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Maitland mobilization versus mulligan mobilization in sub-acute and chronic non-specific neck pain

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Abstract
Background: Neck pain is a public health problem and a common source of disability. Maitland and Mulligan mobilization are common techniques of manual therapy. Limited evidence about which technique is better in improving chronic neck pain. Furthermore, the effect of mobilization in sub-acute neck pain hasn't been studied. The objective of study to compare the short term effect of Maitland and Mulligan mobilization in sub-acute and chronic non specific neck pain to improve pain pressure threshold, rang of motion, joint position sense and to evaluate the effect of treatment on psychological factors.
Study design: Randomized clinical trial.
Method: 44 patients with sub-acute or chronic neck pain were randomized into Maitland group: 22 patients received central postro anterior pressure or unilateral postero anterior pressure. Mulligan group: 22 patients received sustain natural apophyseal glides. The treatment was 2 times /week for three weeks. The outcome measurements were pain pressure threshold, cervical range of motion and joint position sens. Measurements were being taken before and after treatment.
Result: Cervical PPT was significantly improved in Maitland group only but the tibialis PPT was significantly improved for both groups. The cervical ROM was significantly improved in extension and rotation only in Maitland group, while Mulligan group had significant improvement in all ROM directions. The JPS in Maitland group was significantly changed in THPE for extension and left rotation and changed in NHPE for extension, right lateral flexion and right rotation. The JPS for Mulligan group was significantly improved in THPE for both lateral flexions.
Conclusion: Mulligan mobilization had greater effect in cervical ROM than Maitland mobilization. Maitland mobilization had more significant improvement of cervical pain pressure threshold than Mulligan mobilization.

Keywords: Maitland mobilization, mulligan mobilization, neck pain

Introduction
Neck pain is one of the common musculoskeletal disorders. It has been reported that 70% of individuals have neck pain at some time in their lives (Tachii, 2015,) [36]. Neck pain is defined as pain or/and stiffness on the posterior aspect of the cervical spine (Ferrari and Russell, 2003) [12].
The main characteristics of neck pain are pain, reduction in the pressure pain threshold (PPT) over the cervical spine and area away from the affected site, tenderness in the cervical spine, restriction in the range of motion (ROM) and poor joint position sense (JPS) (Pool *et al*., 2006, McNair *et al*., 2007) [28, 24].
Medication, exercises and manual therapy (MT) are the most widely used treatments for neck pain (Vincent *et al*., 2013). MT techniques are commonly used to reduce pain, improve cervical kinesthesia and improve joint mobility (Kingston *et al*., 2014, Sterling *et al*., 2001) [19, 34]. Maitland and Mulligan mobilization techniques are the most common types used (Kingston *et al*., 2014, Kanlayanaphotporn *et al*., 2009) [19, 18]. Maitland mobilization technique usually involve low velocity rhythmic movement of short or large amplitudes applied anywhere within a cervical joint ROM (Aquino *et al*., 2009) [3]. Despite widespread use of Maitland mobilization, there has been contradictory result on the efficacy of this technique for neck pain (Ali *et al*., 2015, Deepa, 2014, Griswold *et al*., 2015, Suvarnnato *et al*., 2013, Dunning *et al*., 2012) [1, 7, 15, 35, 8].

A common type of Mulligan mobilization is sustained natural apophyseal glide (SNAG). It involves a combination of active movement and passive glide (Mulligan, 2010) [26]. Few studies have reported the effects of Mulligan mobilization on improving chronic neck symptoms (Ali 2014, Tachii, 2015) [2, 36].

Unfortunately, very few studies have compared Mulligan and Maitland mobilization for non-specific neck pain. In addition, there were wide variations in the application of techniques, duration of treatment and outcomes measurement (Gautam, 2014, Inderpreet *et al*., 2013, Pérez *et al*., 2014, Lopez *et al*., 2015) [13, 17, 21]

Objective of the study

- To find out the effectiveness of Maitland mobilization in improving neck PPT, ROM, JPS,

1. To find out the effectiveness of Mulligan mobilization in improving PPT, ROM, JPS, Secondary objective

- To compare the effectiveness of two different techniques in improving neck PPT, ROM, JPS, in sub-acute and chronic non-specific neck pain.

Hypothesis

1. No significant effectiveness of Mulligan or Maitland mobilization in improves PPT, ROM, JPS,

No significant difference between Mulligan and Maitland mobilization in improves PPT, ROM, JPS

Methodology

Study design

The study design was randomized trial. The randomization was done by using Graph Pad software (http://www.graphpad.com/quickcalcs/randomize2/) before patient's enrolment.

