Multiple pairwise comparison tests revealed that there were significant increase of DSEP amplitude in the post-treatment condition compared with the pre-treatment one in both groups. As well as, there were significant reduction of DSEP latency in the post-treatment condition compared with the pre-treatment one in both groups \( (p<0.05) \).

Regarding between subject effects, multiple pairwise comparisons revealed that there were significant increase \( (p<0.05) \) in DSEP amplitude in the study group compared with control group, with no significant differences in DSEP latency between both groups.
Table (1): Descriptive statistics and unpaired t-tests for the mean age, body mass, height, and BMI of the patients with cervical radiculopathy for both groups.

<table>
<thead>
<tr>
<th>Items</th>
<th>Study group mean ± SD</th>
<th>Control group mean ± SD</th>
<th>Comparison t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>47.8±4.83</td>
<td>47.52±5.5</td>
<td>0.191</td>
<td>0.849</td>
</tr>
<tr>
<td>Body mass (Kg)</td>
<td>77.28±7.54</td>
<td>73.44±8.5</td>
<td>1.689</td>
<td>0.098</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.44±5.76</td>
<td>167.6±8.66</td>
<td>1.36</td>
<td>0.18</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.93±2.44</td>
<td>26.27±2.06</td>
<td>1.023</td>
<td>0.311</td>
</tr>
</tbody>
</table>

*: Significant level with alpha level <0.05. Kg: Kilogram. SD: Standard Deviation. Cm: Centimeter. t-value: Calculated t. kg/m²: Kilogram per meter square. p-value: Probability value.

Table (2): Descriptive statistics and multiple pairwise comparison tests (post hoc tests) for the DSEP amplitude and DSEP latency in patients with cervical radiculopathy in pre and post exercises for both groups.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Study group</th>
<th>Study group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-treatment</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>DSEP latency (ms)</td>
<td>20.64±1.81</td>
<td>20.22±1.71</td>
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<tr>
<td>DSEP amplitude (microvolt)</td>
<td>1.5±0.7</td>
<td>1.96±0.8</td>
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</table>

Multiple pairwise comparisons between pre and post-treatment values for all dependent variables

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>DSEP latency</th>
<th>DSEP amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>0.008*</td>
<td>0.01*</td>
</tr>
<tr>
<td>Study group</td>
<td>0.0001*</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

Multiple pairwise comparisons between control group and study group for all dependent variables, pre and post-treatment

<table>
<thead>
<tr>
<th>Measuring periods</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSEP latency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control group vs.</td>
<td>0.05</td>
<td>0.155</td>
</tr>
<tr>
<td>study group</td>
<td>0.425</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

*: Significant at the alpha level (p<0.05).

**Discussion**

The present study was designed to investigate the effect of SNAGS Dermatomal Somatosensory Evoked Potential (DSEP) in chronic cervical radiculopathy patients. The finding of this study revealed that statistically significant improvement in somatosensory evoked potential (decreased latency and increased amplitude), after treatment application in both groups and higher improvement in somatosensory evoked potential amplitude in favor to the study group.

Up to our knowledge there was no previous studies assessed the effect of SNAGS on the SEP in cervical radiculopathy patients. There was several studies confirmed the effectiveness of SNAGS on neck pain and improving the neck disability index [3,11,12] and the effectiveness of SNAGS in cervicogenic headache and dezenise [13,14].

The effectiveness of SNAGS accompanied by neurodynamics was studied in a case report. Both technique showed immediate improvements in pain, radiculopathy pain, cervical range of motion and functional abilities. The patient was discharged from physical therapy by the second week after four treatment sessions with complete pain resolution maintained at a four-month follow-up period [15].

Even though application of a SNAG is a popular manual therapy technique, the exact mechanism by which it works is unknown [16]. The rationale for the technique was initially based on a biomechanical explanation where repositioning of the
superior articular facet using a SNAG would cause correction of positional fault, thus resulting in reduced pain and increased ROM in the neck [17]. Furthermore, normal movement in the articular surface is essential for maintaining the mobility of the adjacent nerves where altered biomechanics can affect the nerve’s excursion [18].

Thus, restoration of normal mechanics at the joint interface can normalize the adverse neurodynmics present as a result of restricted joint movement [19,20].

So the improvement in DESP could be attributed to the restoration of normal spinal articular mechanics at the facet joint [21]. The superior and inferior facets in turn form the posterior boundary for the intervertebral foramen, which is one of the interfaces which compress the cervical nerve roots [22]. Mulligan SNAGS mobilization could ameliorate pain by either separating the facet surfaces or releasing the entrapped meniscoid, or by allowing the entrapped meniscoid to return to its intra articular position, or perhaps by stretching adhesions [23]. When cervical SNAGS on the C5/C6 intervertebral joint were combined with right rotation, sympathoexcitatory responses have been achieved in asymptomatic subjects, suggesting that the effect achieved as a result of SNAGS is similar to that of manipulation induced analgesia through a centrally mediated phenomenon [24]. Similar sympathoexcitatory responses have also been achieved when a mobilization with movement was done in the peripheral joints where hypalgesia was found not involving the endogenous opioid system [25,26]. This would have improved the excursion of the nerve root at the interface, thus improving its gliding ability and reducing noxious inflammatory chemical stimuli, neural oedema and hypoxia [27,28]. The exact mechanism by which immediate improvements brought about by SNAGS are unknown and are believed to be intricately complex involving many systems, including sympathoexcitation and non-opioid hypoalgesia [16].

Conclusions:

Sustained natural accessory apophyseal glides (mulligan technique) provides an additional objective and measurable effective in treatment of chronic cervical radiculopathy patients as it improves dermatomal somatosensory evoked potential than conventional physical therapy program alone.

References


15- ANANDKUMAR S.: The effect of sustained natural apophyseal glide (SNAG) combined with neurodynamics


