International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Sustained Natural Apophyseal Glides Effect on Scalenus Anterior Muscles Electromyograph Activity in Subjects with Neck Pain

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ABSTRACT
Background: *Neck pain is one of the most prevalent, disabling, and costly musculoskeletal disorders, affecting individuals across all age groups. Its prevalence is estimated to range between 30% and 50% in the general population, with a higher incidence reported among women. A primary contributing factor to neck pain is the sustained being in incorrect postures over extended periods as forward head posture(FHP).*
Purpose: *The purpose was to investigate the effect of sustained natural apophyseal glides technique on the electromyographic activity of accessory respiratory muscles specifically the scalenus anterior muscles.*
Methods: *Twenty eight subjects were recruited for this research from the Outpatient clinics of Faculty of Physical Therapy, Cairo University. Subjects received 3 sessions per week for one month. Electromyography(EMG) was assessed before and after 4 weeks of study. All participants received three sessions/ week for four weeks.*
Results: *There was significant improvement in electromyography of scalenus anterior muscles and neck pain following treatment.*
Conclusion: *Adding of mulligan SNAGs technique to traditional physical therapy program has a significant effect in improvement of neck pain, function and accessory respiratory muscle function.*
Keywords: *Accessory Respiratory Muscles, Neck Pain, Mulligan SNAGs, Forward Head Posture*

1. INTRODUCTION

Neck pain is a serious condition that significantly affects individuals, their families, communities, healthcare services, and workplaces. Maintaining improper posture like forward head for prolonged periods is a major cause for deep neck flexors weakness due to their lengthening, elevated scapula due to tension in the levator scapula also sternocleidomastoid(SCM), suboccipitalis and upper trapezius (UT) tension, Yang, S., Boudier-Revéret, M., Yi, Y. G., Hong, K. Y., & Chang, M. C. (2023).
Therefore, muscle imbalance around the neck such as shortening, lengthening, excessive tension or weakness can lead to round shoulder posture. This posture is characterized by forward displacement of the shoulders and a slight flexion of upper thoracic spine during sitting, which increase mechanical stress and contributes to the development of chronic neck pain, Lauman, S. T., & Anderson, D. I. (2021).
In addition, FHP is known to have a large influence on respiratory function by weakening the accessory respiratory muscles. Kang, N. Y., Im, S. C., & Kim, K. (2021).
The sternocledomastoid (SCM), scalene muscles, upper trapezius (UT) and pectoralis major (PM) muscles are important accessory respiratory muscles involved in inspiration (Lee, and Chu, 2014), (Legrand et al., 2003) and prolonged forward head weakens these muscles. This type of weakness is a functional weakness or fatigue due to long time being short (tight), tense, hyperactive which could be a reason for decreasing their respiratory function (Lee, and Chu, 2014). Forward head posture has a negative impact on the respiratory functions. This could be caused by morphological changes in the thorax in the form of expansion of the upper chest and narrowing of the lower chest, which restrict lower thoracic expansion or disturb the biomechanics of the thoracic cage with limited respiratory movements of the lower ribs.
The concept of SNAGs is to enhance therapeutic effect by enabling subjects to perform active movements while pain is improved at the lesion site by manual techniques. This is a new concept in the manipulative therapy field, and differs from traditional manipulative therapy by combining the active movements of the patients with additional passive movements performed with the aid of therapists, Keyur M. Patel, Dr. M. Balaganapathy and Hinal M. Patel, (2016).

2. MATERIALS AND METHODS:

It was a prospective, pre-post study. It was authorized by the research ethics committee of Cairo University, Faculty of Physical Therapy on October 9, 2018 (No:P.T.REC/012/002098). The study was also registered at Pan African Clinical Trials Registry (PACTR202005710448178).

Participants:

Twenty eight subjects were recruited for this research from the Outpatient clinics in Faculty of Physical Therapy, Cairo University. Each subject received 3 sessions per week for one month (Kim J. et al., 2018).

Inclusion criteria:

Twenty eight participants their ages between 30 and 50 years old, have forward head posture and non specific neck pain.

