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Adding Visceral Manipulation to Exercises on Pain, Range of Motion, Function, and Scapular Protraction in Patients with Non-Specific Neck Dysfunction After Dyspepsia

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ABSTRACT
Objective: The aim of this study was to investigate the effect adding visceral manipulation to exercise program on pain, range of motion, function, and scapular protraction in patients with non-specific neck dysfunction (NSND) after dyspepsia.**Design:** A single-blinded, randomized controlled study. **Setting:** Outpatient physical therapy setting.**Methods:** Sixty patients with NSND after dyspepsia (18-43 years) were recruited and allocated randomly into 3 equal groups.**Intervention:** Visceral Manipulation (VM) group, exercises group (EX) and VM plus EX group. The program was carried out 3 times a week for 6 weeks.**Outcome measures:** The cervical range of motion device for neck range of motion, Tape Measure for scapular protraction, Neck Disability Index (NDI) for neck function and visual analog scale for pain were used to assess participants at baseline and after 6 weeks of treatment. Results: There were statistically significant differences between the three groups on neck range of motion, neck pain, Cranio-cervical flexion, functional activity, and scapular retraction with preferring to VM plus Ex-group ($p < 0.05$). After six weeks of treatment, the mean (SD) for Pain and NDI were 18.75±6.85mm and 15.96±4.13 in the combined group; 227±8.01mm and 10.95±2.44 in the Ex-group; 37.75±8.65mm and 28.05±5.4 in the VM-group respectively.**Conclusion:** Adding VM to exercises was superior to either VM or exercises alone in improving range of motion, pain, functional activity, and shoulder retraction in patients with NSND after dyspepsia. However, exercises were more effective than VM on neck range of motion, craniocervical flexion, neck pain, functional activity, and scapular protraction.

Keywords:
Non-Specific Neck Pain, Dyspepsia, Visceral Manipulation, Stabilizing Neck Exercises.
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Introduction

Neck pain develops in 30 to 50% of adults every year, and in 50 to 85% of these individuals, the pain does not regress completely and becomes chronic.[1] Neck Pain is associated with poor posture, anxiety, depression, neck strain, and occupational activities.[2] The major type of neck pain is Non-Specific Neck Pain (NSNP) which have multifactorial etiology with no signs or symptoms of major structural pathology.[3] Stiffness, limited range of motion and functions impairment can occur at neck or the neighboring areas, as scapular region or thoracic spine, as a result of chronic neck pain leading to a negative impact on health-related quality of life.[1,4]

An estimated 20 to 60 % of patients with Gastrointestinal (GIT) disease have head and neck symptoms.[5] Ischemia and inflammation of visceral structures impair their mobility causing visceral dysfunction. Therefore, visceral nociceptors are activated making nociceptive painful stimuli that may be referred to the somatosensory system affecting somatic area.[6] When the gastric function is not normal, the neck may be affected through irritated sympathetic nerves.[7] Therefore, the pain may be referred to the cervical area that innervated by the same neural roots according to viscerosomatic convergence or convergence-projection theory.[8]

Dyspepsia is a GIT problem with a spectrum of symptoms like epigastric pain and burning, feeling bloated after a meal, early satiation, distension in the epigastric region, nausea and vomiting.[9] With dyspepsia, gastric and duodenal dysfunction occurred due to their motility disturbances might cause neck pain.[10]

American Physical Therapy Association (APTA) guidelines for neck pain prefer multimodal treatments that contain manual therapy and exercise because they were safe and effective for pain and disability at short and intermediate-term.[11,12] Visceral Manipulation (VM) is a manual technique that aims to diagnose, normalize, restore and improve mechanical, vascular, and neurologic visceral function.[13] Visceral Manipulation technique can detect mobility disturbances of intra-abdominal organs and treat them.6 Visceral Manipulation on patients with GIT problems showed improvements at pain sensation, functional activities, quality of life, and symptoms of underling diseases, and produced immediate hypoalgesic effect on related somatic tissue.[14]

Exercise is considered the first-line treatment of NSNP for restoring function, decreasing pain, and correcting biomechanical disturbances, psychological, and behavioral characteristics of chronic pain problems.[15] Also, exercise was used to increase the GIT motility and regularize the peristaltic motion which improve dyspepsia symptoms and reduce stress accompanying with dyspepsia.[16] Cervical stabilization exercises had positive effects of on the cervical range of motion (ROM), deep cervical flexors endurance, neck pain, disability and scapular protraction and improvements of posture and neck function, and the quality of life.[17-19]

The effect of VM in patients with NSNP after dyspepsia has been investigated;[20] however, the results should be considered with caution due to some important methodological limitations (i.e., pilot study, a single treatment session, immediate effect). To the best of the authors' knowledge, there is a lack of randomized controlled trials in literature about the effect of VM or specific exercise in patients with NSNP after dyspepsia. Therefore, the current study was conducted to investigate the effect of adding VM to stabilizing neck exercises on neck range of motion, neck pain, functional activity, and scapular protraction in patients with NSND after dyspepsia.

Materials and methods.

Study design.

The current study was a prospective, single-blinded, parallel group, randomized controlled trial. The current study was approved by the Faculty of Physical Therapy, Cairo university ethical committee board (P.T.REC/012/002376). This study was prospectively registered at the Pan African Clinical Trials Registry the reference number: PACTR202007913630105. Subjects were recruited from Mit Ghamer Central Hospital, Dhakahlia, Egypt, Ministry of Health. The study was performed at Mit Ghamer Central Hospital outpatient clinic from March 2021 to November 2022. The contributors had been knowledgeable about the aim, study benefits, right to withdraw at any time, and the attained information concealment. A written consent form was signed before participation. This study was reported according to CONSORT guidelines.

Participants.

All patients were recruited from referrals of internal medicine physicians and were screened for the eligibility to participate in this study. Sixty patients of both genders with NSND after dyspepsia had been selected based on the study inclusive criteria: age ranged from 18 to 43 years old, with body mass index range from 19 to 34 Kg/m^2, diagnosed by internal medicine physicians, with NSND more than 3 months. Exclusive Criteria were one of the followings: An acute infection, inflammation, or signs of serious disease as a tumor, a bleed in part of the body, a thrombosis, a perforated ulcer, enlarged lymph nodes, unexplained weight loss, aneurysm, or a heart condition, structural alterations or cervical abnormalities, history of cervical whip-lash type injury, surgery on the neck, shoulders, chest, or abdomen, or if treatment for neck pain two weeks prior to the study or using analgesics, muscle relaxants, and psychotropic and anti-inflammatory drugs in the 5 days prior to intervention.

Sample size.

To avoid type II error, the sample size calculation was conducted before the beginning of the study. G*power (*version 3.1.9.2; Germany*) was used to compute a priori sample size (F tests—multivariate analysis of variance [MANOVA]: repeated measures, within-between interaction), with an effect size of 0.49,18 80% power, and a two- sided 5% significance level. As a result, the overall sample size was 44 patients. This number was increased by 30% to be 60 patients to account for the dropout.

Randomization.

