

CHAPTER IV

RESULTS

The current study investigated the effectiveness of the single thoracic manipulation and the single thoracic mobilization techniques on the cervical range of motion measured by a Cervical Range of Motion (CROM) device, the pain level at rest using a visual analog scale, and the pressure pain threshold (PPT) using a pressure algometer in subjects with chronic mechanical neck pain. There are two main parts of the current study. The first part addressed the reliability of the measurement tools used in the current study and the second part focused on the effectiveness of the single thoracic manipulation and the single thoracic mobilization techniques on the cervical range of motion, pain level at rest, and pressure pain threshold.

4.1 Reliability of the measurement tools

4.1.1 The reliability of the Cervical Range of Motion (CROM) device

The intra-tester reliability of the CROM was performed in 10 healthy subjects. Each subject was measured for their cervical range of motion in flexion, extension, left and right lateral flexion and left and right rotation. Each subject performed three trials in each direction and rested for one minute between each direction. The data was recorded when the subject felt stretching at their neck. The intra-tester reliability protocol in the current study followed the method in the study of Youdas et al., (1991). The ICC (3, 1) was employed to test the intra-tester reliability in the current study. The results of the intra-tester reliability of cervical range of motion in the current study are shown in Table 1 and the raw data of each subject is presented in Appendix D.

Table 1 The intraclass correlation coefficients for the cervical range of motions using the cervical range of motion (CROM) device (N=10)

Motions (degrees)	ICC (3, 1)
Flexion	0.94
Extension	0.95
Left lateral flexion	0.97
Right lateral flexion	0.98
Left rotation	0.94
Right rotation	0.91

4.1.2 The reliability of the pressure algometer

The intra-tester reliability of the pressure algometer was investigated in 10 healthy subjects. Each subject was assessed for the pressure pain threshold (PPT) on levator scapulae, splenius capitis and upper trapezius muscles. Each subject was asked to perform two trials for each side on the splenius capitis, levator scapulae, trapezius muscles and on the sternum as a non-muscular site and rested for 30 seconds between each trial. The data was recorded when the pressure sensation turned into a pain sensation for each subject. The intra-tester reliability protocol of the current study was described by Ylinen et al., (2007). The ICC (3, 1) was employed to test the intra-tester reliability in the current study. The result of the intra-tester reliability of PPT on each muscle in the current study is shown in Table 2, and the raw data for each subject is presented in Appendix E.

Table 2 The intra-class correlation coefficient of the pressure pain threshold (PPT) using the pressure algometer (N=10)

Site of measurement	ICC (3, 1)
Left splenius capitis	0.95
Right splenius capitis	0.98
Left upper trapezius	0.98
Right upper trapezius	0.97
Left levator scapulae	0.95
Right levator scapulae	0.96
Sternum	0.96

4.2 Immediate effect of single thoracic manipulation and single thoracic mobilization on cervical range of motion, pain level at rest and pressure pain threshold

4.2.1 Demographic data

Thirty-three patients with chronic mechanical neck pain were recruited in the current study. Each subject was randomly assigned into three groups using a block randomized allocation. The mean demographic data and baseline of outcome measures for the subjects are showed in Table 3 and Table 4 respectively. The raw demographic data in each subject is presented in Appendix F.

Table 3 Demographic data of the subjects in the current study

Characteristic	Single thoracic manipulation (n=11)		Single thoracic mobilization (n=11)		Control (n=11)	
	Mean± SD	Range	Mean± SD	Range	Mean± SD	Range
Age (yrs)	35.33±11.60	21-52	40.58±11.75	22-58	35.18±11.48	22-51
Weight (kg)	62.45±10.09	48.5-82	57.33±8.52	47-74	56.75±8.28	44-70
Height (cm)	163.50±7.68	152-175	161.16±6.08	157-170	163.08±6.22	156-175
BMI (kg/m ²)	163.50±7.68	20.28-32.02	21.76±2.75	18.75-21.19	21.32±2.80	17.18-27.23

key: yrs = years, kg = kilogram, cm = centimeter, m = meter

Table 4 Baseline of outcome measures

Characteristics	Single thoracic manipulation	Single thoracic mobilization	Control
Pain level at rest : VAS (mm); mean ± SD	42.72±18.17	46.17±17.36	43.72±16.75
Cervical range of motion; mean ± SD			
Flexion (degrees)	57.66±7.85	59.45±7.53	59.75±10.48
Extension (degrees)	49.88±13.76	59.69±6.81	49.87±16.22
Left lateral flexion (degrees)	32.78±7.85	36.60±7.67	32.24±9.13
Right lateral flexion (degrees)	33.45±9.05	38.66±4.79	31.45±8.64
Left rotation (degrees)	52.96±6.42	56.60±8.23	54.60±10.52
Right rotation (degrees)	55.33±6.40	57.33±7.10	53.93±11.40
Pressure pain threshold; mean ± SD			
Left levator scapulae (kg)	4.44±1.86	4.11±1.61	4.11±1.74
Right levator scapulae (kg)	4.38±1.78	4.22±1.70	4±1.35
Left splenius capitis (kg)	3.25±1.51	3.05±1.22	3.18±1.77
Right splenius capitis (kg)	3.11±1.37	2.82±1.30	2.98±1.58
Left upper trapezius (kg)	3.96±1.86	3.70±1.63	3.60±1.97
Right upper trapezius (kg)	3.73±1.86	3.68±1.68	3.16±1.33
Sternum (kg)	2.71±1.00	2.89±1.03	3.13±1.17