Exclusion criteria:

Participants weren't included if they were smokers, had any chest disease, heart failure, neurological disorders affecting respiratory muscles or any muscular dystrophies, previous cervical or thoracic surgeries, unable to rate their pain on numeric pain scale and if they had any musculoskeletal abnormalities like kyphosis , scoloiosis and kyphoscoliosis.

A) Assessment procedures:

1-Numeric rating scale (NRS)

It is used to assess intensity of pain in clinical pain research (Dworkin, 2004) and rank from zero (no pain) to 10 (unbearable pain) (Serlin, 1995).

2-Neck disability index (NDI)

It is a reliable and valid design to assess the effect of neck pain on daily activity of the patients. (Vernon, 1991)

2- EMG measuring system:

EMG measurements device was used for EMG measurements for accessory respiratory muscles specifically (Scalenus anterior muscles)

B) Treatment procedures:

Subjects received convential physical therapy program plus mulligan SNAGs, subjects seated on chairs with back support while a therapist position was behind the subject. The therapist applied a force to the spinous process in the upper side of the fixed joint with the thumb of the right hand and applied a passive gliding exercise continuously, while the left thumb is placed with the right thumb. The gliding exercise of the cervical SNAGs for cervical flexion performed by the subjects actively repeating flexion of their necks and returning back to the neutral position. In addition, cervical SNAGs for extension is conducted by the subjects repeatedly performing extension of their necks and returning back to the neutral position. Here, the application of the passive gliding exercise maintained its direction in the antero-superior direction along the line of the articular surface of the facet joint while flexing the neck and returning back to the neutral position, as well as when extending the neck and returning back to the neutral position repeatedly (Mulligan , 1999). Convential physical therapy program was : two strengthening (deep cervical flexors and shoulder retractors) exercises and two stretching (cervical extensors and pectoral muscles)exercises based on Kendall et al., approach (Kendall , Kendall McCreary and Provance, 1993), an infrared lamp (250 W) was located 50 cm from the patients' neck and applied for 15 minutes. After superficial thermal therapy, transcutaneous electrical nerve stimulation (Uniphy Phyaction 782; Uniphy BV, Son, The Netherlands) at a frequency of 100 Hz (250-microsecond pulses) applied for 20 minutes using two 4 * 6-cm electrodes was placed on both sided of the spinous process of the C7 vertebre (Chiu, Hui-Chan and Chein, 2005), (Gonzalez-Iglesias, Fernandez-de-Las- Penas and Cleland, 2008).

Statistical design and data analysis:

Demographic data of subjects of both groups

Sample size calculation

Sample size calculation was done depending on pain as reported from pilot study, with 90% power at $\alpha = 0.05$ level, for one group and effect size = 0.5 using F test. The minimum proper sample size is 28 subjects. The sample size was calculated using the G*Power software (version 3.0.10)

Data analysis and statistical design

Data were expressed as mean± SD. Shapiro-Wilk test was used for testing normality of data distribution. One-way MANOVA was used to compare within group effects for measured variables (pain intensity by NRS, and neck function disability by NDI, electromyography response of Scalenus anterior muscles). Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. P less than or equal to 0.05 was considered significant.

3. RESULTS:

Demographic data of subjects:

A total of twenty eight subjects participated in this study received mulligan technique (SNAGs). As shown in table (1); the mean values of subjects age, weight, height and BMI of the study group were (37.18±3.97) years, (75.82±8.4) kg, (169.9±8.07) cm and (26.23±1.7) kg/m2 respectively.

Normality test:

Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk test for normality showed that all measured variables were normally distributed (p>0.05).

I- pain intensity:

The mean values ± SD of pain intensity pre and post study of the study group were 7 ± 1.1 and 1.82 ± 0.98 cm respectively. There was a statistically significant decrease of pain post study (p = 0.001).

II- Neck function disability:

Within group comparison

The mean values ± SD of NDI pre and post study of the study group were 16.54 ± 4.16 and 7.73 ± 1.35 respectively. There was a statistically significant decrease of NDI post study (p = 0.001).

Table (1): Mean ±SD of pain, NDI pre and post study of the study group.