Sixty subjects were assigned randomly to receive Visceral Manipulation (VM Group), Stabilizing Neck Exercises (EX Group) or Visceral Manipulation and Stabilizing Neck Exercises (VM + EX Group) using computer-generated block randomization. The block size was set at 6 and 9 to avoid selection bias and limit variability among the groups. Sealed, sequentially numbered opaque envelopes were used to ensure concealed allocation. The first author, who was not involved in data collection, produced the randomization. When the fourth author opened the envelope, therapy was started based on group allocation. The fifth author, blinded to group allocation, collected data at baseline and when the treatment period ended.

Intervention

After the baseline measurements, envelopes were unfolded by the fourth author, who continued with treatment consistent with group allocation. Visceral manipulation and VM plus EX groups received visceral manipulation treatment for improving visceral motility and mobility. The specification of VM is a low load, long duration stretches along the lines of maximal fascial restrictions. Palpation was applied and the pressure was directly to the skin, into the direction of restriction just until resistance (tissue barrier) was felt. Once found, the collagenous barrier was engaged for 90 to 120 seconds for each technique without sliding over the skin or forcing the tissue until the fascia complex started to yield and a sensation of softening was achieved.[20,21] The VM intervention was applied once every week for 6 weeks. The details of the VM intervention are presented in **Supplementary (1).**

The exercises were applied for EX and VM plus EX groups. The therapeutic exercises divided to stretching neck exercises, stabilization exercises and dynamic neck stabilization exercises,[18, 22] as in **Supplementary (2).**Each exercise session comprised warm-up exercises, 45-minute stabilization exercises, and cool-down and stretching exercises, including neck and shoulder girdle muscles.[23] At stretching exercises, each exercise was repeated for 3 times and held for 20 seconds. The movements were applied slowly till the limit of pain then holding was applied for 20 seconds then returning back to the starting position. Resting was taken for 20 seconds then the movement was applied again at same manner for 3 times.[24]

The stabilization exercise training was designed to restore cervical muscle endurance and coordination. These exercises were applied for 3 sets, 10 repetitions, 10 s of contraction at repetition with 10 s of rest and 1 minute rest between sets.[25] Dynamic exercises training aimed to increase muscle strength. The progression of exercises was performed using different colors of Thera-Band (200-cm-long precut section of a Thera-Band, The Hygenic Corporation, Akron, OH) indicating varied resistance. Patients started with the Thera-band with the least resistance (colored red) at first 3 weeks. Each exercise was applied 3 sets to every exercise with different repetition every week. At first week, the patient made 10 repetitions, each one was lasted for 10 sec and rest for 10 sec then 1 minute rest was taken between sets. At the second week, the exercises were applied at same manner, but the repetitions were increased to 15 repetitions. At the third week, 20 repetitions were applied with the same color (same resistance) of the Thera-Band at same manner.[23] At the second 3 weeks after completing the exercises with the red Thera-Band, the patients changed it to more resistance color (green or blue) and were applying the same exercises at the same manner of the first 3 weeks with same sets, time, repetitions and rest time.[23] During the isometric exercises, elongation was encouraged to be maintained at 100%.[22]

Outcome measures

The demographic characteristics of participants such as age, gender, height, weight, body mass index was recorded at baseline. All the measured outcomes were assessed at baseline and at the end of the sixth week of the treatment program by the fifth author, who was blinded to the allocation. The primary outcome measures were neck ROM. The secondary outcomes were neck pain, functional activity and scapular protraction.

Cervical range of motion (CROM) assessment. The CROM device measured neck range of motions in flexion and extension, right/left lateral flexion, right/left rotation and craniocervical flexion and extension for each subject.[26,27] The CROM device has been extensively studied and has shown good reliability and validity compared to other methods of examination.[28]

Pain assessment. Visual analogue scale (VAS) is a valid, reliable, and appropriate for measuring pain sensation in clinical practice.[29] Visual analogue scale is a self-reported scale consisting of a horizontal or vertical line consisted of a 100-mm on the line with the description "no pain" on the far left and "worst possible pain" on the far right. The patient is asked to tick the line on the point that best refers to pain.[30]

Functional activity assessment. Neck disability index (NDI) is the most widely used and most strongly validated and reliable instrument for assessing self-rated disability or functional activity in patients with neck pain.[31] The Neck Disability Index is a self-report questionnaire that consists of 10 items concerning daily living, pain and concentration. Each item is scored from 0 – 5, 0 representing no disability and 5 signifying extreme disability. A minimum clinically important difference (MCID) of at least 5 points from a total of 50 is required to be clinically meaningful.32 The Arabic version of the NDI possesses adequate face and content validity, feasibility, internal consistency, and test-retest reliability to enable the measurement of the disability level in chronic neck pain patients.[32]

Scapular protraction assessment. Tape measure was used for measuring scapular protraction. The distance between the postero-lateral borders of the acromion and the vertebral spinous process at the intersection of a line connecting the inferior angle of the scapulae landmarks was measured for right and left scapula for each patient.[33]

Statistical analysis

SPSS software for Windows (*Chicago, IL, USA*) version 25.0 was used for statistical analysis. Intention to treat analysis with multiple imputation method was conducted to account for the data missing from the sixth-week measurements. Descriptive statistics were conducted for three groups at baseline. Shapiro-Wilk's test was utilized to examine the normality of data. Two-way mixed design MANOVA was conducted to detect differences between the groups on the combined mean change scores of neck range of motion, neck pain, functional activity and scapular protraction. The F value used reliant on Wilks' lambda and follow-up univariate ANOVAs were performed when the MANOVA demonstrated a significant effect ($P < 0.05$). Multiple comparisons were conducted with Bonferroni correction to avoid type 1 error. The significance level was set at ($p < 0.05$) for all statistical tests.

Results

The participants flow throughout the study is shown in **Fig. (1).** Seventy-five participants were enrolled to participate in the current study with NSNP after dyspepsia. Ten participants did not meet the inclusion criteria and five subjects refused to participate in the study. So, 60 participants were eligible to join the study, and they were allocated randomly into three equal groups. There were no adverse events or complains to the intervention. The demographic and clinical outcome data at baseline of all participants in VM group, EX group, and VM plus EX group are showed in **Tables (1) and (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 (1).**