Sample size calculation

Sample size was calculated by using http://www.stat.ubc.ca/~rollin/stats/ssize /n2a.html which uses PPT mean (µ1=1.48, µ2= 1.70) and standard deviation (0.25) of previous study (Lopez *et al*., 2015) [21]. The significant value is 0.05 and power .80**.**

Subjects

A total of 44 patients (41females and 3 males), with 10 sub-acute and 34 chronic case of non-specific neck pain participated in this study. They were recruited from the rehab clinic of King Abdul-Aziz Hospital and East Jeddah General Hospital in Jeddah, Saudi Arabia from December 2016 to May 2017. Their ages ranged from 21 to 50 years. The patients were randomly assigned to one of two groups according to the order of Graph Pad software randomization. A total of 22 patients (2 males and 20 females) were participated to Maitland mobilization group and 22 patients (1male and 21 female) were participated to Mulligan mobilization group**.**

Eligibility criteria

Inclusion criteria

Patients aged between 20 to 50 years, with neck pain more than once a week (without radicular symptoms) and posterior neck pain from the superior nuchal line to the first thoracic vertebra were included in the study (Pérez *et al*., 2014).

Exclusion criteria

Patients with contraindications to mobilization (e.g. pregnancy, whiplash injury, tumor, fracture, metabolic diseases, rheumatoid arthritis, osteoporosis and resting blood pressure higher than 140/90 mmHg), those with cervical radiculopathy, fibromyalgia pain syndrome, vestibular system deficits, previous neck surgery, neck pain associated with vertigo caused by vertebrobasilar insufficiency or chronic headache and those receiving physical therapy treatment in the previous three months were excluded from the study (Pérez *et al*., 2014, Tachii, 2015) [36].

Ethical considerations

The study was approved by the Institutional Review Board at the Faculty of Applied Medical Sciences, Imam Abulrahman Bin-Faisal University, Saudi Arabia (IRB-PGS-2016-03-143) before the subject examination and treatment. All participants signed a consent form before being engaged in the study.

Evaluative instrumentations

The following instruments were used to assess the subjects:

1. Cervical Range of Motion (CROM) Instrument is used to measure cervical ROM and JPS (Loudon *et al*., 1997) [22]. It is a reliable and valid device. It consists of three gravitational inclinometers system for flexion, extension and lateral flexion, and a magnetic inclinometer for rotation) (Tousignant *et al*., 2006, Tousignant *et al*., 2000, Tousignant *et al*., 2002, Audette *et al*., 2010) [39, 37, 38, 4].
2. Pain Pressure Threshold (PPT) Instrument is used to measure the sensitivity to pain. It is composed of an electronic algometer (Somedic AB, Farsta, Sweden) with a circular probe of 1 cm2 (Martínez-Segura *et al*., 2012, Sterling *et al*., 2010) [23, 34].

Evaluation procedures

Every patient was examined by the primary investigator. A standardized musculoskeletal examination of the cervical spine was performed to identify the target vertebral level for interventions. The painful segments that matched the patient's pain were detected and treated. Each patient received a total of 6 treatment sessions over 3 weeks, 2 times per week. The following measurements were performed for all participants before treatment (pre-test) and after 6 sessions of treatment (post test)**.**

1. **Cervical range of motion:** The patient was sitting in chair and the cervical ROM device was put over the patient's head. The patient was asked to move her/his head in flexion, extension, rotation and lateral flexion to the point of restriction or pain while the inclinometer measured the degree of movement. Every movement was performed three times and the average was calculated (Lopez *et al*., 2015) [21].
2. **Cervical joint position sense:** The patient was asked to sit upright on a chair with feet on the floor and to look straight ahead. A CROM device was fixed to the patient's head. The patient was blindfolded, and his/her trunk was fastened to the back of a chair using a Velcro strap. The target position was defined as midpoint of full flexion, extension, right and left lateral flexion, right and left rotation ROM for each patient. Neutral

head position (NHP) was zero, To familiarize the patient with target and neutral position, the patient's head was passively moved with slow speed from the target position to neutral position. The patient was permitted to concentrate on each position for 2-3 seconds. Once the patient recognized the target and neutral position, the test was carried out. The patient was asked to move his/her head from target position to neutral head position (NHP). After staying in the NHP for 2-3 seconds, the patient was asked to move the head to the target position and remain in that position for 2-3 seconds, at which time the joint position error was recorded. The difference between the original target angle and the observed target angle was measured and reported value was recorded. The average of three trials was used for the evaluation. No feedback about the performance was given during the test (Lee *et al*., 2006, Loudon *et al*., 1997) [20, 22].

