MULLIGAN SUSTAINED NATURAL APОPHYSEAL GLIDES VERSUS THORACIC MANIPULATION ON MECHANICAL NECK PAIN: A RANDOMIZED CONTROLLED STUDY

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ABSTRACT

Objective: To compare the effect of adding Mulligan sustained natural apophyseal glides (SNAGs) versus thoracic manipulation (TM) to conventional physical therapy (CPT) on pain, neck range of motion (ROM) and functional activities in subjects with mechanical neck pain (MNP). Design: A single blinded, parallel groups randomized controlled study. Setting: Department of physical therapy, university hospital. Participants: Sixty patients with MNP were assigned randomly into 3 equal groups. Intervention: Mulligan SNAGs and CPT (group I), TM plus CPT (group II), and CPT only (group III). All participants received 3 sessions per week for four weeks. Main Outcome Measures: Visual analogue scale (VAS), pressure algometer, neck ROM, and neck disability index (NDI) were measured at baseline, after 4 weeks and then after 1 month with no intervention. Results: After 4 weeks of intervention, group I showed superiority to group II and III in all measured outcomes (P<0.05) except for flexion and extension ROM (P>0.05). Also, group II showed superiority to group III in all measured outcomes (P<0.05) except for flexion ROM and NDI (P>0.05). After one-month follow-up, group I showed superiority to group II and III in all measured outcomes (P<0.05) except for extension ROM (P>0.05). In addition, group II showed superiority to group III in all measured outcomes (P<0.05). Conclusion: Adding Mulligan SNAGs or TM to CPT showed significant improvements, in favor of Mulligan SNAGs, on pain intensity, pressure pain threshold, cervical ROM, and disability than CPT alone.

Key words: Mechanical neck pain; Mulligan SNAGs; Thoracic manipulation.

1. INTRODUCTION

Mechanical neck pain (MNP) is considered one of the most widely recognized musculoskeletal conditions [1]. The vast majority of cervical spine pain has no identifiable cause; it is diagnosed as MNP [2]. MNP is characterized by neck pain that is provoked by sustained neck postures and neck movement [3]. The frequency of MNP is obviously incremented by subjects with more severe postural variations from the norm, and the pain resulted from cumulative effects of frequent or repeated mild stress over a long period of time [4]. Poor postures during working, quick awkward movement of the head, or sleeping in a wrong position are considered various reasons that may cause MNP [5].

Neck pain occurs very commonly in the general population and its incidence in the adult population is nearly ten percent at any given time. It is estimated that fifty to seventy percent of the population during their lifetime will complain from neck pain at least once, while about sixty percent of individuals experience chronic pain for 5 years from the first onset of their symptoms [6]. It was reported that about 50% of subjects with neck pain will have debilitating symptoms [7], more than one third of patients will experience chronic symptoms for more than six months [8], and approximately one third of patients will be a burden on the healthcare system for 10 years [9].
The treatment protocols which are used for MNP are stabilization and relaxation trainings [9], manual and mechanical assisted manipulation techniques [10], dry needling [11], muscle energy techniques [12], osteopathic-type mobilization [13], muscle specific strength training [14], and posture correction exercises [15]. Mulligan sustained natural apophyseal glides (SNAGs) is considered a successful treatment option for different orthopedics dysfunctions. It is a mobilization with movement technique that has immediate improvement in pain-free range of motion (ROM). It has been suggested to apply a combination of Mulligan mobilization techniques with other methods of manual techniques by the literature [16].

Applying manual procedures to the thoracic spine has evidence to be emerged for subjects with MNP [17, 18]. It was reported that applying thrust manipulation to the thoracic spine (multiple levels) has immediate improvements in the neck pain and function at rest compared to patients receiving a placebo manipulation [18]. In addition, it exhibits superior outcomes compared to the patients receiving non-thrust techniques at thoracic spine at short-term follow-up [17-19]. The proposed mechanisms for the effect of thoracic manipulation on mechanical neck pain include hypoalgesia in distant areas by activating descending inhibitory pathways, restoration of the normal biomechanics of the dorsal spine, increased the distribution of joint forces on the neck and thereby reducing the mechanical stress [19].