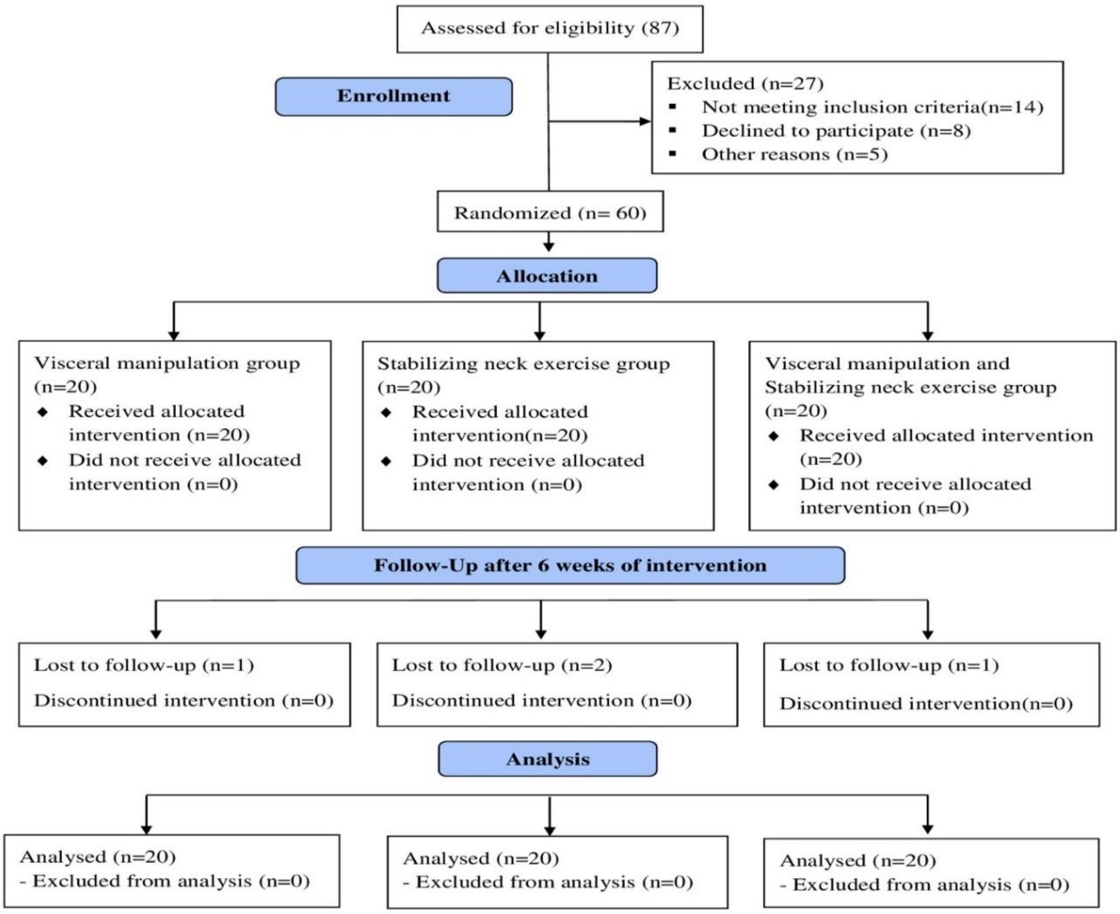

Fig (1): Participants' flow chart

Table (1): General characteristics of subjects.

General characteristics	Group VM (n=20)	Group EX (n=20)	Group VM + EX (n=20)	F-value	P-value
Age (years)	32.5± 8.2	30.8± 7.3	30.4± 7.6	0.427	0.655
Weight (kg)	77.5±12.4	74.9±13.3	75.2± 15.6	0.220	0.803
Height (cm)	172.3±8.9	170.8±8	169.9± 10.4	0.365	0.696
BMI (kg/m^2)	26 ±3.4	25.7±4.6	25.8± 3.8	0.031	0.969
Sex: Males, n (%) Females, n (%)	7 (35%) 13 (65%)	7 (35%) 13 (65%)	10 (50%) 10 (50%)	x^2 =1.2	0.535

VM, visceral manipulation group; EX, exercise group; VM+EX, visceral manipulation plus exercise group BMI, body mass index; M, males; F, females; P: probability; x2, chi square; data are represented as mean.

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

Variable	Group VM	Group EX	Group VM + EX	F- value	P value
Neck flexion (deg)	52.1±11.19	45.85±9.08	50.15±11.97	1.74	0.184
Neck extension (deg)	57.75±10.76	56.35±11.69	55.1±12.3	0.261	0.771
Neck Rt side bending (deg)	26.05±5.01	26.5±8.59	25.9±7.68	0.037	0.964
Neck Lt side bending (deg)	25.45±3.69	25.65±5.56	26.75±6.91	0.318	0.729
Neck Rt rotation (deg)	59.45±7.75	58±8.91	57.05±10.81	0.342	0.712
Neck Lt rotation (deg)	60.1±5.82	59.25±7.39	60.3±8.91	0.111	0.895
Craniocervical flexion (deg)	10.9±2.13	9.9±3.85	9.75±3.61	0.724	0.489
Craniocervical extension (deg)	26.1±9.3	24.6±9.5	24±7.2	0.300	0.742
Rt shoulder protraction (cm)	28.75±3.17	29.35±2.53	29.3±2.73	0.277	0.759
Lt shoulder protraction (cm)	29.15±2.94	29.85±2.97	29.95±3.17	0.413	0.663
NDI (%)	41.2±7.75	40.9±7.91	41.35±6.95	0.019	0.981
VAS (mm)	61.5±11.82	60.5±11.91	58±10.32	0.503	0.608

VM, visceral manipulation group; EX, exercise group; VM+EX, visceral manipulation plus exercise group; deg., degrees; cm, centimeter; NDI, Neck Disability Index; VAS, Visual Analogue Scale; p, probability; η2, partial eta square; Rt, right; Lt, left * Data are mean± SD, P-Value < 0.05 indicate statistical significance

Mixed design multivariate analysis was conducted to assess the difference between participants in the three groups in the amount of change in their scores on the outcome measures. Statistically Significant multivariate effects were found for the main effects of groups, Wilk's A = 0.068, $F_{24,92}$ = 10.83, P< 0.001, η^2 = 0.73, for time, Wilk's A = 0.015, $F_{12,46}$ = 246.7, p <0.001, η^2 = 0.98, as well as for the interaction between groups and time, Wilk's A= 0.028, $F_{24,92}$ = 18.93, p < 0.001, η^2 = 0.83.

There were significant effects regarding follow-up univariate ANOVAs after 6 weeks for neck ROM: neck flexion outcome variable, $F_{2,57}$ = 14.79, p = 0.001, η^2 = 0.342, neck extension outcome variable, $F_{2,57}$ = 17.65, p = 0.001, η^2 = 0.383, neck right side bending outcome variable, $F_{2,57}$ = 30.14, p= 0.001, η^2 = 0.514, neck left side bending, $F_{2,57}$ = 37.44, p = 0.001, η^2 = 0.568, neck right rotation outcome variable, $F_{2,57}$ = 15.37, p = 0.004, η^2 = 0.350, neck left rotation outcome variable, $F_{2,57}$ = 30.2, p = 0.476, η^2 = 0.514. Statistically significant changes for craniocervical joint movements: craniocervical flexion outcome variable, $F_{2,57}$ = 0.018, p = 0.982, η2 = 0.001, craniocervical extension outcome variable, $F_{2,57}$ = 0.554, p = 0.578, η2 = 0.019. Statistically significant changes for shoulder protraction: right shoulder protraction outcome variable, $F_{2,57}$ = 17.960, p= 0.001, η^2 = 0.387, left shoulder protraction outcome variable, $F_{2,57}$= 25.759, p = 0.001, η^2 = 0.475. Statistically significant changes for NDI and VAS: for NDI outcome variable, $F_{2,57}$ = 26.959, p = 0.001, η^2 = 0.486, and for VAS outcome variable, $F_{2,57}$ = 29.252, p = 0.001, η^2 = 0.507 as shown in **Table (3).**

Table (3). Clinical Characteristics of subjects after 6 weeks of Intervention (N=60)*

