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Prevention and Rehabilitation

The effectiveness of a multimodal approach in the treatment of patients with upper crossed syndrome: A randomized controlled trial

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ABSTRACT

Objectives: Considering the multitude of contributing factors to upper crossed syndrome (UCS), a multimodal treatment may be an effective therapeutic option. This study aimed to examine the effectiveness of the multimodal approach, including muscle energy technique (MET), cervical and scapulothoracic stabilization exercises, and postural correction training with ergonomic advice, in the treatment of patients with UCS.

Methods: This randomized controlled trial randomly assigned 40 patients with UCS aged 30–55 years to either group A (intervention group, n = 20) who received the multimodal approach or group B (control group, n = 20) who received MET only. The trial evaluated the craniovertebral angle (CVA) and sagittal shoulder angle (SSA) measured by photogrammetry, pain intensity estimated using the visual analog scale (VAS), and functional disability evaluated using the Arabic version of the neck disability index (ANDI) pretreatment and four weeks after intervention.

Results: The within-group analysis demonstrated a substantial decrease in VAS and ANDI and an increase in CVA post-intervention ($P < 0.001$). Only the multimodal group exhibited a significant change in SSA ($P < 0.0001$). Between-group differences were noteworthy, favoring the multimodal intervention ($P < 0.0001$).

Conclusions: A 4-week multimodal approach that comprises MET, cervical and scapulothoracic stabilization exercises, and postural correction training with ergonomic advice has remarkable improvements in CVA, SSA, pain intensity, and functional disability in patients with UCS, highlighting it as a superior choice.

1. Introduction

Upper crossed syndrome (UCS) is characterized by the altered activation of specific muscles and postural deviations of the head, neck, and shoulders. Alterations in muscle activation include tightness of suboccipital and short erector spinae muscles of the neck, levator scapulae, and upper trapezius (UT) muscles on the dorsal side crossed by tightness of pectoralis major and minor, sternocleidomastoid (SCM), and scalene muscles on the ventral side, and weakness of deep neck flexors (DNFs) on the ventral side crossed by weakness of rhomboids, serratus anterior (SA), and middle and lower trapezius muscles on the dorsal side (**Page et al., 2010**).

Furthermore, UCS is a combination of forward head posture (FHP) and rounded shoulder posture (RSP) associated with cervical hyperlordosis, thoracic hyperkyphosis, protraction and elevation of both shoulders, along with internal rotation, abduction, and winging of both scapulae i.e. scapular dyskinesis (**Kibler and Sciascia, 2010**; **Page et al., 2010**). Such changes lead to a variety of disorders within the body, including stress on the cranial-cervical and cervico-thoracic junctions, glenohumeral joint instability, and numerous musculoskeletal-related symptoms in the head, neck, and shoulders (**Kang et al., 2012**).

UCS poses a significant health concern in several developed

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countries. It is considered a work-related musculoskeletal disorder since it leads to substantial days off and the associated costs for compensation and disability (**Sim et al., 2006**). With the prevalence of this syndrome, it is of prime importance to find an effective and comprehensive treatment approach.

Exercise therapy is one of the most evidence-based approaches covering an essential part of patients with postural abnormalities (**Sheikhhoseini et al., 2018**). Stretching and strengthening exercises (**Ruivo et al., 2017**), muscle energy technique (MET) (**Gillani et al., 2020**), stabilization exercises (**Fathollahnejad et al., 2019**; **Kang et al., 2018**), myofascial release (**Kim et al., 2016a**), and posture correction exercises (**Shete and Shah, 2019**) have been approved as effective interventions. When used in isolation, these maneuvers focus primarily on stretching short muscles and strengthening weak ones while ignoring other UCS-related dysfunctions, such as motor control deficits and sustained poor posture. However, several review studies have questioned the effectiveness of strengthening and stretching exercises in addressing postural abnormalities (**Hrysomallis, 2010**; **Hrysomallis and Goodman, 2001**).