3. **Pain pressure threshold (PPT):** This was measured over the following site: (1) area of maximum tenderness over the cervical spine (spinous process) (2) bilateral tibialis anterior muscle (upper one-third of the muscle belly). The pressure was applied perpendicularly over the identified sites at a rate of 40 KPa/s until the individual verbally stated that the pressure was starting to change to a pain sensation. At which point, the pressure was stopped. The test was repeated three times for each site with 30 seconds between measurements. An average of three measurements was calculated (Uthaikhup *et al*., 2015, Sterling *et al*., 2001, Salom-Moreno *et al*., 2014, Martínez-Segura *et al*., 2012) [40, 23, 31, 34].

Treatment procedure

Maitland mobilization group

Oscillatory pressure was directed onto the central posterior-anterior of spinous process of the target segment or unilateral posterior-anterior of the facet joint of the target segment (Hengeveld and Banks, 2013) [16]. Oscillatory pressure was applied for 2 minutes and repeated 3 times with a 1-minute rest between each mobilization. The grade of mobilization and the pressure site were based on patient examination findings and response to mobilization (Pérez *et al*., 2014, Lopez *et al*., 2015) [21]

Mulligan mobilization group

SNAG

The patient was sitting. Mobilization with movement towards the painful and restricted side (flexion, extension, rotation and lateral flexion) and over pressure was applied by the patient at the end of active movement. Mulligan mobilization was repeated ten times in each of three sets (Mulligan, 2010) [26].

Data analysis

The data was analyzed by using SPSS version 20. Independent t-test was used for comparing the baseline demographic data between the groups. Shapiro-wilk test was applied to all variables to test the normality distribution. All variables were normally distributed ($P>0.05$) except the joint position sense was not normally distributed ($P<0.05$). Therefore, parametric analysis was conducted for normal distributed variables by using Paired t-test to compare the effects of pre and post interventions within the groups and Independent t-test to compare the effect of intervention between the groups. Non-parametric analysis was conducted for non-normal distributed variable (joint position sense) by using wilcoxon test to compare the effect of intervention within the groups and mann-whitney test to compare the effect of intervention between the groups. The level of significant is 0.05.

Results

A total of 107 subjects were recruited in this study. Fifty seven subjects did not meet the inclusion criteria. Forty four subjects completed all assessment and treatment in the study.

Demographic data for Maitland and Mulligan groups

Table 1: Descriptive data for Maitland and Mulligan groups

Parameter		MaG (n=22)	MuG (n= 22)	P value
		Mean ± SD	Mean ± SD	
Age		36 ± 9	36 ± 8	0.875
Hight (Cm)		159.28 ± 7.05	157.80 ± 6.50	0.474
Weight (Kg)		68.39 ± 22.43	72.06 ± 19.04	0.562
Body mass index		27.0 ± 8.6	28.7 ± 7.7	0.497
pain duration (days)		870 ± 1088	813 ± 1059	0.862
Gender	Female (%)	20 (45.5%)	21 (47.7%)	
	Male (%)	2 (4.5%)	1 (2.3%)	
Pain duration (Subacute) (%)		5 (11.4%)	5 (11.4%)	
Pain duration (Chronic) (%)		17 (38.6%)	17 (38.6%)	
Pain location (neck & scapula)		15.9%	18.2%	
Medications	Before treatment	9.1%	20.5%	
	After treatment	2.3%	0%	

MaG (Maitland group), MuG (Mulligan group), SD (standard deviation).

4.2 Comparison pressure threshold within and between groups

There was significant improvement of cervical PPT was observed in MaG only. Left tibialis PPT was significant improved in both groups. While right tibialis PPT significant in MuG. No significant change between groups in pain and both tibialis PPT. whereas a significant difference in cervical PPT were observed between groups, this result showed that Maitland mobilization was more effective than Mulligan mobilization in improving the cervical PPT (Table 2).

Table 2: Significant difference of threshould within and between groups

		Within groups			Between groups	
		Maitland	Mulligan			
	Pre Mean±SD	Post Mean±SD	Pre Mean±SD	Post Mean±SD	(Pre) P-value	(Post) P-value
PPT						
Cervical	311.6±99.6	361.8±106.3	280.3±110.1	287.3±125.91	0.329[a]	0.040[*]
P-value	0.020[*]		0.711[a]			
Rt.Tib.	579.7±172	612.1±204.7	469.3±181.7	551.9±168.7	0.329[a]	0.294[a]
P-value	0.185[a]		0.031[*]			
Lt.Tib.	566±225.3	627.6±224.7	463.5±172.2	534.1±190.8	0.045[*]	0.144[a]
P-value	0.011[*]		0.004[*]			

MaG (Maitland group), MuG (Mulligan group), NPRS (numeric pain rating scale), PPT (pain pressure threshould), Rt.Tib. (Right Tibialis) & Lt.Tib. (Left Tibialis).