Variable	Group VM	Group EX	Group VM + EX	F- value	P- value	η^2
Neck flexion (deg)	49.95±8.57	56.4±6.51	63±7.52	14.79	0.001	0.342
Neck extension (deg)	54.4±8.89	61.85±10.38	70.3 ±5.28	17.65	0.001	0.383
Neck Rt side bending (deg)	30.9±4.06	35±3.97	40.3±3.45	30.14	0.001	0.514
Neck Lt side bending (deg)	30.3±3.84	34.45±3.37	39.4±2.66	37.44	0.001	0.568
Neck Rt rotation (deg)	63.4±6.81	68.95±7.52	75.4±6.15	15.37	0.001	0.350
Neck Lt rotation (deg)	64.3±5.98	69.15±4.95	78.65±6.74	30.2	0.001	0.514
Craniocervical flexion (deg)	12.6±2.68	14.85±2.68	17.7±2.63	18.363	0.001	0.392
Craniocervical extension (deg)	24.6±8.7	26±8.6	27.4±7.3	0.554	0.578	0.019
Rt shoulder protraction (cm)	26.9±2.51	24.6±2.43	22.4±2.16	17.960	0.001	0.387
Lt shoulder protraction (cm)	27.25±2.84	24.4±1.84	22.15±1.92	25.759	0.001	0.475
NDI (%)	28.05±5.4	20.45±6.07	15.96±4.13	26.959	0.001	0.486
VAS (mm)	37.75±8.65	27±8.01	18.75±6.85	29.252	0.001	0.507

VM, visceral manipulation group; EX, exercise group;VM+EX,visceral manipulation plus exercise group; deg., degrees;cm, centimeter; NDI, Neck Disability Index;VAS, Visual Analogue Scale; p, probability; η^2, partial eta square; Rt, right; Lt, left * Data are mean± SD, P-Value < 0.05 indicate statistical significance.

Between Groups Effects.

After 6 weeks of interventions, VM plus EX group showed superiority to VM and EX groups in neck range of motion, craniocervical flexion, neck pain, functional activity, and scapular protraction on patients with NSND after dyspepsia(*p*<0.05) except for craniocervical extension (*p*>0.05). Also, the EX-group showed superiority to VM group in all previous variables (*p*<0.05) except craniocervical extension (*p*>0.05)as in **Table (4).**

Within Groups Effects.

After 6 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 craniocervical extension (P>0.05) as in Table (5).

Table (4). Between Groups Effects after 6 weeks of intervention.

Outcome	Group VM versus group EX		Group VM versus group VM + EX		Group EX versus group VM + EX		η^2
	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value	
Neck flexion (deg)	-6.45 (-12.36,-0.53)	0.028	-13.05 (-18.96,-7.13)	0.001	-6.6 (-12.51,-0.68)	0.024	0.342
Neck extension(deg)	-7.45 (-14.05,-0.84)	0.022	-15.9 (-22.5,-9.29)	0.001	-8.45 (-15.05,-1.84)	0.008	0.383
Neck Rt side bending(deg)	-4.1 (-7.09,-1.11)	0.004	-9.4 (-12.39,-6.41)	0.001	-5.3 (-8.29,-2.31)	0.001	0.514
Neck Lt side bending(deg)	-4.15 (-6.74,-1.55)	0.001	-9.1 (-11.69,-6.5)	0.001	-4.95 (-7.54,-2.35)	0.001	0.568
Neck Rt rotation(deg)	-5.55 (-10.89,-0.21)	0.039	-12 (-17.34,-6.65)	0.001	-6.45 (-11.79,-1.11)	0.013	0.350
Neck Lt rotation(deg)	-4.85 (-9.48,-0.21)	0.037	-14.35 (-18.98,-9.72)	0.001	-9.5 (-14.13,-4.86)	0.001	0.514
Craniocervical flexion(deg)	-2.25 (-4.33, -0.16)	0.03	-5.1 (-7.18, -3.01)	0.001	-2.85 (-4.93, -0.77)	0.004	0.392
Craniocervical extension(deg)	-1.4(-7.8,5)	0.99	-2.7 (-9.1,3.6)	0.892	-1.3(-7.7,5)	0.99	0.019
Rt shoulder protraction (cm)	2.3 (0.44,4.15)	0.01	4.5 (2.64,6.35)	0.001	2.2 (0.34,4.05)	0.01	0.387
Lt shoulder protraction (cm)	2.85 (1.09,4.61)	0.001	5.1 (3.34,6.85)	0.001	2.25 (0.49,4.01)	0.008	0.475
NDI	7.6 (3.49,11.71)	0.001	12.09 (7.98,16.19)	0.001	4.49 (0.38,8.59)	0.02	0.486
VAS	10.75 (4.61,16.89)	0.001	19 (12.85,5.14)	0.001	8.25 (2.11,14.39)	0.005	0.507

VM, visceral manipulation group; EX, exercise group; VM+EX, visceral manipulation plus exercise group; deg., degrees; cm, centimeter; NDI, Neck Disability Index; VAS, Visual Analogue Scale; p, probability; η^2, partial eta square; Rt, right; Lt, left; MD, mean difference; CI, confidence interval, P-Value < 0.05 indicate statistical significance

Table (5). Within group changes from baseline to after 6 weeks of intervention

Outcome	Group VM (n=20) Change from baseline to 6weeks		Group EX (n=20) Change from baseline to 6weeks		Group VM + EX (n=20) Change from baseline to 6weeks	
	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value
Neck flexion	2.15 (-1.95,6.25)	0.29	-10.55 (-14.65,-6.44)	0.001	-12.85 (-16.95, -8.74)	0.001
Neck extension	3.35 (0.15,6.54)	0.04	-5.5 (-8.69, -2.31)	0.001	-15.2 (-18.39,-12.01)	0.001
Neckright side bending	-4.85 (-7.53,-2.16)	0.001	-8.5 (-11.18,-5.81)	0.001	-14.4 (-17.08,-10.47)	0.001
Neckleft side bending	-4.85 (-7.02,-2.67)	0.001	-8.8 (-10.97, -6.62)	0.001	-12.65 (-14.82, -10.47)	0.001
Neckright rotation	-3.95 (-7.14,-0.75)	0.016	-10.95 (-14.14,-7.75)	0.001	-18.35 (-21.54,-15.15)	0.001
Neckleft rotation	-4.2 (-6.63,-1.76)	0.001	-9.9 (-12.33,-7.46)	0.001	-18.35 (-20.78,-15.91)	0.001
Craniocervical flexion	-1.7 (-2.72, -0.68)	0.037	- 4.95 (-5.97, -3.92)	0.001	-7.95 (-8.97, -6.92)	0.001
Craniocervical extension	1.4(-2.1,5)	0.420	-1.4(-4.9, 2.1)	0.436	-3.4(-6.9, 0.17)	0.062
Right shoulder pro	1.85 (0.79,2.91)	0.001	4.75 (3.69,5.81)	0.001	6.9 (5.84,7.95)	0.001
Left shoulder pro	1.9(0.53,3.26)	0.007	5.45(4.08, 6.81)	0.001	7.8(6.43,9.16)	0.001
NDI	13.15 (10.48,15.81)	0.001	20.45 (17.78, 23.11)	0.001	25.39 (22.73,20.05)	0.001
VAS	23.75 (19.94,27.55)	0.001	33.5 (29.69,37.3)	0.001	39.25 (35.44,43.05)	0.001

VM, visceral manipulation group; EX, exercise group; VM+EX,visceral manipulation plus exercise group; deg., degrees;cm, centimeter; NDI, Neck Disability Index;VAS, Visual Analogue Scale; p, probability; Rt, right;Lt, left; MD, mean difference; CI, confidence interval, P-Value < 0.05 indicate statistical significance.