key: kg = kilogram, mm = millimeter

4.2.2 Immediate effect of single thoracic manipulation and single thoracic mobilization on cervical range of motion

The significant differences of the cervical range of motion within the group in the three groups using a paired t-test are presented in Table 5. The results show that the cervical range of motion in the single thoracic manipulation group significantly increased in all directions ($p < 0.05$). The results in the single thoracic mobilization group significantly increased in flexion, left and right lateral flexion and left and right rotation ($p < 0.05$), but there is no significant difference in extension ($p = 0.076$), whereas, the results in the control group were not significantly changed in all directions ($p > 0.05$).

Table 5 The cervical range of motion of subjects within group

Motions (degrees)	Single thoracic manipulation (n=11)		Single thoracic mobilization (n=11)		Control (n=11)	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Flexion	5.21±5.35	0.009*	3.89±4.65	0.020*	2.12±5.79	0.253
Extension	7.93±5.19	0.000*	3.09±5.18	0.076	1.87±3.72	0.125
Left lateral flexion	6.06±4.34	0.001*	4.60±4.83	0.010*	1.45±4.99	0.357
Right lateral flexion	4.72±5.52	0.018*	2.84±3.40	0.020*	1.63±3.60	0.163
Left rotation	8.06±3.54	0.000*	5.27±6.12	0.017*	1.45±3.86	0.240
Right rotation	5.87±5.26	0.004*	6.84±7.95	0.017*	2.66±4.53	0.080

Key: * = Significantly different (p-value < 0.05)

^a = Paired T-test

When comparing between each pair using an analysis of covariance (ANCOVA) after adjustment for differences in baseline values of cervical range of motion (Table 6), the results show that the cervical range of motion in the single thoracic manipulation group significantly increased more than those in the control group in flexion, extension, left lateral flexion and left rotation ($p = 0.01$, $p = 0.005$, $p = 0.032$ and $p = 0.000$, respectively), but there were no significant differences in right lateral flexion and right rotation ($p = 0.068$ and $p = 0.126$, respectively). The cervical range of motion in the single thoracic mobilization significantly increased more than the control group only in flexion and left lateral flexion ($p = 0.011$ and $p = 0.035$, respectively). When comparing between single thoracic manipulation and

single thoracic mobilization, there were no significant differences in all directions ($p > 0.05$). The raw data of the cervical range of motion in each subject is presented in Appendix G.

Table 6 Comparison of cervical range of motion between groups (N=33)

Motions (degrees)	Control VS Single thoracic manipulation		Control VS Single thoracic mobilization		Single thoracic manipulation VS Single thoracic mobilization	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Flexion	6.73±2.50	0.015*	6.08±2.15	0.011*	0.02±2.20	0.990
Extension	6.14±1.92	0.005*	1.94±2.05	0.356	4.35±2.39	0.085
Left lateral flexion	3.63±2.00	0.032*	4.31±1.90	0.035*	0.88±1.99	0.664
Right lateral flexion	3.66±1.89	0.068	2.03±1.73	0.254	0.57±1.93	0.768
Left rotation	6.94±1.61	0.000*	3.65±2.20	0.114	3.23±2.21	0.161
Right rotation	3.10±2.13	0.162	4.12±2.87	0.168	1.38±2.96	0.646

Key: * = Significantly different (p-value <0.05)

^a = Analysis of covariance (ANCOVA)

4.2.3 Immediate effect of single thoracic manipulation and single thoracic mobilization on pain level at rest

The significant differences of the pain level at rest within group in the three groups using a paired t-test are presented in Table 7. The results show that the pain level at rest in the single thoracic manipulation group significantly decreased ($p = 0.007$), whereas, there were no significant difference of the pain level at rest within groups in both the single thoracic mobilization and the control groups ($p = 0.133$ and $p = 0.065$, respectively).

Table 7 The pain level at rest of subjects within group

Variable	Single thoracic manipulation (n=11)		Single thoracic mobilization (n=11)		Control (n=11)	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Pain level at rest : VAS (mm)	8.18±8.08	0.007*	6.55±13.2	0.133	7.09±11.3	0.065

Key: VAS = visual analog scale, mm = millimeter

* = Significantly different (p-value <0.05)

^a = Paired T-test

When comparing between each pair using an analysis of covariance (ANCOVA) after adjustment for differences in baseline values of pain level at rest, there were no significant differences between single thoracic manipulation and control groups, single thoracic mobilization and control groups, and single thoracic manipulation and single thoracic mobilization groups ($p = 0.551$, $p = 0.872$ and $p = 0.732$ respectively) (Table 8). The raw data for the pain level at rest in each subject is presented in Appendix H.