Despite the prevalence, functional disability, and economic consequences of patients with UCS, a substantial gap exists in the literature, which fails to provide adequate and high-quality evidence to effectively direct the conservative treatment of UCS (**Sahrmann et al., 2017**). From a clinical perspective, considering the diversity of the contributing factors to UCS, a multimodal treatment might be regarded as an effective therapeutic alternative. However, there is a lack of randomized clinical trials evaluating the efficacy of this approach. Accordingly, this study aimed to investigate the effectiveness of a multimodal approach. The approach includes MET, cervical and scapulothoracic stabilization exercises, and postural correction training with ergonomic advice on a craniovertebral angle (CVA), sagittal shoulder angle (SSA), pain intensity, and functional disability in patients with UCS. It was hypothesized that patients with UCS who received the multimodal approach would achieve better improvements than control patients who received MET alone.

2. Methods

2.1. Ethical considerations

The Ethical Board of the Faculty of Physical Therapy, Cairo University, has approved the trial (no: P.T.REC/012/002561). This study was reported in the Pan African Clinical Trial Registry with a record number (PACTR202001862833093). Each participant provided written consent and understood the right to withdraw from the study at any time. This study complied with the Declaration of Helsinki.

2.2. Design

A single-blinded, randomized, controlled trial.

2.3. Setting

This study took place in the physical therapy outpatient clinic of Al-Hekma, a specialized hospital for spinal disorders in Dakahlia, Egypt.

2.4. Sample size estimation

The sample size was determined using the G*Power software (version 3.0.10, Germany). Based on F tests (multivariate analysis of variance [MANOVA]: effects and interactions), 32 patients were an adequate sample size, with Type I error (α) = 0.05, power (1-α error probability) = 0.95, and effect size = 0.66, calculated from a pilot study of 10 patients who received the same program between July and November 2019. To account for the likelihood of dropout, forty patients were recruited (assuming a 20% dropout rate).

2.5. Patient recruitment and allocation

Forty patients of both genders aged 30–55 years who visited the physical therapy outpatient clinic of Al-Hekma specialized hospital for spinal disorders in Dakahlia, Egypt, were randomly recruited from December 2019 to October 2020. The inclusion criteria were as follows: patients who had been experiencing chronic upper body pain for >3 months, with CVA and SSA values of <48° (**Watson and Trott, 1993**) and <52° (**Raine and Twomey, 1997**), respectively, when evaluated through photogrammetry and those with weakness of the DNF, SA, rhomboids, and middle and lower trapezius muscles, and tightness of the UT, levator scapulae, scalene, suboccipital, and short erector spinae muscles of the neck, pectoralis major and minor, and SCM muscles, according to the specialized tests conducted (**Page et al., 2010**). All participants were conscious, cooperative, and not receiving analgesics.

Participants with severe obesity (**Horn et al., 2019**), marked limitations in shoulder ROM, leg length discrepancy, structural thoracic kyphosis, functional or structural scoliosis, visual deficits, pregnancy, cognitive impairment, osteoporosis, congenital deformity, and neurological disorders were excluded.

Patients who met the study's eligibility criteria were randomly allocated to either group A (intervention group, n = 20) who received a combination of MET, cervical and scapulothoracic stabilization exercises, and postural correction training in addition to ergonomic advice or group B (control group, n = 20) who received MET only.

Participants were randomized in a 1:1 ratio using computer-generated block randomization, followed by a concealed allocation by opening sequentially numbered and sealed envelopes; a card inside revealed the group assignment.

2.6. Outcome measures

The two groups were subjected to the same test battery: baseline and after a 4-week intervention. The evaluated parameters included CVA and SSA through photogrammetry, pain intensity through the visual analog scale (VAS), and functional disability through the Arabic version of the neck disability index (ANDI).

2.7. Assessments

2.7.1. Photogrammetry

The photogrammetric method has high inter- and intra-rater reliability and good validity compared with radiographs. Three anatomical points were marked on the shoulders with adhesive reflective markers: the right tragus of the ear, the midpoint between the greater tuberosity of the humerus and the posterior aspect of the acromion process, and C7 spinous process (Fig. 1). Patients were asked to stand comfortably while keeping arms beside their bodies and their weight evenly distributed on both feet. A digital camera (Canon IXY 16 MP, Japan) was placed on a tripod at a distance of 50 cm off the lateral aspect of the patient's right foot. The camera's height was adjusted to match the patient's height; thus, the camera was at the patient's tragus level. The horizontal alignment of the camera was adjusted using an inclinometer. While patients were looking at a fixed target in front of them, the therapist took three sagittal plane photos. The open-access Kinovea software assessed CVA and SSA on the digitized photographs (**Singla et al., 2017**).