Discussion

The current study results opposed with authors hypothesis that there were no effects of adding visceral manipulation to stabilizing neck exercises on neck range of motion, neck pain, functional activity, and scapular protraction on patients with NSND after dyspepsia. Up to the author's knowledge, this study was the first study investigated the effect of adding VM to stabilizing neck exercise on patients with NSND after dyspepsia. The findings of this study revealed that adding VM to stabilizing neck exercise showed improvements of neck ROM, craniocervical flexion, neck pain, functional activity, and scapular protraction in patients with NSND after dyspepsia ($p<0.05$) except craniocervical extension ($p>0.05$) over either VM or stabilizing neck exercise alone.

The results of this study revealed improvements of neck ROM after the application of VM with stabilizing neck exercise in NSNP patients after dyspepsia. Visceral manipulation could release the tension in the supporting membrane connecting the visceral and musculoskeletal system in the cervical spine. It also improves the structural dysfunction and poor posture, therefore neck ROM improved.34 Stabilization exercises could enhance the kinesthetic awareness, stabilizing the spinal column and building and maintaining good posture.[35] Also, stabilization exercises could increase the coordination between the deep and the superficial neck muscles, improve balance between the scapular upward and downward rotator muscles, and increase soft tissue flexibility that allow neck to move more.[36,37]

Previous studies recommended that the multimodal intervention approach had better results.[18,21] This study results were supported by **Eguaras et al. (2019)**[38] who concluded that VM could improve cervical mobility, symptoms of Gastroesophageal Reflux (GERD), and C4 spinous process pressure pain threshold on patients with GERD. However, the study was applied for only 2 weeks with different population. On other hand, this result was partially consistent with **Silva et al. (2018).**[20] Author reported that there were significant improvements only for neck extension, right side bending, and left side bending after 7 days of treatment on 28 patients with NSNP after dyspepsia.20 This conflict may be due to the small sample size and the short intervention period of that study.

Previous studies supported this study results regarding the effect of stabilizing exercise on neck ROM.[35,37]**Gendy et al. (2021)**[35] concluded that stabilization exercises have beneficial effect on ROM, disability and pain on patients with chronic mechanical neck pain opposed to conventional physical therapy program. However, the participants were only females. Also, **Javdaneh et al. (2021)**[37] suggested that neck exercise training combined with the scapular stabilization exercise was more effective for increasing cervical ROM and reducing pain, forward head posture and scapula upward rotation with chronic neck pain and scapular downward rotation defects. While neck stabilization exercise increased neck ROM in the 3 plane measurements, scapular stabilization exercise had more effect on increasing transverse neck mobility.[39]

The results of this study revealed improvement of neck pain after the application of VM with stabilizing neck exercise in NSNP patients after dyspepsia. Visceral manipulation could stimulate the mechanoreceptors in the skin leading to activate A beta afferent fibers, thereby inhibiting pain. Also, VM of the stomach and liver has an immediate hypoalgesic effect on related somatic tissue through nociceptive inhibition of the phrenic nerve.[14] Stabilization exercise could increase the activity of motor pathway which might have an inhibitory effect on the pain center at brain, thus the pain sensation improved. During exercise, Endogenous opiates and Beta-endorphins could be released from the pituitary gland due to stimulation of muscle ergoreceptors (stretch receptors). These secretions could block both peripheral and central pain.[40] Also, stabilization exercises with stretching made an improvement in neuromuscular control that might activate descending inhibitory pathways from the midbrain.[41] Beside this, scapular stabilization exercises decreased the compression force on cervical facets causing neck pain reduction and decrease the tension in the axioscapular muscles, therefore the pain decreased.[37,39]

The results of this study were in a line with **Silva et al. (2018)**[20] who reported that VM of the stomach and liver decreased neck pain significantly of patients with NSNP after dyspepsia. Previous systematic review stated that stabilization exercise can provide some benefits to control neck pain.[42] In addition, **Celenay et al. (2016a)**[23] revealed that stabilization exercises with and without connective tissue massage might be effective for reducing pain, anxiety and physical health while increasing the quality of life in patients with chronic mechanical neck pain. **Kuo et al. (2020)**[19] suggested that cervical stabilization exercises improved neck pain, control of deep cervical flexors, craniovertebral angle, and the forward head posture. However, the study was a quasi-experimental study, and the participants were only violin players. In contrast, Villalta **Santos et al. (2019)**[6] showed that the application of VM alone or VM with exercise had the same effect on reducing the pain sensation. This conflict might be due to the small sample size (N=20), most of them were females (19 females,1male), sampling method(convenience),and different population(LBP with Dyspepsia) of that study.

Neck pain and dysfunction are strongly related at patient with NSNP and they affect directly on each other.[43] In this study, the application of VM with stabilizing neck exercise improved neck dysfunction in NSNP patients after dyspepsia. The mechanism of VM is depending on the plastic, viscoelastic and piezoelectric properties of connective tissues. Therefore, VM can release tensions and enhance tissue remodeling through manual gentle forces that reorganizing collagen fibers and changing the viscosity at treated area leading to decrease pain and restore function.[21] Functional activity improved by stabilization exercise through improving neuromuscular function, restore sensorimotor control of the cervical spine muscles and scapular muscles.[37,42]

This study results were supported by **Yangdol and Gandhi (2021)**[34] who reported that single session of visceral manipulation may benefit in improving the forward head posture, neck disability and reducing the pain for patient with NSNP. However, that study was a pilot study with small sample size. This study results were in line with **Ahmadreza et al.** (2016)[17] who mentioned that stabilization exercise was effective for patients with chronic neck pain in improving disability, pain, and cross-sectional area of deep flexor muscles. **El-Sayed et al. (2022)**[39] reported that stabilization exercise could reduce neck pain severity and functional disability.

Altered kinematic of the scapula may be present in subjects with chronic neck pain.[37]Therefore, normalizing the activation of the Serratus anterior and Trapezius muscles is essential for neck and shoulder rehabilitation.[44] According to the results of this study, VM with exercises could improve scapular protraction in NSNP patients after dyspepsia. The improvement of the proprioceptive communication through mechanical relation within the body after VM application decreased the pain threshold, structural abnormality, and faulty posture.[45] Also, VM could alter the activation of the Upper Trapezius muscle that normalize shoulder position through normalizing the activity of the Phrenic nerve.[20] Stabilization exercise improved scapular protraction through changing in motor recruitment or strengthening of muscles that are responsible for normalize shoulder function.[18] Besides, Scapular stabilization exercises and stabilization training could improve the control of the Serratus anterior, lower Trapezius, and upper Trapezius muscles, thus bring the scapula closer to normal position.[44]

This study results were enhanced with previous studies.[44,45]**Ghillodia and Gandhi, (2020)**[45] reported that VM improved mobility, pain and disability at right shoulder after two weeks of treatment on patients with adhesive capsulitis at right shoulder. However, the population was different. This study results were enhanced by **Im et al. (2016)**[44] who stated that stabilization exercise could improve the head posture, pain, quality of life and bring the scapula closer to normal positions in the patients with neck pain and forward head posture.

