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Effects of Maitland Orthopedic Manipulative Physiotherapy and Stretching applied to Cervical Vertebra on Pain, Range of Motion, and Muscle Tone of Adults with Forward Neck posture

The purpose of this study is to investigate effects of Maitland orthopedic manipulative physiotherapy and stretching on pain, cervical range of motion, and muscle tone of adults with forward neck posture. A total 40 subjects were divided into a Maitland OMPT group(n=20) and a stretching group(n=20), performing joint mobilization exercise and stretching three times per week for six weeks. As for changes in pain, statistically significant decrease were found before and after the exercise within group comparison($p<.01$), while no statistically significant difference was observed between-group comparison. In changes in cervical range of motion before and after the exercise, the Maitland OMPT group showed statistically significant increase($p<.01$) in flexion, (left lateral flexion($p<.05$), extension, left rotation, right rotation, and right lateral flexion, while the stretching group showed statistically significant increase($p<.05$) in extension($p<.01$), left rotation, left lateral flexion, right rotation, and right lateral flexion. However, no significant differences in between group comparison in flexion, extension, right rotation, left rotation, right lateral flexion and left lateral flexion. The results of measuring muscle tone changes showed that the Maitland OMPT group and the stretching group did not show significance in within and between group comparison($p<.05$). In conclusion, the Maitland OMPT and stretching were effective on improving pain and range of motion.

Key words: *Maitland; Orthopedic Manipulative Physical Therapy; Stretching; Forward Neck Posture*

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INTRODUCTION

Due to wide diffusion of personal computers and smartphones, students and office workers who usually use these devices are frequently complaining of musculoskeletal disorders in the neck and the shoulders(1). Long term use of visual display terminals such smartphones may induce musculoskeletal disorder including neck pain, low back pain, and shoulder pain(2). Kim et al. mentioned forward neck posture as a representatively poor posture, reporting that the posture is common in patients with temporomandibular disorder as well as changes in cervical curvature, bent shoulders, and asymmetric shoulder heights. A forward neck posture with cervical anterior tilting and head extension may induce compression on the occipital lower part, leading to referred pain such as headache in the back, the sides, and the front of the head(3). According to Calliet, forward neck posture increases flexion moment in the neck because the head is positioned forward, and induces compensatory retraction of the atlanto-axial joint and the atlanto-occipital joint to shorten the muscles at the back of the head and the neck and make the atlanto-axial bone protruded relatively forward(4). In addition, the posture induces stretch of cervical lower muscles and long term stretch causes loss of normal lordosis of the cervical vertebrae(5), while it weakens deep flexor muscles such as rhomboids, serratus anterior, and lower trapezius, and causes contraction of pectoralis major, pectoralis minor, upper trapezius, and levator scapularis(6,7).

Various methods have been provided to treat forward neck posture; joint mobilization uses passive traction and joint play to maintain or recover free joint mobility, a method that has been applied for reducing pain or treating joint dysfunction(7). Oh et al. reported that joint mobilization was helpful for improving posture of the cervical joint and functions of the head neck part(7). Lee showed that Kaltenborn joint mobilization was effective on improvement in range of motion, increase in craniovertebral angle and cranial rotation angle, and pain reduction of patients with forward neck posture(8). While joint mobilization is effective on forward neck posture treatment, each technique shows differences in intensity and range of application when used in orthopedic manual physical therapy(OMPT).

Maitland Orthopedic Manipulative Physiotherapy is one of the OMPT based on Brickwall concept. It consistently sets up and verifies hypotheses on patients' problems through clinical reasoning, displays the problems using movement diagram, and treats them with various physiological movement, five grade joint mobilization, and proper muscle training(9). Kim in a study of effects of the Maitland OMPT reported that a hip joint mobilization technique of Maitland Grade III was significantly effective on increase of range of motion in stroke patients(10).

Meanwhile, stretching as a main technique to treat forward neck posture has been variously applied in terms of intensity, period, and frequency based on clinical determination of therapists in order to resolve shortening, scar tissue formation, and limitation in range of motion by hypomobility(11,12). In addition, when applied after isometric contraction, stretching may improve flexibility and change muscular characteristics such as increase in muscular activity(12).