Table 8 Comparison of the pain level at rest between groups (N=33)

Variable	Control VS Single thoracic manipulation		Control VS Single thoracic mobilization		Single thoracic manipulation VS Single thoracic mobilization	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Pain level at rest : VAS (mm)	2.46±4.05	0.551	0.86±5.26	0.872	1.66±4.79	0.732

Key: VAS = visual analog scale, mm = millimeter

^a = Analysis of covariance (ANCOVA)

4.2.4 Immediate effect of single thoracic manipulation and single thoracic mobilization on pressure pain threshold

The significant differences of the pressure pain threshold (PPT) within group in the three groups using a paired t-test are presented in Table 9. The results show that the PPT of subjects in the single thoracic manipulation group significantly increased at left and right levator scapulae, left and right splenius capitis and left and right upper trapezius ($p = 0.001$, $p = 0.009$, $p = 0.018$, $p = 0.024$, $p = 0.040$ and $p = 0.046$, respectively), but there was no significant different change at sternum ($p = 0.170$), whereas, the results in the single thoracic mobilization and control groups were not significantly different in all areas ($p > 0.05$).

Table 9 The pressure pain threshold of subjects within group

Variable	Single thoracic manipulation (n=11)		Single thoracic mobilization (n=11)		Control (n=11)	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Left levator scapulae (kg)	0.65±0.46	0.001*	0.42±0.68	0.067	0.10±0.49	0.518
Right levator scapulae (kg)	0.21±0.20	0.009*	0.11±0.18	0.055	0.31±0.80	0.217
Left splenius capitis (kg)	0.45±0.52	0.018*	0.11±0.20	0.087	0.00±0.51	1.00
Right splenius capitis (kg)	0.33±0.41	0.024*	0.51±0.78	0.055	0.15±0.56	0.373
Left upper trapezius (kg)	0.40±0.56	0.040*	0.41±1.14	0.257	0.03±0.35	0.743
Right upper trapezius (kg)	0.41±0.60	0.046*	0.22±0.49	0.167	0.01±0.42	0.890
Sternum (kg)	0.29±0.65	0.170	0.20±0.35	0.087	0.00±0.44	1.00

Key: kg = kilogram, * = Significantly different (p-value <0.05), ^a = Paired T-test

When comparing between each pair using an analysis of covariance (ANCOVA) after adjustment for differences in baseline values of pressure pain threshold (Table 10), the results showed that the PPT in single thoracic manipulation group significantly increased more than those in the control group at left levator scapulae (p = 0.011), but there were no significant differences at right levator scapulae, left and right splenius capitis and left and right upper trapezius. The results have no significant differences for all muscles between the single thoracic mobilization and control groups and the single thoracic manipulation and single thoracic mobilization groups (p > 0.05). The raw data of the pressure pain threshold in each subject is presented in Appendix I.

Table 10 Comparison of the pressure pain threshold between groups (N=33)

Variable	Control VS Single thoracic manipulation		Control VS Single thoracic mobilization		Single thoracic manipulation VS Single thoracic mobilization	
	Mean±SD	p-value ^a	Mean±SD	p-value ^a	Mean±SD	p-value ^a
Left levator scapulae (kg)	0.57±0.20	0.011*	0.33±0.24	0.191	0.25±0.24	0.324
Right levator scapulae (kg)	0.12±0.24	0.609	0.35±0.23	0.154	0.15±0.08	0.074
Left splenius capitis (kg)	0.42±0.22	0.078	0.08±0.16	0.612	0.33±0.17	0.076
Right splenius capitis (kg)	0.14±0.19	0.461	0.35±0.27	0.214	0.21±0.26	0.421
Left upper trapezius (kg)	0.30±0.20	0.154	0.34±0.37	0.376	0.03±0.39	0.940
Right upper trapezius (kg)	0.43±0.22	0.071	0.02±0.21	0.894	0.18±0.23	0.444
Sternum (kg)	0.12±0.24	0.608	0.17±0.17	0.330	0.01±0.22	0.955

Key: kg = kilogram

* = Significantly different (p-value <0.05),

^a = Analysis of covariance (ANCOVA)

The current study shows that the single thoracic manipulation group significantly improved cervical range of motion, pain level at rest and PPT more than the control group and the single thoracic mobilization results in significant improvements in cervical range of motion in same directions in patients with chronic mechanical neck pain. However, there were no statistically significant differences of cervical range of motion, pain level at rest, and PPT between the single thoracic manipulation and single thoracic mobilization groups in patients with chronic mechanical neck pain.