The prevalence of NP is considerably high in the general population making it a common source of disability and physical impairments [20]. Currently, there is not much quality evidence on the efficacy of manual therapy on NP. Furthermore, there are systematic reviews that even question the efficacy of manual therapy in patients with neck pain [21, 22].

Manual therapy of a body area may treat restrictions or dysfunction in adjacent body segments, such as treating the thoracic spine for neck pain [23]. Mulligan SNAGs to thoracic spine [24] or thoracic manipulation [25] improves pain and function in subjects with neck pain, but the difference of their impacts on MNP has not been investigated.

There is a lack of studies investigating the effect of mulligan SNAGs versus thoracic manipulation in subjects with MNP. Therefore, the purpose of this study was to investigate the effect of adding Mulligan SNAGs to the thoracic spine and thoracic manipulation to neck stability exercises on pain intensity, pain pressure threshold, cervical ROM and functional activities on patients with mechanical neck pain.

2. MATERIAL AND METHODS:

Design and setting:
The study was an assessor-blinded, parallel group, randomized controlled study.

Subjects were recruited from department of physical therapy in a university hospital. The assessment of subjects and the application of Mulligan SNAGs, thoracic manipulation, and conventional physical therapy were carried out between August 2019 and July 2020. The Ethical Committee for Human Research approved the study protocol [No: P.T.REC/012/002344] and the study was registered [reference No: PACTR202001587283053] at Pan African registry. Subjects were asked to join the current study and signed the written consent form before participation.

Participants
All patients with MNP and referred to the physical therapy department by orthopedist participated in this study if they fulfilled the inclusion criteria as: aged ranged from 18 to 45 years, neck pain provoked by movement, neck pain and stiffness for at least 2 weeks, neck pain with sufficient intensity (equal to or greater than 4 points on VAS). Patients were ruled out if they have history of malignancy, inflammatory joint, muscle disease or infection, fractures of neck and thorax, cervico-thoracic surgery, canal stenosis of cervical spine, neurological deficit, whiplash injury within 6 weeks of examination, vertigo and cervicogenic headache, acute trauma, cervical radiculopathy or myelopathy.
Assessed for eligibility (75)

Excluded (n=15)
- Not meeting inclusion criteria (n=10)
- Decline to participate (n=5)
- Other reasons

Enrollment

Randomized (n=60)

Allocation

Mulligan SNAGs & conventional physical therapy program
- Received allocated intervention (n=20)
- Did not receive allocated intervention (n=0)

Thoracic manipulation & conventional physical therapy program
- Received allocated intervention (n=20)
- Did not receive allocated intervention (n=0)

Conventional physical therapy program
- Received allocated intervention (n=20)
- Did not receive allocated intervention (n=0)

Follow-Up after 1 month of intervention

Lost to follow-up (n=0)
Discontinued intervention (n=0)

Lost to follow-up (n=0)
Discontinued intervention (n=0)

Lost to follow-up (n=0)
Discontinued intervention (n=0)

Follow-Up after 1 month of NO intervention

Lost to follow-up (n=0)
Discontinued intervention (n=0)

Lost to follow-up (n=1)
Discontinued intervention (n=0)

Lost to follow-up (n=2)
Discontinued intervention (n=0)

Analysis

Analyzed (n=20)
Excluded from analysis (n=0)

Analyzed (n=20)
Excluded from analysis (n=0)

Analyzed (n=20)
Excluded from analysis (n=0)

Fig 1 Participants’ flow chart
Sample size and Randomization

G*Power (version 3.1.9.6, Dusseldorf, Germany) were used to estimate the sample size with 0.39 effect size, 10% beta error, and a two-sided 0.05 alpha error to find out minimum clinically important differences of 20mm on pain intensity and 10.5 points on neck disability index between the groups. A pilot study, 5 participants in each group, was used to detect the effect size. The total estimated sample was fifty-four patients and, to account for the drop out, the size was increased by 10% to be 60 participants. Sixty participants were assigned randomly into 3 equal groups. The randomization was generated by an author who was not entailed in data collection. It was generated using a computer-generated block with block size equal 6 to eliminate the source of bias and minimize the variability between the groups. Sealed, opaque sequentially numbered envelopes were used to ensure concealed allocation of participants. The third author opened the envelopes, and hence carried on with treatment according to groups allocation. The blind assessor to groups allocation collected the data at baseline, after 4 weeks of intervention, and then after one month of no intervention.