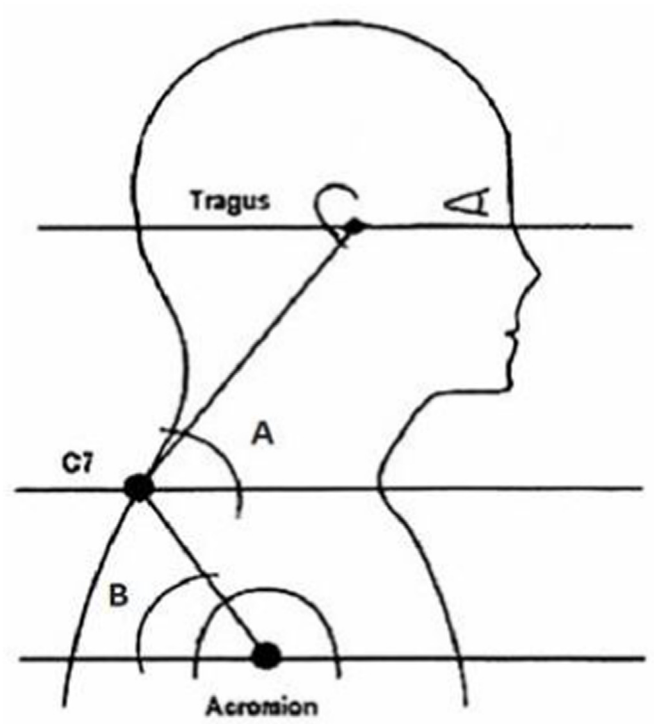

Fig. 1. Postural angles and adhesive marker placement: A, CVA; B, SSA.

CVA was defined as the point where the horizontal line drawn across the C7 spinous process intersects with the line drawn from the ear tragus to the C7 spinous process. SSA was defined as the intersection of a line drawn from the C7 spinous process to the midpoint in the lateral shoulder between the larger tuberosity of the humerus and the posterior portion of the acromion process and the horizontal line drawn across the same midpoint (**Singla et al., 2017**) (Fig. 1).

2.7.2. Pain intensity

The patient's pain intensity was assessed using VAS, which is a 10-point scale (ranging from 0 to 10), with 0 indicating “no pain” and 10 indicating “the worst possible pain.” The participants wore a vertical mark on the line to indicate the level of discomfort they were experiencing (**Price et al., 1983**).

2.7.3. Functional disability

The functional disability was evaluated by using ANDI. The index is a self-reporting questionnaire of the participant's perceived disability. ANDI is graded from 0 to 50 points, with ten categories and six distinct responses in each category. The patient selected the one that accurately describes his or her state, with higher scores suggesting greater disability (**Shaheen et al., 2013**).

2.8. Blinding

Single blinding was performed, wherein all assessments were performed by the same physical therapist, who was unaware of the patients' treatment group, and followed a standardized approach to ensure that the participants' positions, instructions, and overall test methods were consistent.

2.9. Intervention

The intervention group received a combination of MET, cervical and scapulothoracic stabilization exercises, and postural correction training with ergonomic advice three times/week for 12 sessions over 4 weeks (**Appendix 1**). All exercises were performed in small groups of no more than five participants.

Exercise variation was adjusted per American College of Sports Medicine standards (**American College of Sports Medicine, 2009**) to ensure adequate workouts. Each participant performed a conventional warm-up and cool-down exercise for 5 min at the start and end of each training session.

2.9.1. Muscle energy technique

The post-isometric relaxation technique—a type of MET—was applied to the shortened muscles. Each muscle was taken just short of the restriction barrier. Subsequently, the patient was asked to contract the muscle using 20% maximal isometric contraction against therapist resistance for 7 s. Once it had recovered from contraction, the muscle was stretched and held beyond the resistance barrier for 20 s for three repetitions (**Chaitow, 2013**). MET was applied to selected muscles during every session (**Appendix 1**).

2.9.2. Cervical and scapulothoracic stabilization exercises

Before executing cervical stabilization exercises, to ensure keeping the spine in a neutral position while achieving a correct DNF muscle contraction, the participants were trained to be familiar with DNF muscle activation employing the Chattanooga Stabilizer Pressure Biofeedback system (DJO Global, Vista, CA, USA) (**Jull et al., 2008**). The intra-class correlation coefficients of the biofeedback unit were 0.81 and 0.93 for the DNF muscle activation and performance assessments, respectively (**Jull et al., 1999**).