*Significant $P<0.05$ & [a] not significant $P>0.05$.

Comparison of cervical ROM within and between groups

There was significant improvement in all cervical ROM in MuG. While MaG was significant improved in cervical extension, right and left rotation only. At the same time no significant change between groups except for right rotation and left bending which mean Mulligan was better than Maitland (Table 3).

Comparison of joint position sense error (JPSE) within and between groups

Maitland group was demonstrated significant improvement in NHP for extension, right rotation and right bending. while the THP was change in extension and left rotation. Mulligan group showed significant improvement of cervical joint sense in THP for left and right lateral flexion. There was no significant change between groups except in NHP for right rotation and right lateral flexion which mean Maitland was better than Mulligan.

Table 3: Significant changes for cervical ROM within and between groups

ROM		Within groups			Between groups	
	MaG		MuG			
	Pre Mean±SD	Post Mean±SD	Pre Mean±SD	Post Mean±SD	(Pre) P-value	(Post) P-value
Flexion	52.8±12.86	54.35±15.93	44.48±14.25	56.6±8.98	0.067[a]	0.842[a]
P-value	0.590[a]		0.000[*]			
Ext.	54.7±19.55	62.53±15.31	55.51±18.10	70.82±14.44	0.944[a]	0.108[a]
P-value	0.033*		0.001*			
RR	60.70±10.91	66.71±10.78	56.75±13.48	74.11±9.83	0.438[a]	0.021[*]
P-value	0.006*		0.000*			
LR	59.6±11.32	66.73±10.46	59.18±15.42	69.68±8.15	0.944[a]	0.330[a]
P-value	0.003[*]		0.000[*]			
RLF	38.42±10.46	40.12±7.84	33.6±8.69	41.71±7.91	0.124[a]	0.769[a]
P-value	0.451[a]		0.000*			
LLF	39.38±10.38	41.15±7.65	38.15±9.68	46.18±7.68	0.541[a]	0.049[*]
P-value	0.437[a]		0.001*			

MaG (Maitland group), MuG (Mulligan group), RR (right rotation), LR (left rotation) RLF (right lateral flexion), LLF (left lateral flexion) & ROM (range of motion) * significant $P<0.05$ & [a] not significant $P>0.05$.

Discussion

The result of this study showed that Maitland technique was better than Mulligan in improving of cervical joint sense and cervical PPT, while Mulligan treatment was more effective than Maitland treatment in improving the cervical ROM. A similar improvement in widespread pain was observed with the use of both techniques.

A reduction in the PPT in the cervical spine was achieved in Maitland mobilization group. Sterling *et al*., 2001 [34] and Lopez *et al*., 2015 [21] reported a significant improvement in cervical PPT following passive cervical mobilization in patients with chronic neck pain. Passive cervical mobilization was shown to trigger hypoalgesic changes and a sympatho-excitatory effect. In addition, these effects were found to extend beyond the specific body segment receiving the treatment (Schmid *et al*., 2008, Kingston *et al*., 2014) [32, 19]. These study findings mirror our observation of a hypoalgesic effect on the cervical spine following mobilization. A significant change in cervical PPT was not demonstrated in Mulligan mobilization group in the current study, in contrast to the finding by Lopez *et al*., 2015 [21], who reported a significant change therein. This difference could be attributed to the fact that Lopez *et al*., 2015 [21] applied the PPT to the C2 for all subjects, whereas current study was only applied to the most painful spinus process for subjects. The PPT devices in both studies were also different. Lopez *et al*., 2015 [21] used a digital algometer (FDX 25, Wagner instruments, Greenwich, CT, USA) while an electronic algometer (Somedic AB, Farsta, Sweden) was utilized in current study, with the force being measured in kilograms/f (Kgf) and KaP/s in both studies respectively. Lopez *et al*., 2015 [21] treated patients with chronic neck pain, whereas subjects with both sub-acute and chronic neck pain were included in the present study. A significant widespread improvement was seen in both tibialis anterior PPT following Mulligan mobilization technique in the current study. Regarding the cervical ROM, a significant improvement in extension and rotation was shown in Maitland Mobilization group in current study. Previous studies support our finding and reported that cervical ROM