The study results showed improvements in neck ROM, craniocervical flexion, neck pain, functional activity, and scapular protraction on patients with NSND after dyspepsia either in VM or exercises alone. However, the exercises were more effective than VM on all the measured outcomes.

This study was limited by the duration of intervention that was for only 6 weeks, so further studies with long intervention periods should be conducted. The study was limited to small sample size, thus larger population will be needed in further studies. Besides, there was no long-term follow-up at this study; accordingly, further studies should be performed to investigate the long-lasting effect of interventions. Finally, the diet of participants that may affect dyspepsia was not controlled during the study. Therefore, further studies should be conducted to investigate the effect of different types of diets on the neck activity, ROM and pain.

Conclusion

Adding VM to exercises was superior to either VM or exercises alone in improving range of motion, pain, functional activity, and shoulder protraction in patients with NSND after dyspepsia. However, exercises were more effective than VM on neck range of motion, craniocervical flexion, neck pain, functional activity, and scapular protraction.

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Supplementary (1)
Visceral Manipulation Program

Program Content	Description
Mobilization of Stomach in Frontal Plane	▪ ***Starting Position***: The patient was lying in the side position; facing right and the therapist was standing behind the patient. ▪ ***Procedure*:**The cranial hand was placed on the lateral costal arch below the diaphragm, approximately at the level of ribs 6-7 on the left and the caudal hand was placed underneath, on top of the ventrolateral lower costal arch.With both hands, pressure was applied medially to press the ribs onto the stomach simultaneously to mobilize the ribs, and hence indirectly the stomach, in a caudal-medial direction. At the end of the movement, the position was held and rebound or vibrations were carried out a rebound or vibrations **(Eric U., 2011).**
 **Mobilization of the Stomach in the Frontal Plane.**	
Mobilization of Stomach in Transverse Plane.	▪ ***Starting Position:***The patient was lying in the side position, facing right and the therapist was standing behind the patient. ▪ ***Procedure***.The cranial hand was placed on the lateral costal arch below the diaphragm, approximately at the level of ribs 6-7 on the left. The thumb reached posteriorly and the fingers anteriorly onto the ribs. In the same way, the caudal hand was places underneath, on top of the lateral lower costal arch.With both hands, pressure was applied medially to press the ribs onto the stomach simultaneously to mobilize the ribs and hence indirectly the stomach, medially and in a rightward rotation. At the end of the movement, the position was held and rebound or vibrations were carried out a rebound or vibrations **(Eric U., 2011).**
 **Mobilization of the Stomach in the Transverse Plane.**	
Mobilization of Stomach in	▪ ***Starting Position:*** The patient was in the supine position, legs bent and the therapist was standing on

Frontal Plane with Long Leg Lever.	the patient's right side. ▪ ***Procedure:*** The cranial hand with the thenar was placed below the left costal arch onto the stomach and the caudal hand grasped the patient's left knee. With the cranial hand, mobilization of the stomach in a cranial-lateral direction was applied and with the caudal hand, both knees were pulled to the right side. At the end of the movement, continuous or intermittent pull on the structures was applied. Both hands are the punctum mobile. The mobilizing effect pertains to the gliding surfaces of the stomach with its caudal visceral joints **(Eric U., 2011).**
	 **Mobilization of the Stomach in the Frontal Plane with Long Leg Lever**
Mobilization of Liver in Frontal Plane with Long Leg Lever.	▪ ***Starting Position:*** The patient was in the supine position, legs bent and the therapist was standing on the patient's left side. ▪ ***Procedure***: The cranial hand with the thenar was placed below the left costal arch onto the liver and the caudal hand grasped the patient's right knee. Mobilization of the liver in a cranial-lateral direction was applied and with the caudal hand, both knees were pulled to the left side.At the end of the movement, continuous or intermittent pull on the structures was applied. Both hands are moving points. The mobilizing effect has an effect on the gliding surfaces of the liver with their caudal visceral joints **(Eric U., 2011).**
	 **Mobilization of the liver in the Frontal Plane with Long Leg Lever.**
Stretching Lesser Omentum.	▪ ***Starting Position:*** The patient was in the supine position, legs bent and the therapist was standing on the patient's left side. ▪ ***Procedure***:The right hand was placed left of the median line below the xiphoid process with four fingers next to each other on top of the stomach wall and the left hand was placed similarly onto the median line next to the right hand. With both hands, pressure was applied slowly posteriorly into the depth of the abdomen to lower the fascial tensions in this area. After penetrating deeply without pain, both hands were pulllateral for stretching the lesser omentum. The pull of this stretch was held for a maximum of 1 min**(Eric U., 2011)**.

<table>
<tr><td colspan="2">
Stretching the lesser Omentum.</td></tr>
<tr><td>Pylorus Treatment.</td><td>▪ Starting Position: The patient was in the supine position, legs bent and the therapist was standing on the patient's left side.
▪ Procedure.At the first the pylorus was detected through looking for the approximate projection on the stomach wall then about five finger-widths cranially above the naval fingers were placed slightly to the right, next to the median line. At this point, sliding posteriorly into the abdomen was performed to find a supple. This detection should be applied slowly, to give the superficial structures time to move out of the way and allow the fascia to relax. The pylorus is sensitive to palpation so small circulations, vibrations, or inhibitions on this point were applied, until the tonus and sensitivity were reduced (Eric U., 2011).</td></tr>
<tr><td colspan="2">
Pylorus Treatment</td></tr>
<tr><td>Myofascial Release of Diaphragm.</td><td>▪ Starting Position: The patient was in the supine position, legs stretched out and the therapist was standing at the head of the patient.
▪ Procedure: Both hands were placed bilaterally under the costal cartilages of the lower ribs (7th to 10th) with hypothenar regions of the hands and last three fingers. During the patient's inspiration, the therapist was gently pulling the points of hands contacts toward the head and slightly laterally, while elevating the ribs simultaneously. During exhalation, the therapist deepened hand contacts towards the inner costal margins with a greater progressive cephalic movement. This technique was repeated for 5 respiratory cycles (Fernández-López I et al., 2021).</td></tr>
</table>

Myofascial release of the diaphragm

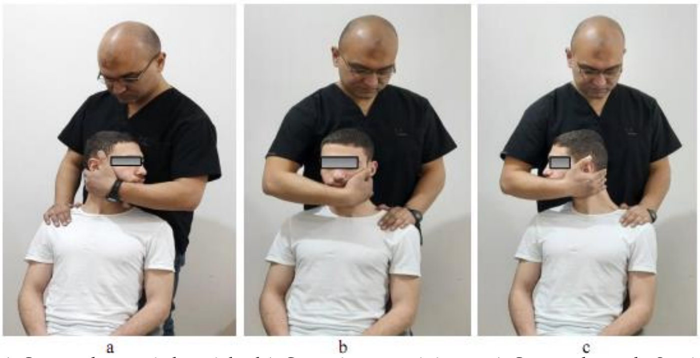
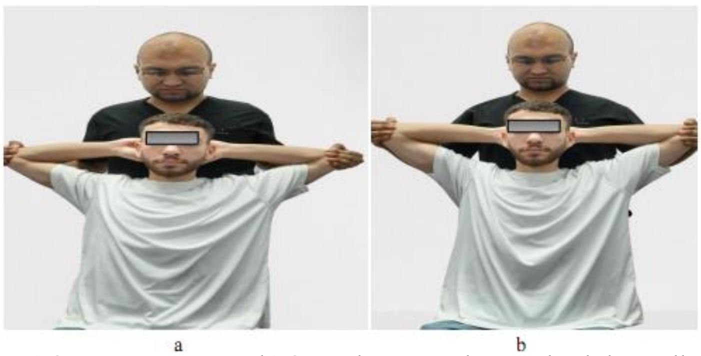
Supplementary (2)
Conventional Physical Therapy
(Stretching Neck Exercises, Neck Stabilization Exercises, Dynamic Neck Stabilization Exercises and Scapular Stabilization Exercises)