Measured variables	**Study group** **Mean ±SD**
Pain Pre study	7 ± 1.1
Post study	1.82 ± 0.98
MD (95% CI)	5.18 (4.4, 5.96)
P-value	0.001*
NDI Pre study	16.54 ± 4.16
Post study	7.73 ± 1.35
MD (95% CI)	8.81 (7, 10.59)
P-value	0.001*

SD: standard deviation, CI: Confidence interval, p-value: level of significance, *: significant,

III- EMG Scalenus anterior muscles:

Duration

Within group comparison

The mean values ± SD of EMG duration of right Scalene muscle pre and post study of the study group were 7.46 ± 1.47 and 6.96 ± 0.74 msec. respectively and of left Scalene muscle pre and post study of group A were 8.11 ± 1.7 and 7.9 ± 1.46 msec. respectively There was no statistically significant difference of EMG duration of right and left Scalene muscles post study (p = 0.073 and 0.425) respectively. As shown in table (2).

Amplitude

The mean values ± SD of EMG amplitude of right Scalene muscle pre and post study of the study group were 569.1 ± 152.5 and 604.3 ± 185.37 uv respectively and left Scalene muscle pre and post study of group A were 504.2 ± 123.9 and 509.1 ± 125.9 uv respectively There was no statistically significant difference of EMG amplitude of right and left Scalene muscles post study (p = 0.130 and 0.837) respectively.

Root mean square (RMS)

The mean values ± SD of EMG RMS of Scalene muscles pre and post study of the study group were 52.73 ± 9.75 and 49.18 ± 5.86 respectively. There was a statistically significant decrease of RMS of Scalene muscles post study (p = 0.026).

Table (2): Mean ±SD of EMG activities of Scalene muscles pre and post study of the study group

EMG of Scalene muscles	**Study group Mean ±SD**
Rt duration (msec)	
Pre study	7.46 ± 1.47
Post study	6.96 ± 0.74
MD (95% CI)	0.5 (-0.05, 1.05)
P-value	0.073
Lt duration (msec)	
Pre study	8.11 ± 1.7
Post study	7.9 ± 1.46
MD (95% CI)	0.21 (-0.33, 0.74)
P-value	0.425
Rt amplitude (uv)	
Pre study	569.1 ± 152.5
Post study	604.3 ± 185.37
MD (95% CI)	-35.2 (-81.7, 11.33)
P-value	0.130
Lt amplitude (uv)	
Pre study	504.2 ± 123.9
Post study	509.1 ± 125.9
MD (95% CI)	-4.9 (-54, 44.18)
P-value	0.837
RMS	
Pre study	52.73 ± 9.75
Post study	49.18 ± 5.86
MD (95% CI)	3.54 (0.47, 6.63)
P-value	0.026*

SD: standard deviation, CI: Confidence interval, p-value: level of significance, *: significant

4. DISCUSSION:

This study measured the effect of mulligan technique (sustained natural apophyseal glides) on accessory respiratory muscle (scalenus anterior) and neck pain.

Twenty eight subjects were included in this study randomly from Outpatient clinics, Faculty of Physical Therapy, Cairo University each subject received 3 sessions per week for month (Kim J. et al., 2018) and examined by specialist to exclude any subjects with cardiovascular diseases, orthopedic diseases, neurological, musculoskeletal disorders, mental disorder which makes cooperation impossible, renal failure, myocardial infarction or pulmonary disorders.

The evaluation of accessory respiratory muscles done by EMG measuring system.

The result of this study was:

1 – E.M.G

For Scalenus anterior muscles:

There was significant improvement before and after the study, the reason for this improvement in electromyography activity could be that the scalenus anterior is an accessory respiratory muscle that originates from the anterior tubercles of the transverse processes of C3 to C6 vertebrae and inserts onto the inner border of the first rib at the scalene tubercle. It plays a role in elevating the first rib during forced inspiration. In improper postures such as FHP, this muscle tends to become shortened and tight, which increasing the mechanical load on the cervical spine and contributing to the increase of neck pain and the decrease of chest expansion.