Choi reported that stretching was effective on correcting forward neck posture in normal people with such posture(13). Lee reported that four week stretching on patients with forward neck posture increased maximum contraction muscular activity and reduced the posture(6). According to Park, static stretching and Evienth-Hamberg stretching improved forward neck posture of subjects(14). Although there have been many studies on identifying effective intervention for improving forward neck posture, few researches have focused on improving the posture by application of OMPT. In this context, we applied the OMPT and stretching to subjects with forward neck posture to identify its treatment effects by comparing pain, range of motion, and muscle tone in their necks before and after the exercise.

METHODS

Subjects

Out of female and male students in a university in Chungcheongnam-do, 40 people who had at least mild deformity in forward neck displacement based on the New York State Posture Rating Chart were selected to be the subjects of this study. They were divided into a Maitland OMPT group(n=20) and a stretching group(n=20). All of them voluntarily consented to participation in this experiment, and we sufficiently explained the content and purpose of this study and received their consent.

Equipments

The devices and equipments used in this study are as seen in Table 1.

Research Methods

Maitland orthopedic manipulative physiotherapy

Joint mobilization exercise is applied in order to increase movement and to improve pain in the joints with movement limitation and pain. The Maitland Orthopedic Manipulative Physiotherapy

Table 1. Measuring devices and research equipments

	Equipment	Model	Company
Height & Weight	Inbody 4.0	BSM 330	Biospace(Korea)
Range of Motion	ROM measurement	Goniometers	Baseline(USA)
Muscle Tone	Muscle tone Palpation device	Myoton PRO	Myoton AS(Estonia)

in this study was applied as follows. A subject was asked to be in prone position on a bed for treatment; the investigator put his/her medial distal phalanx of a thumb on the spinous process of the cervical spinal segment with limited movement and assisted the position with his/her other thumb. For joint mobilization exercise, gliding to posterio-anterial direction was applied to the cervical vertebrae. The six week exercise at Grade III of Manipulative Movement in order to enhance mobility of cervical joints was performed with a session of 30 second exercise and 30 second rest for eight times, three times per week(15,16).

Stretching

The subjects in this study performed static stretching on the sternocleidomatoid and the trapezious upper three times per week for six weeks.

Sternocleidomastoid

As a subject was in supine position on a bed, the therapist held the head of the subject in a way that both ears of the subjects were conveniently wrapped by both hands of the therapist. Then, the therapist turned the head of the subject fully to the right, performing lateral flexion to the left and traction at the same time. The maximum stretching was maintained for 30 seconds and then 10 seconds of rest was applied by releasing the maximum stretching posture. The session was repeated four times, and thus a total 160 seconds were applied for the stretching.

Upper trapezius

When a subject was in supine position on a bed, the investigator wrapped the back of the subject's head with his/her right hand, supporting the subject's head with his/her wrist and arm, and holding the subject's chin with his/her left hand. Then, the investigator performed traction, inducing that the cervical vertebrae of the subject were gradually and fully turned to the right and were laterally flexed to the left. The initial stretching posture and period were consistent with those applied to the sternocleidomastoid.

Measurement

Measurement of Pain

We used the visual analogue scale as one of the commonly used pain assessment scales clinically in order to measure the neck pain of the subjects.

Measurement of Range of Motion of Cervical Vertebrae

We used a Goniometer to measure range of motion of the cervical vertebrae of the subjects. As the subjects were in an initial position without pain based on anatomical position, the investigator measured the angles of flexion, extension, left and right rotation, and left and right lateral flexion to the possible maximum active range of motion. All the angles were measure twice so that we obtained the mean values from these values. The measurements were performed before and after the six week experiment, on the movements of the cervical vertebrae.

Measurement of Muscle Tone

We used a digital touch, soft tissue measuring device(Myoton PRO) to assess the muscle tone of the subjects. The left and right sternocleidomastoid and the upper trapezius were measured in terms of muscle tone, which were consistent with the muscles applied by the stretching. The Myoton PRO is a non invasive device, enabling to measure muscle spasticity, elasticity, and muscle tone. It rapidly measures physiological conditions of the soft tissue, being smaller and more portable when compared to other measurement devices. It enables objective measurement as it compensates for interrater reliability as a weakness of the existing soft tissue measurement devices. The interrater reliability was referred to as r=.97 to 99, while the intrarater reliability was as r=.98 to 99(17).