Outcome measures:

- Cervical range of motion (CROM) instrument was used to measure the neck ROM for flexion, extension, rotations, and lateral flexion using 3 separate inclinometers which are attached to a plastic frame and secured to the head by Velcro strap and nose bridge. The sagittal plane inclinometer measures flexion - extension, the frontal plane inclinometer measures right and left lateral flexion, and the horizontal plane inclinometer with a magnetic neck collar measures right and left rotation. Measurements were expressed in degrees with high degree of validity and reliability [26].
- Pressure algometer (Baseline instruments, White Plains, New York, USA) was used to measure pressure pain threshold (PPT) over the trigger points. The pressure algometer is a hand-held instrument used to assess sensitivity to pressure force near a trigger point in pounds or kilogram. Pressure algometer has high validity with an excellent inter and intra rater reliability [27].
- The visual analogue scale (VAS) was used to evaluate pain intensity level. It is a 10-cm (100-mm) line; with 0 refer to no pain while 100mm refer to extreme pain. Patients were requested to place a mark along the line to express their level of pain. The reliability VAS is moderate to good in subjects with musculoskeletal conditions [28].
- Neck Disability Index (NDI) is a self-administered questionnaire to assess the disability accompanying neck pain. The Arabic version of NDI used in this study is a valid, reliable and responsive instrument. It includes 10 items that assess pain intensity and daily life activities i.e., personal care, lifting, reading, headaches, concentration, work, driving, sleeping and recreation. Each questionnaire item is scored from 0 to 5 with higher scores indicate greater disability [29].

Intervention: All subjects in the three groups received the conventional physical therapy program.

- The conventional physical therapy program included neck isometric exercises, chin tucks and neck muscles stretching. Exercises were performed 5 sets with 10 repetitions with 2 min rest between each set [30] table 1.
- In Mulligan mobilization techniques, the patient sat astride at one side of the bed to stabilize the pelvis and the therapist stood on the side. The patient's hands were placed behind the neck to protract the scapula and allow the therapist to make hand contact with the mid thoracic spine. The ulnar border of therapist's mobilizing hand was central, and the other arm holed the thoracic wall. The cephalic glide was applied parallel to the plane of the facet joint. Traction was applied prior to glide, which was achieved by therapist knee extension and sustained as the patient actively extends the trunk in thoracic SNAGs extension, flexes the trunk in thoracic SNAGs flexion, laterally flexes the trunk away from the therapist in thoracic SNAGs lateral flexion, and rotates the trunk in thoracic SNAGs rotation. Rhythmical glides and mobilizations were done for 6 repetitions [31].
- In thoracic manipulation techniques, the patients were asked to lie in a prone position on a standard table. The facet joints of subjects from T3-T7 levels were marked on both sides. Patients were then asked to take deep breathing, and at the end of expiration, the treating author applied thoracic manipulation (screw thrust) technique at both facet joints of T3-T7. If a clicking sound (i.e., release of gas from joint cavities) was not
perceived on the first trial, the patient was requested to re-position and the same technique was repeated. This technique was performed for a maximum of two trails and was accomplished within 2 minutes [32].