was not significant changes in all directions after immediate effect of central posteroanterior mobilization in cervical spine (Lopez *et al*., 2015) [21] or after immediate and 24 hours follow up of unilateral posteroanterior thoracic mobilization (Suvarnnato *et al*., 2013) [35]. In contrast to our result the previous studies were added routine physical therapy to Maitland mobilization and founded significant changed in all cervical ROM (Farooq *et al*., 2017, Griswold *et al*., 2015, Deepa, 2014, Gautam, 2014) [11, 15, 7, 13]. The study by Pérez *et al*., 2014 was reported significant change in all cervical ROM after 4 sessions of Maitland mobilization. The difference between previous study and our study may be because Pérez *et al*., 2014 applied unilateral posterior-anterior oscillatory pressure in 4 sessions to treat chronic neck pain only, compared to current study that applied central and unilateral posterior-anterior oscillatory pressure in 6 sessions to treat sub-acute and chronic neck pain. Mulligan mobilization was also demonstrated a significant overall improvement in ROM in the current study. This is similar to the findings of other studies (El-Sodany *et al*., 2014, Gautam, 2014, Pérez *et al*., 2014, Bowler *et al*., 2017) [9, 13, 5]. In comparison between both techniques, better results were achieved using Mulligan mobilization rather than Maitland mobilization to enhance ROM overall. This finding is supported by those in other research (Gautam, 2014, Sailor and Alagesan, 2011, Reid *et al*., 2014) [13, 30, 29] Maitland mobilization technique significantly decreased cervical JPSE in three directions (extension NHPE and THPE, right lateral flexion NHPE, right rotation NHPE and left rotation THPE). Improvement was observed in all directions, excepting flexion, but this improvement was not statistical significance. There was no research to date study the effect of cervical spine passive mobilization on JPS. The majority of previous studies were evaluated the impairment of JPS in traumatic and non traumatic neck pain (Woodhouse and Vasseljen, 2008, Loudon *et al*., 1997, Elsig *et al*., 2014, Stanton *et al*., 2016, Wibault *et al*., 2013, Vuillerme *et al*., 2008) [44, 22, 10, 33, 43, 42]. The efficacy of passive mobilization is due to stimulation of the mechanoreceptor within the joint and muscles, which results in increased proprioceptive awareness (Sterling *et al*., 2001) [34]. A significant decrease of THPE (left and right lateral flexion) was found following the application of Mulligan mobilization in the current study. There is a dearth of studies on the effect of Mulligan mobilization and cervical JPS. The current study result was consistent with the finding of Tachii, 2015 [36], in which it was demonstrated that the application of SNAG mobilization led to a significant improvement in JPS. A significant change in both rotation directions was not found following the use of Mulligan SNAG mobilization in the current study, similar to the finding by Reid *et al*., 2014 [29], that SNAG mobilization had no effect on rotation cervical JPSE in patients with cervicogenic dizziness. Mulligan and Maitland mobilization techniques involve the application of accessory gliding of cervical spine. This stimulates the articular mechanoreceptors, which in turn, excites the gamma motor neurons, thereby increasing muscle spindle sensitivity and improving proprioceptive awareness. Both techniques may also induce stretching of the anterior muscles (i.e. longus capitis and longus colli) or the dorsal intervertebral muscles. Similarly, stimulation of the mechanoreceptors within the muscle increases muscle spindle sensitivity via the gamma motor neurons, thus facilitating proprioceptive acuity (Sterling *et al*., 2001) [34]. There were some limitations in the findings of JPSE in the current study. An improvement in cervical JPSE in all cervical directions could not be established, possibly owing to the absence of high sensitivity in the measuring instrument used. Secondly, isometric exercises were not added to the mobilization technique employed in the current study, as was the case in previous researches (Tachii, 2015, Reid *et al*., 2014) [36, 29]. Thirdly, the number of times that the test is repeated is a crucial component of correctly performed JPS. At least six trials are needed in order to identify any significant JPSE-related changes (de Vries *et al*., 2015) [6].

Study limitations

- Combining the sub-acute and chronic non-specific neck pain
- The use of cervical ROM device to measure the joint position sense. It was not sufficient sensitive to detect the small changes.
- The speed of head movement during the JPS test was difficult to control. When the subjects move the head faster than 2.1 0/s the cervical input decreased, and the vestibular input increased (de Vries *et al*., 2015) [6].
- Small number of male subjects in the study.
- Small number of sub-acute cases

Conclusion and Recommendations

This study shows Mulligan mobilization had greater significant improvement of cervical ROM than Maitland mobilization. Maitland mobilization had more significant improvement of cervical pain pressure threshold than Mulligan mobilization. Further studies are needed to show the long term effect of these techniques, include more subjects with sub acute neck pain and more male subjects to participate. In addition to use more sensitive tools to measure the joint position sense.

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