Data Analysis

We used the SPSS(ver. 18.0 for Windows) for data analysis in the results of this study. Kolmogorow Smirnov test was used for testing normal distribution of all the data.

Changes in pain, range of motion, and muscle tone in the neck before and after the six week intervention were identified using statistical processing by paired t-test. Independent T-test was used for statistical processing in order to investigate between group differences of the Maitland OMPT group and the stretching group. For the level of statistical significance, α=.05.

RESULTS

Characteristics of the subjects

The general characteristics of the subjects are as seen in Table 1.

Table 1. Characteristics of the subjects (n=40)

	Maitland mean±SD	Stretching mean±SD	t	p
kg	68.29±14.15	65.92±6.61	-.53	.60
cm	169.44±10.67	170.19±8.11	-.58	.56
year	21.10±1.52	21.20±2.09	.12	.90

Changes in pain within and between groups

Within-group changes in cervical pain before and after the experiment

As for changes in cervical pain before and after the experiment in each group, the pain was reduced from 5.00±.81 to 2.70±1.41(p<.01) in the Maitland OMPT group and was reduced from 5.30 ±.94 to 2.80±1.22(p<.01), indicating both groups showed statistically significant improvement (Table 2).

Table 2. Comparison of cervical pain on each groups (M±SD)

Variable	Group	Pre-test	Post-test	t	p
VAS (Score)	Maitland	5.00±.81	2.70±1.41	-6.273	.000**
	Stretching	5.30±.94	2.80±1.22	-8.135	.000**

* p<.05, ** p<.01

Between-group changes in cervical pain before and after the experiment

The analysis of changes in cervical pain between the groups based on intervention method showed that no statistically significant differences were found in improvements in cervical pain between the two groups(Table 3).

Table 3. Comparison of cervical pain between the groups (M±SD)

Variable	Group	Rate of change	t	p
VAS (Score)	Maitland	-2.30±1.15	.418	.681
	Stretching	-2.50±.97		

* p<.05

Changes in cervical range of motion within and between groups

Within group changes in cervical motion before and after the experiment

As for changes in cervical motion of each group before and after the experiment, the Maitland OMPT group showed statistically significant improvement in all the cervical motions including flexion, left lateral flexion(p<.05), extension, left rotation, right rotation, and right lateral flexion (p<.01). In the stretching group, cervical motions including left rotation, right rotation, left lateral flexion, right lateral flexion(p<.05), and extension (p<.01) increased statistically significantly, and the flexion increased from 50.20±4.89(before) to 52.40±6.07(after the experiment). However, no significant improvement was observed(Table 4).

Between group changes in cervical motion before and after the experiment

As for changes in cervical motion before and after the experiment between the groups based on intervention, the Maitland OMPT group showed 3.10±3.78 for flexion, 8.70±6.66 for extension, 6.70±6.53 for left rotation, 7.80±6.16 for right rotation, 2.60±2.63 for left lateral flexion, and 6.50±4.97 for right lateral flexion, while the stretching group showed 2.20±4.23 for flexion, 7.80±4.04 for extension, 6.10±8.26 for left rotation, 5.00±6.83 for right rotation, 1.50±1.95 for left lateral flexion, and 3.50±4.00 for right lateral flexion. However, there was no statistically significant difference was found between the two group(Table 5).

Changes in muscle tone within and between groups

The muscle tone in the right scm before and after the Maitland OMPT increased from 15.08± 1.42Hz to 15.83±1.86Hz, which was not a significant change(p>.05). For the left scm, the muscle tone increased from 15.36±1.60Hz before to 15.71 ±1.50Hz after the experiment, which was not significant(p>.05).

The muscle tone in the right trapezius before and after the experiment increased from 15.00±1.66Hz to 15.14±2.08Hz, which was not a significant change(p>.05). For the left trapezius, the muscle tone increased from 15.80±1.08Hz before to 16.60 ±1.95Hz after the experiment, which was not significant(p>.05).