Table 1. Conventional physical therapy program

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isometric exercises</td>
<td>Patient were asked to hold his head against resistance of therapist’s hand for 6sec then relax for 6 secs in the direction of flexion, extension, side bending, and rotation. 10 repetitions for each direction.</td>
</tr>
<tr>
<td>Chin in exercise</td>
<td>Patients were asked to retract the head keeping their eyes looking at front target and hold for 30sec then relax for 10sec for 10 repetitions.</td>
</tr>
<tr>
<td>Scapular retraction</td>
<td>In standing position, patients were asked to bring their shoulder blades together in the backward direction, hold for 6sec then relax for 15 repetitions.</td>
</tr>
<tr>
<td>Stretching techniques</td>
<td>Stretching of neck flexors, extensors, side bending and rotators, maintain the stretching position for 30 sec then relax for 10sec for 3 repetitions.</td>
</tr>
<tr>
<td>Cervical extension</td>
<td>In standing position, patients were asked to grasp the base of the neck with both hands and then extend the neck as far as possible for 15 repetitions.</td>
</tr>
<tr>
<td>Shoulder shrugs</td>
<td>In standing position, patients were instructed to bring up their shoulders towards the ears then relax for 15 repetitions.</td>
</tr>
<tr>
<td>Shoulder rolls</td>
<td>In standing position, patients were instructed to roll the shoulders in a circle in the forward direction then relax for 15 times. The same procedure was done for shoulders in the backward direction for 15 times.</td>
</tr>
</tbody>
</table>

Statistical analysis

The measured variables were statistically analyzed and compared using SPSS for windows version 25 (Chicago, IL) with 0.05 type I error. Data were checked for normal distribution, homogeneity, and presence of outliers. Shapiro-Wilks test for normality showed that the measured variables were normally distributed (p > 0.5). Data are expressed as mean and standard deviation for all outcomes except for gender (counts). Two-way mixed design MANOVA were used to compare among the groups on the combined effect of all outcomes.

When MANOVA was statistically significant, a follow up with univariate ANOVAs was done for every outcome measure. Bonferroni correction was considered for pairwise comparisons to protect against type I error.

3. RESULTS

The demographic and clinical outcome data before the treatment of all participants in Mulligan SNAGs, thoracic manipulation and CPT program groups are showed in table 2. There were no statistically significant differences among the groups in age, sex, height, weight, and body mass index data (P>0.05) as in table 2.

Two-way mixed design MANOVA was conducted to assess the difference among subjects in the three groups on the combined effect of all the outcome measures. There were statistically significant multivariate effects in the groups, Wilk’s A = 0.12, F(18,98) = 10.47, p< 0.001, η2 = 0.66, time, Wilk’s A = 0.01, F(18,40) = 326.3, p < 0.001, η2 = 0.99, and the groups time interaction, Wilk’s A= 0. 01, F(36,80) = 17.42, p < 0.001, η2 = 0.89. Mixed design ANOVA tests showed significant differences in VAS, F(4,114)= 39.19, p< 0.001, η2 = 0.58, NDI, F(4,114)= 37.65, p< 0.001, η2 = 0.57, pain pressure threshold, F(4,114) = 126.63, p< 0.001, η2 = 0.82, flexion, F(4,114) = 31.06, p< 0.001, η2 = 0.52, extension, F(4,114)= 13.63, p< 0.001, η2= 0.34, right lateral flexion, F(4,114)= 30.65, p< 0.001, η2= 0.52, left lateral flexion, F(4,114) = 34.75, p< 0.001, η2 = 0.55, right rotation, F(4,114)= 63.65, p< 0.001, η2= 0.7, and left rotation, F(4,114)= 60.5, p< 0.001, η2 = 0.68.
Between Groups Effects:
After 4 weeks of intervention, Mulligan group showed superiority to TM and CPT group in all measured outcomes (P<0.05) except for flexion and extension ROM between Mulligan and TM groups (P>0.05). Also, TM group showed superiority to CPT group in all measured outcomes (P<0.05) except for flexion ROM and NDI (P>0.05).

After one-month follow-up, Mulligan group showed superiority to other groups in all measured outcomes (P<0.05) except for extension ROM between Mulligan group and TM group (P>0.05). In addition, TM group showed superiority to CPT group in all measured outcomes (P<0.05), as in table 3 and 4.

Within-Groups Effects:
After 4 weeks of intervention, statistically significant improvements were detected in all dependent variables (p<0.001) when comparing the pre and post-intervention results in each group except for pressure pain threshold and right lateral flexion in the CPT group (P>0.05). Also, there were statistically significant improvements in all dependent variables (p<0.001) when comparing the pre and follow-up results in each group except for pressure pain threshold in the CPT group (P>0.05) after one-month follow-up as in table 5.