The significant improvements observed in this study align with enhancements in cervical posture and range of motion, which help in reducing muscle tension, restore muscle length, function, and consequently enhance the respiratory function and decrease neck pain.

2 – Neck pain and function:

There was significant improvement before and after study, the reduction in neck pain can be attributed to the neurophysiological effects of mulligan SNAGs mobilization. Mobilization technique stimulates mechanoreceptors within the cervical spine, which contributes to a reduction in muscle hypertonicity and an enhancement of sensorimotor control. Additionally, pain reduction may occur through the activation of the Gate control mechanism, wherein stimulation of large-diameter A-beta fibers inhibits the transmission of nociceptive signals carried by A-delta and C fibers at the spinal cord level. The mobilization also promotes improvement in posture and cervical range of motion, further contributing to the alleviation of neck pain.

The results of this study agree with the results of Naz, S., Jamali, N.., Iftikhar, A.., Nawaz, H.., Iqbal, T.., & Ghafoor, F. (2023). Which approved that there was significant improvement with the group who receieved mulligan S.N.A.Gs in pain and function using NPRS and NDI, participants with mechanical neck pain, aged between 20 and 55 years, were enrolled and randomly divided into two groups. Group A received manual therapy based on the mulligan concept, which involved (NAGs), (SNAGs), and self-SNAGs performed in the seated position. Group B, consisting of 13 patients, followed the McKenzie protocol, comprising seven movements: four involving neck extension, two involving lateral flexion and rotation, and one in the flexion direction.

Another study supports the improvement in neck pain and decrease disability done by Kashif, M., Manzoor, N., Safdar, R., Khan, H., Farooq, M., & Wassi, A. (2022).

A total of forty female participants aged between 20 and 40 years, all diagnosed with cervicogenic headache (CGH), were randomly divided into two equal groups: a treatment group (n=20) and a control group (n=20). The treatment group received Sustained Natural Apophyseal Glides (SNAGs), while the control group underwent a placebo intervention. Each group received its respective treatment for 20 minutes per session, three times a week, totaling 12 sessions over a four-week period. The primary outcome measures included the Neck Disability Index (NDI) and the Visual Analogue Scale (VAS).

A study also done by Abd El-Azeim, A., & Grase, M. (2023). Supports our results in the effect of adding mulligan SNAGs to the convential treatement in decrease pain and improve function, mobility and muscle activity. A total of ninety participants (44 females and 46 males) diagnosed with chronic mechanical neck pain by a physician and referred to the physiotherapy clinic were enrolled in this randomized controlled trial. Participants were randomly assigned to two groups. Group A (experimental group) received the mulligan technique in conjunction with conventional therapy, while Group B (control group) received conventional therapy alone. Both groups have treatment for three times per week for a duration of four weeks. Outcome measures included muscle activity assessed via electromyography (EMG), pain intensity measured using the (VAS), and functional disability evaluated by the Arabic version of the (NDI). Assessments were conducted before and after the 12 treatment sessions. the mulligan technique produced superior improvements in muscle activity, pain reduction, and functional outcomes compared to conventional therapy alone.

A study also done by Rezkallah, S. S., & Abdullah, G. A. (2018). Reported the effect of combine of mulligan SNAGs or myofascial release on improve neck pain and ROM, A single-blinded randomized controlled trial was conducted involving seventy participants diagnosed with non-specific neck pain (NS-NP). Subjects were randomly assigned to one of three groups: the SNAGs group, which received Sustained Natural Apophyseal Glides combined with exercise; the MFR group, which received Myofascial Release along with exercise; and a control group that received exercise alone three times per week over a four-week period. Outcomes assessed included pain intensity, cervical range of motion and neck functional status.

Both the SNAGs combined with exercise group and the MFR combined with exercise group demonstrated marked improvements, including significant reductions in pain and disability levels, along with enhanced cervical ROM. In contrast, the control group, which received exercise only, showed comparatively smaller improvements in pain relief, functional outcomes, and ROM.

5. CONCLUSION:

Adding of mulligan SNAGs technique to traditional physical therapy program has a significant effect in improvement of neck pain, function and accessory respiratory muscle function.

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