Table 4. Comparison of range of motion on each groups

(M±SD)

Variable	Group	Pre-test	Post-test	t	p
F(°)	Maitland	46.50±9.87	49.60±8.43	2.590	.029*
	Stretching	50.20±4.89	52.40±6.07	1.642	.135
E(°)	Maitland	37.00±11.78	45.70±10.39	4.126	.003**
	Stretching	38.40±6.53	46.20±6.35	6.091	.000**
Lt. R(°)	Maitland	48.40±6.96	55.10±7.92	3.243	.010**
	Stretching	48.40±6.29	54.50±4.90	2.334	.044*
Rt. R(°)	Maitland	48.50±8.47	56.30±9.26	4.004	.003**
	Stretching	50.50±2.91	55.50±6.11	2.315	.046*
Lt. SB(°)	Maitland	34.20±7.26	36.80±5.86	3.122	.012*
	Stretching	34.30±4.47	35.80±3.85	2.423	.038*
Rt. SB(°)	Maitland	30.10±3.31	36.60±4.71	4.134	.003**
	Stretching	33.80±4.87	37.30±5.12	2.762	.022*

* p<.05, ** p<.01
F : flexion, E : extension, Lt. R : left rotation, Rt. R : right rotation, Lt. SB : left side bending, Rt. SB : right side bending

Table 5. Comparison of range of motion between the groups

(M±SD)

Variable	Group	Rate of change	t	p
F(°)	Maitland	3.10±3.78	.501	.622
	Stretching	2.20±4.23		
E(°)	Maitland	8.70±6.66	.365	.719
	Stretching	7.80±4.04		
Lt. R(°)	Maitland	6.70±6.53	.180	.859
	Stretching	6.10±8.26		
Rt. R(°)	Maitland	7.80±6.16	.963	.349
	Stretching	5.00±6.83		
Lt. SB(°)	Maitland	2.60±2.63	1.060	.303
	Stretching	1.50±1.95		
Rt. SB(°)	Maitland	6.50±4.97	1.486	.155
	Stretching	3.50±4.00		

* p<.05
F : flexion, E : extension, Lt. R : left rotation, Rt. R : right rotation, Lt. SB : left side bending, Rt. SB : right side bending

The muscle tone in the right scm before and after the stretching increased from 13.57±0.93Hz to 13.96±0.83Hz, which was not a significant change(p>.05). For the left scm, the muscle tone increased from 14.18±1.41Hz before to 14.38±1.48Hz after the experiment, which which was not significant(p>.05).

The muscle tone in the right trapezius before and after the stretching increased from 15.80±1.08Hz to 16.60±1.95Hz, which was not a significant change(p>.05). For the left trapezius, the muscle tone increased from 15.65±2.45Hz before to 15.91±1.60Hz after the experiment, which was not significant(p>.05)(Table 6).

Table 6. Comparison of muscle tone on each groups

(M±SD)

		Pre	Post	t	p
Maitland	R. SCM	15.08±1.42	15.83±1.86	−1.53	0.13
	L. SCM	15.36±1.60	15.71±1.50	−0.66	0.51
	R. Tra	15.00±1.66	15.14±2.08	−0.41	0.68
	L Tra	15.80±1.08	16.60±1.95	−0.77	0.44
Stretching	R. SCM	13.57±0.93	13.96±0.83	−0.97	0.33
	L. SCM	14.18±1.41	14.38±1.48	−0.95	0.34
	R. Tra	15.80±1.08	16.60±1.95	−0.77	0.44
	L Tra	15.65±2.45	15.91±1.60	−0.31	0.76

As for between-group comparison, the muscle tone in the right scm was 16.22±2.41Hz in the Maitland OMPT group and 15.61±2.75Hz in the stretching group, showing no significant difference(p>.05). For the left scm, the muscle tone was 15.85±0.79Hz in the Maitland OMPT group and 16.04±2.17Hz in the stretching group, showing no significant difference(p>.05). The muscle tone in the right trapezius was 15.57±1.38Hz in the Maitland OMPT group and 15.33±2.14Hz in the stretching group, showing no significant difference(p>.05). For the left trapezius, the muscle tone was 15.75±2.47Hz in the Maitland OMPT group and 15.82±2.33Hz in the stretching group, showing no significant difference(p>.05)(Table 7).