Table 2. Baseline Demographic and Clinical Characteristics of Subjects (N=60) *

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group I (n=20)</th>
<th>Group II (n=20)</th>
<th>Group III (n=20)</th>
<th>F-Value</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>28.25±9.58</td>
<td>24.8±7.23</td>
<td>25.25±5.32</td>
<td>1.23</td>
<td>0.3</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>8/12</td>
<td>6/14</td>
<td>11/9</td>
<td>$X^2$=2.61</td>
<td>0.27</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.2±10.16</td>
<td>70.68±6.61</td>
<td>76.4±6.59</td>
<td>2.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>166.8±7.18</td>
<td>169.0±6.81</td>
<td>171.6±4.39</td>
<td>2.95</td>
<td>0.06</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.42±4.2</td>
<td>24.82±2.76</td>
<td>26.01±2.79</td>
<td>1.24</td>
<td>0.3</td>
</tr>
<tr>
<td>VAS (mm)</td>
<td>78.4±6.5</td>
<td>73.8±11.13</td>
<td>72.7±8.56</td>
<td>2.29</td>
<td>0.11</td>
</tr>
<tr>
<td>PPT (kg/cm²)</td>
<td>1.3±0.25</td>
<td>1.43±0.44</td>
<td>1.56±0.57</td>
<td>1.76</td>
<td>0.18</td>
</tr>
<tr>
<td>NDI</td>
<td>25.2±4.83</td>
<td>23.55±4.58</td>
<td>24.45±3.86</td>
<td>0.69</td>
<td>0.5</td>
</tr>
<tr>
<td>Flex (deg.)</td>
<td>35.5±6.86</td>
<td>37.35±7.07</td>
<td>38.85±9.35</td>
<td>0.92</td>
<td>0.41</td>
</tr>
<tr>
<td>Ext. (deg.)</td>
<td>37.75±8.03</td>
<td>41.5±9.33</td>
<td>38.25±9.36</td>
<td>1.04</td>
<td>0.56</td>
</tr>
<tr>
<td>RLF (deg.)</td>
<td>26.6±6.11</td>
<td>27.15±5.41</td>
<td>26.35±5.42</td>
<td>0.11</td>
<td>0.9</td>
</tr>
<tr>
<td>LLF (deg.)</td>
<td>24.6±5.56</td>
<td>24.65±4.88</td>
<td>24.5±4.73</td>
<td>0.01</td>
<td>0.99</td>
</tr>
<tr>
<td>RR (deg.)</td>
<td>37.1±5.17</td>
<td>35.45±4.03</td>
<td>36.1±3.99</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>LR (deg.)</td>
<td>36.55±4.86</td>
<td>37.4±4.06</td>
<td>35.5±3.25</td>
<td>1.07</td>
<td>0.35</td>
</tr>
</tbody>
</table>

BMI, body mass index; M, males; F, females; F, fisher test; p, probability value; $X^2$, Chi Square; VAS, Visual Analogue Scale; PPT, Pressure Pain Threshold; NDI, Neck Disability Index; Flex, Flexion, deg., degrees; Ext, Extension; RLF, Right Lateral Flexion; LLF, Left Lateral Flexion; RR, Right Rotation; LR, Left Rotation; CI, Confidence interval; p, probability value. * Data are mean± SD, P-Value < 0.05 indicate statistical significance. * Data are mean± SD for age and height and counts for gender, P-Value < 0.05 indicate statistical significance.
4. DISCUSSION

The current study aimed to test the effect of adding Mulligan SNAGs versus thoracic manipulation to neck stability exercises on pain intensity level, pressure pain threshold, cervical ROM, and functional activities in patients with MNP. The main findings of this study showed significant differences after 4 weeks of intervention in all measured outcomes except for pressure pain threshold and right lateral flexion in the CPT group. After one-month follow-up, significant differences were detected in all measured outcomes except for PPT in the CPT group.