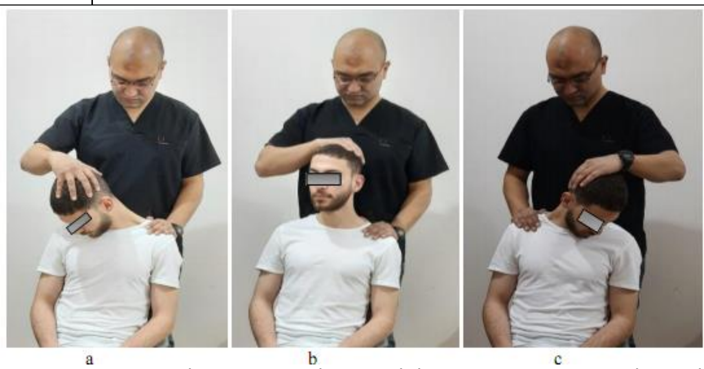
Program Content	Description
1- Stretching Neck Exercises.	
-Stretching Side Bending Muscles of Neck.	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position, and the therapist was standing back to the patient. ▪ ***Procedure***: The head was moved to side bending toward the shoulder at opposite side of the desired muscles as far as comfortable (to right muscles and left muscles). Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin., 2015).**

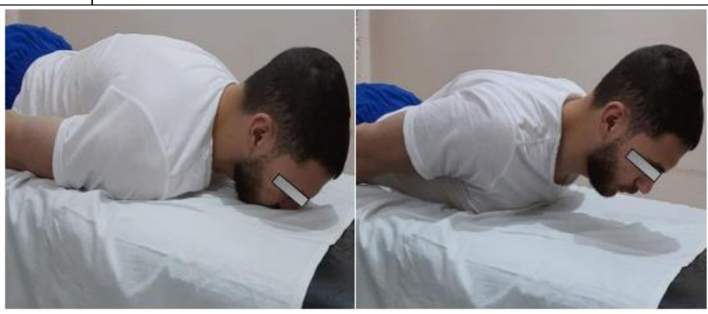
a b c

a) Stretch to left side b) Starting position . c) Stretch to right side.

Program Content	Description
- Stretching Neck Rotators.	▪ ***StartingPosition:*** The patient seated relaxed on chair with back support at upright position, and the therapist was standing back to the patient. ▪ ***Procedure***: The head was rotated toward the opposite shoulder of the

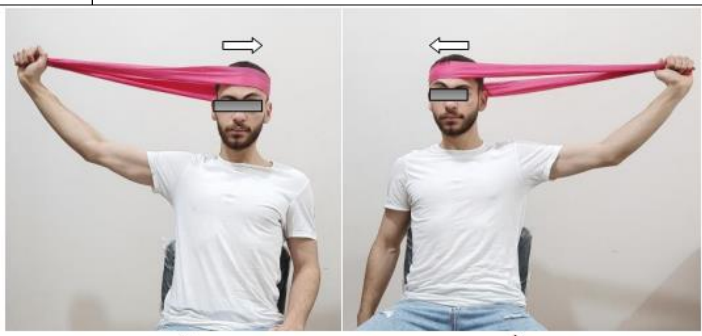
	desired muscles as far as comfortable (to right muscles and left muscles). Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin., 2015).**
 **a) Stretch to right side b) Starting position. c) Stretch to left side.**	
- Stretching Neck Flexors (unilaterally).	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position, and the therapist was standing back to the patient. ▪ ***Procedure:*** The head was rotated toward the opposite shoulder of the desired muscle then was side bending to the rotated side then extension of the head was applied as far as comfortable (to right muscles and left muscles). Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin ., 2015).**
 a**) Stretch to left side b) Starting position . c) Stretch to right side.**	
- Stretching of Pectorals Muscles (bilaterally).	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position both arms holding behind the neck, and the therapist was standing back to the patient. ▪ ***Procedure***: Both arms were moved slowly backward without movement of trunk as far as comfortable .Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin ., 2015).**
 **a) Starting position . b) Stretch pectorals muscles bilaterally.**	

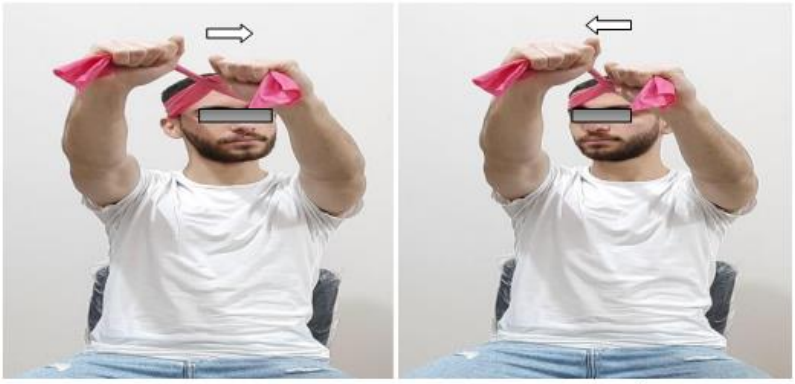
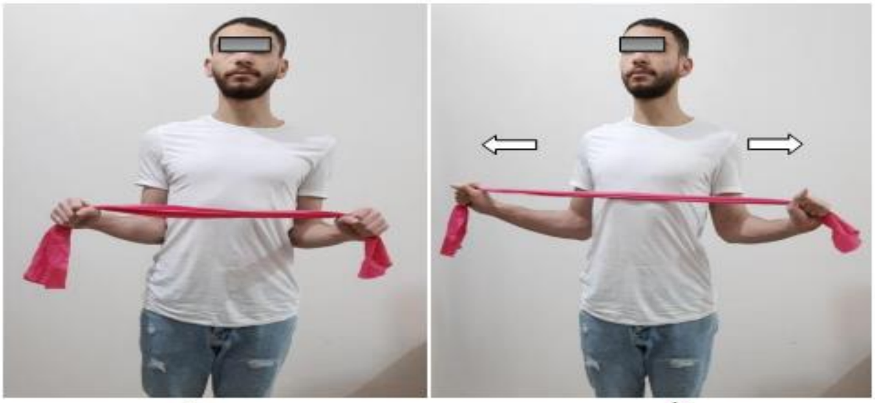
-Stretching Neck Extensors. **tretching of Upper Fiber of Trapezius (unilaterally).**	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position, and the therapist was standing back to the patient. ▪ ***Procedure:***The head was moved to right side then flexion of the head at same side was applied with slightly rotation as far as comfortable that was for the left muscle fibers then to the left side at same manner for the right muscle fibers. Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin., 2015).**
 **a) Stretch to left side b) Starting position . c) Stretch to right side**	
Stretching of Levator Scapulae (unilaterally).	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position, and the therapist was standing back to the patient. ▪ ***Procedure:*** The head was moved forward without pain then was rotated to right side as far as comfortable with good stabilization of the left shoulder that was for the left muscle fibers then to the left side at same manner for the right muscle fibers. Holding time was: 20 seconds, Repeated times were: 3 times **(Griffin., 2015).**
 ***a) Stretch to left side b) Starting position . c) Stretch to right side.***	
2-Stabilization Exercises **I-Neck Stabilization Exercises.**	
-Chin Tuck.	▪ ***StartingPosition:*** The patient was in relaxed supine position and relaxed with a towel in the posterior area of the neck. ▪ ***Procedure***: The patient pressed on the towel by his neck without pain for contracting the deep neck flexors (chin in). That was applied for 10 sec and resting for 10 sec (**Bernal-Utrera C et al., 2020**).