Table 7. Comparison of rmuscle tone between the groups

(M±SD)

Variable	Group	Rate of change	t	p
Rt. SCM	Maitland	16.22±2.41	−0.97	0.33
	Stretching	15.61±2.75		
Lt. SCM	Maitland	15.85±0.79	−0.31	0.76
	Stretching	16.04±2.17		
Rt. Trapezius	Maitland	15.57±1.38	−0.87	0.39
	Stretching	15.33±2.14		
Lt. Trapezius	Maitland	15.75±2.47	−0.26	0.80
	Stretching	15.82±2.33		

DISCUSSION

In this study we applied the joint mobilization of the Maitland Orthopedic Manipulative Physiotherapy to the cervical vertebrae and stretching to the sternocleidomastoid and the upper trapezius for adults who had at least mild deformity in forward neck posture, measuring pain changes by the visual analogue scale and changes in range of cervical motion by gorniometer to identify therapeutic effects. When changes in the cervical pain were measured by the visual analogue scale for the Maitland OMPT group and the stretching group, both groups showed statistically significant reduction(p<.05). Similarly, Hyun observed statistically significant reduction in pain when join mobilization was applied to patients with cervical pain(18) ; Na provided significant effects on pain reduction when chiropractic therapy was applied to cervical disorder patients with military neck(19); and Jun reported that Kaltenborn joint mobilization significantly reduced the pain of patients with chronic cervical pain(20). Jeon et al. showed significant reduction in pain in the head and the neck

by stretching including flexion and extension(21), and Lee and Yoo reported reducing effects of stretching on patients with neck pain, all of which support the results of this study(22). The Maitland OMPT may stimulate sensory tissues such as the muscle spindle, the Golgi tendon organ, and the joint mechanoreceptor to affect reduction in pain and muscle spasm and the stretching may recover the length of the muscles to enhance range of joint motion to induce skeletal relocation and normal alignment of cervical vertebrae, reducing the pain. Both the Maitland OMPT group and the stretching group showed statistically significant increase in changes in cervical range of motion after the experiment. Similarly, Na reported that all the ranges of motion in the cervical vertebral portion of patients with military neck due to reduced cervical lordosis were enhanced by chiropractic therapy(19); Hyun reported significant increase in changes in cervical range of motion when patients with cervical pain were divided into a group of conservative physical therapy and a group of conservative physical therapy and joint mobilization technique for treatment(18). Such results may be affected by that joint mobilization normalized rolling and gliding, essential components of normal joint movement, to recover joint functions. Jeon et al. observed increase in cervical range of motion when stretching was applied to old patients(20) , and Park reported that Evjenth-Hamberg stretching and static stretching induced statistically significant differences in cervical range of motion of patients with forward neck posture, results that are consistent with those of this study(14). Stretching enhanced range of motion in the joints maybe because it extended the contracted muscles to recover their normal length to contribute to the enhancement. Not all the ranges of motion were increased, however, maybe because each subject varied in each range of motion. Meanwhile, the muscle tone of the Maitland OMPT group and the stretching group did not show statistically significant results both in within- and between-group comparison ($p<.05$). Such results are not consistent with those of Magnusson et al. in which muscular adaptation is controlled by mechanical, metabolic stimulation due to muscular contraction and relaxation and stretching of muscular fibers in exercise may serve as a main stimulus(23). It may be because the stimulation in this study was insufficient to induce changes in muscle tone. This study may be limited in that the number of the subjects was too small to generalize the therapeutic effects and that the effects could not be maximized because the cervical motion of the subjects was provided with one direction. Further studies are needed to generalize the effects with more subjects and sufficient research period and to develop proper therapeutic programs based on physical conditions of subjects.

CONCLUSION

We in this study investigated effects of Maitland orthopedic manipulative physiotherapy and stretching on pain, cervical range of motion, and muscle tone of adults who had at least mild deformity in forward neck displacement. The results of this study are as follows.

As for changes in pain, both the Maitland OMPT group and the stretching group showed statistically significant decreases before and after the exercise in within group comparison($p<.01$).

In changes in cervical range of motion before and after the experiment, the Maitland OMPT group showed statistically significant increase ($p<.01$) in flexion,(left lateral flexion($p<.05$), extension, left rotation, right rotation, and right lateral flexion, while the stretching group showed statistically significant increase($p<.05$) in extension, ($p<.01$), left rotation, left lateral flexion, right rotation, and right lateral flexion.

The results of measuring muscle tone changes showed that the Maitland OMPT group and the stretching group did not show significance in within and between group comparison($p<.05$).

In conclusion, both the Maitland OMPT and the stretching were effective on improving pain and range of motion.

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