In this study, Mulligan SNAGs was effective on pain, cervical ROM and functional activities in patients with MNP. This study results were supported by numerous studies that have established the efficacy of Mulligan SNAGs in subjects with NP [33-39]. In contrast, this study results were opposing to Ganesh et al. [40] who compared the effectiveness of Maitland and Mulligan’s mobilization and exercises on pain response, range of motion and concluded that manual therapy interventions were no better than supervised exercises in reducing pain, improving ROM and neck disability. This contrast with the results of this study might be due to the different
treatment frequency as the sessions were 5 sessions per week for two weeks. The subjects were instructed to continue the strengthening and stretching exercises at home for a period of extra four weeks, when Maitland and Mulligan’s mobilization techniques were stopped after two weeks only. Moreover, Ganesh et al. [40] assessed ROM using universal goniometer.

The accessory movement, gliding mobilization, accompanied Mulligan technique improve pain due to enhancing the nutrition and circulation to the joint, removing the nociceptive metabolites and better healing of small injuries of the soft tissue, thus enhancing smooth and pain free movements [41]. Furthermore, mobilization might reduce pain through stimulation of descending pain-inhibitory pathways and secretion of serotonin and noradrenaline, which reduce muscle spasm, improve movement and neck function [42].

In this study, Thoracic manipulation was effective on pain, cervical ROM and disability on patients with MNP. The findings of the current study were in line with numerous studies that have established the efficacy of thoracic manipulation in subjects with NP [43-51]. However, these study findings were in contrast with Khoja et al. [52]...
who reported that thoracic thrust manipulation does not provide additional effect over the multimodal neck program on pain, cervical ROM, and disability. This contrast with the results of this study might be due the difference in study designs, using a small sample size, and short intervention. Moreover, Khoja et al. [52] did not mention the duration and frequency of the intervention program which might affect the internal and external validity of these results.

Spinal manipulation thrust alters spinal biomechanics and activates paraspinal sensory neurons during the technique itself which affect the nervous system. Spinal manipulation thrust would modulate or alter sensory neuron or proprioceptive signals to the central nervous system [53, 54].

In this study, Neck stabilization exercises were effective on pain, cervical ROM and functional activities on subjects with MNP. The current study results were supported by numerous studies that have established the effectiveness of neck stabilization exercises in subjects with NP [55-58].

However, this study results of were not supported by Griffiths et al. [59] who found that adding neck stabilization exercises to a general neck advice and exercise program did not show better clinical outcome overall in the treatment of chronic NP. These findings may be due to different mean age as the patients were aged 18 years and older with no limitation of age which make the study not homogenous. In addition, the frequency and duration of the program were not mentioned, and the researchers only mentioned that the progression, repetitions, and hold time of the exercises were decided by the treating therapist which might differ from one therapist to another. Some mechanisms were proposed through which stabilization exercises decreases neck pain. Stimulation of the mechanoreceptors and enhancement of the activity of sensory signals by muscle contraction and different connective tissues strain inhibit the pain mediating pathway. In addition, intense exercise enhances the activity of the motor pathways which exerts an inhibitory effect on brain pain mediating centers [60]. Hence the current study found that both Mulligan SNAGs and thoracic manipulation when added to CPT program result in better improvement, in favor of Mulligan SNAGs than CPT alone in treatment of subjects with MNP.

The current study has some limitations. It was not possible to blind the patients and the therapist owing to the nature of the treatments. In addition, a relatively small sample size was used in the current study but was sufficient to detect the minimal clinically important changes in pain intensity and NDI. Furthermore, the functional activities of the neck muscles have not recorded. Future studies should be carried out to investigate long term effect of the intervention after 6 months or more with a larger population to increase the power and the generalizability of the study. Moreover, researches should be done using other investigative procedures as electromyography (EMG) to discover the effect of Mulligan SNAGs and thoracic manipulation on muscle activity.

5. CONCLUSION

Adding Mulligan SNAGs or thoracic manipulation to conventional physical therapy program showed significant improvements, in favor of Mulligan SNAGs, on pain intensity, pressure pain threshold, disability, and cervical ROM than conventional physical therapy program alone in patients with MNP.

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Declaration of conflict of interests

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List of abbreviations:

- SNAGs: Sustained natural apophysial glides
- TM: Thoracic manipulation
• CPT: Conventional physical therapy
• CROM: Cervical range of motion
• VAS: Visual analogue scale
• NDI: Neck disability index
• MANOVA: Multivariate analyses of variance

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