<table>
<tr><td colspan="2">
a b
a) Starting position. b) Flexion of upper cervical joint.</td></tr>
<tr><td>-Craniocervical Flexion Exercise (Co-contraction of Deep and Superficial Neck Flexors in Supine Decubitus).</td><td>▪ Starting Position.The patient was in relaxed supine position and with a towel in the posterior area of the neck.
▪ Procedure: The patient was making chin in then head flexion was applied without pain for contracting the deep and superficial neck flexors. That was applied for 10 sec and resting for 10 sec (Bernal-Utrera C et al., 2020).</td></tr>
<tr><td colspan="2">
a b
a) Starting position. b) Craniocervical flexion.</td></tr>
<tr><td>-Craniocervical Extension Exercise.</td><td>▪ StartingPosition:The patient was in relaxed prone position.
▪ Procedure: The patient was making chin in then head extension was applied without pain for contracting the deep neck extensors. That was applied for 10 sec and resting for 10 sec (Kuo Y Let al., 2020).</td></tr>
<tr><td colspan="2">
a b
a) Starting position. b) Craniocervical extension.</td></tr>
<tr><td>-Shoulder Shrugs.</td><td>▪ Starting Position:
The patient was in standing upright position with chin in.

▪ Procedure:
The patient was shrugging the shoulders, bringing them up towards the ears.
This was done for 10 repetitions (Kaka B et al., 2015).</td></tr>
</table>

 a b **a) Starting position. b) Shoulder shrugs movement**	
-Shoulder Rolls.	▪ ***StartingPosition:*** The patient was in standing upright position with chin in. ▪ ***Procedure:*** The patient was rolling the shoulders forward in a circle then to backward in a circle. Then participant relaxes and repeats the procedure for 10 times **(Kaka B et al., 2015).**
 a b **a) Starting position. b) Shoulder rolls movement**	
II- Neck Dynamic Stabilization Exercises.	
-Cervical Extension Dynamic Isometric (sitting).	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position one end the loop of the thera-band was attached to the participant's head and the other end to a sturdy stand. ▪ ***Procedure:***The patients was bending forward (chin in) and pushing backward as much as possible without pain, then holding for 10 sec and slowly returned to the starting position and took rest for 10 sec, keeping the spine posture erect throughout the exercise**(Bernal-Utrera C et al., 2020).**
 a b **a) Starting position. b) Isometric movement.**	
- Cervical Flexion-Dynamic Isometric (sitting).	▪ ***Starting Position:*** The patient seated relaxed on chair with back support at upright position one end the loop of the thera-band was attached to the participant's head and the other end to a sturdy stand.

<table>
<tr><td></td><td>▪ Procedure:The patients was bending forward (chin in) and pushing forward as much as possible without pain, then holding for 10 sec and slowly returned to the starting position and took rest for 10 sec, keeping the spine posture erect throughout the exercise (Bernal-Utrera C et al., 2020).</td></tr>
<tr><td colspan="2">
a b
a) Starting position. b) Isometric movement.</td></tr>
<tr><td>-Cervical Side Bending-Dynamic Isometric (sitting).</td><td>▪ Starting Position:The patient seated relaxed on chair with back support at upright position one end the loop of the thera-band was attached to the participant’s head and the other end to a sturdy stand.
▪ Procedure:The patients was bending forward (chin in) and pushing for making side bending as much as possible without pain (to right side then to left side), then holding for 10 sec and slowly returned to the starting position and took rest for 10 sec, keeping the spine posture erect throughout the exercise (Bernal-Utrera C et al., 2020).</td></tr>
<tr><td colspan="2">
a b
a) Isometric movement to the left side. b) Isometric movement to the right side</td></tr>
<tr><td>-Cervical Rotation-Dynamic Isometric (sitting)</td><td>▪ Starting Position: The patient seated relaxed on chair with back support at upright position, one end of the open the thera-band was at right hand and the other end was at left hand. The middle of band was made like a loop around head.
▪ Procedure: The patients was bending forward(chin in) and rotating the head as much as possible without pain (to right side then to left side),, then holding for 10 sec and slowly returned to the starting position and took rest for 10 sec, keeping the spine posture erect throughout the exercise (Bernal-Utrera C et al., 2020).</td></tr>
</table>

 a b **a) Isometric movement to the left side. b) Isometric movement to the right side**	
III- Scapular Stabilization Exercises	
-Scapular Retraction.	▪ ***Starting Position:*** The patient was in standing upright position with chin in. ▪ ***Procedure:*** The patient held the thera-band and both ends held at both hands then the patient was making a Scapular adduction and shoulder external rotation for 8 sec then graduated to 12 during later weeks as neck dynamic stabilization exercises **(Celenay S T et al., 2016 a).**
 a b **a) Starting position. b) *S*capular retraction movement.**	
-Chest Row Exercise (standing position).	▪ ***Starting Position:***The patient stood in front to a sturdy stand with upright posture and chin in, the middle of the thera-band is fastened securely to a sturdy stand at elbows level. ▪ ***Procedure*:**The patient was pushing both arms backward with flexed elbows as much as possible without pain this exercise was applied for 6 sec, 3 sets and 1 minute rest between sets. This exercise graduated in progression along weeks of exercise (6 sec for 1stweek, 8 sec for 2nd week, 10 sec for 3rd week) **(Celenay S T et al., 2016 aandKuo Y L et al., 2020).**

a b

a) Starting position. b) Chest row movement

-Chest Flies Exercises (standing position).	▪ ***Starting Position:*** The patient stood in front to a sturdy stand with upright posture and chin in, the middle of the thera-band is fastened securely to a sturdy stand at shoulders level. ▪ ***Procedure:***The patient was pushing both arms backward with extended elbows as much as possible without pain making them like Y shape. This exercise was applied for 6 sec, 3 sets and 1 minute rest between sets. Then this exercise was applied at same manner but in W shape of both arms and the patient was rotating both arms backward with stabilizing of both shoulders **(Fathollahnejad K et al., 2019**). This exercise graduated in progression along weeks of exercise (6 sec for 1stweek , 8 sec for 2nd week, 10 sec for 3rd week) **(Celenay S T et al., 2016 a and Kuo Y L et al., 2020).**

a b

a) Starting position. b) Chest flies movement.