The cervical bracing approach with DNF activation was performed. The participants were instructed to keep their spines as neutral as possible during the exercises and throughout the day. The exercises were applied and progressed following those described in the literature (**Dusunceli et al., 2009**; **Ylinen et al., 2003**). The exercises comprised cervical spine bracing workouts in various neurodevelopment phases (supine, prone, quadrupedal, and bipedal). In each position, the participants sustained the contraction for 10 s, with 6–10 repetitions. All exercise repetitions were gradually raised from 8 to 12. Then, while keeping a stable spine, cervical isometric exercises were executed straight forward, obliquely, toward the right and left, and straight backward using elastic resistance bands, with 10 repetitions and a 6–10-s holding time. Furthermore, the workouts incorporated functional training with exercise balls on unstable surfaces to improve unconscious muscle activation, with 10 repetitions and a 10–15-s holding time.

Scapulothoracic stabilization exercises comprised particular exercises for the muscles affecting scapular alignment. The thoracic bracing approach was undertaken, which comprised postural alignment and minimal multifidus muscle activity while maintaining scapular orientation. The patients were instructed to keep their positions and contractions while performing the exercises, including scapular retraction, eccentric scapular retraction, scapular retraction combined with shoulder lateral rotation, forward punches, and dynamic hugs (**Mottram et al., 2009**; **Kisner and Colby, 2012**). The participants began working out with either the yellow or red latex TheraBand professional resistance bands (The Hygenic Corporation, Akron, OH, USA). They executed 10 repetitions, each with a 6–10-s holding time. After completing 15 repetitions without noticeable pain or tiredness, the participants proceeded to the next color of the resistance band in green and blue succession.

2.9.3. Postural correction training with ergonomic advice

The participants were asked to conduct postural correction exercises while sitting and standing with their backs against the wall and arms relaxed at their sides, with two mirrors reflecting their front and sides to achieve the proper position of the lumbar, thoracic, and cervical spines. Exercise intensity was determined according to the patient's symptomatic response (**Kisner and Colby, 2012**). **Appendix 2** demonstrates these exercises, and **Appendix 1** demonstrates the repetitions from sitting or standing positions. Moreover, the participants in this group received instructions on how to assume the proper posture in their daily lives (**Kim et al., 2016b**; **Van den Heuvel et al., 2003**; **Komiyama et al., 1999**), as demonstrated in **Appendix 3**.

The control group received MET only in the same manner as previously described in the intervention group, three times/week for 12 sessions over four weeks.

2.10. Statistical analysis

Before the final analysis, data were checked for normality hypotheses. The Shapiro–Wilk test showed that CVA, SSA, and ANDI data were normally distributed. Accordingly, to evaluate CVA, SSA, and ANDI at various testing groups and measuring periods, a $2 \times 2 \times 3$ mixed design MANOVA was utilized. Wilks' lambda was used to calculate the F value. When the MANOVA revealed a significant time $\times$ group interaction effect, an additional univariate analysis of variance (ANOVA, two-way mixed model) was performed. For VAS, the Wilcoxon signed-rank and Mann–Whitney U tests investigated the within-and between-group analysis, respectively. *P* values <0.05 were considered statistically significant.

3. Results

Of the 126 patients with UCS who were screened for eligibility, 83 did not meet the inclusion criteria, and three refused to participate. Consequently, 40 patients began their assigned therapies and completed the follow-up (Fig. 2). No documented adverse effects associated with the treatments were noted.

Repeated measures MANOVA indicated a significant main effect of time (Wilks' $\Lambda = 0.05$, $F(3, 36) = 195.61$, $P = 0.0001$, $\eta^2 = 0.94$), treatment (Wilks' $\Lambda = 0.42$, $F(3, 36) = 16.02$, $P = 0.0001$, $\eta^2 = 0.57$), and a substantial time $\times$ treatment interaction (Wilks' $\Lambda = 0.18$, $F(3, 36) = 51.72$, $P = 0.0001$, $\eta^2 = 0.81$). Follow-up univariate ANOVAs revealed a significant change for CVA ($F = 58.65$, $P < 0.001$, $\eta^2 = 0.60$), SSA ($F = 48.56$, $P < 0.001$, $\eta^2 = 0.56$), and ANDI ($F = 40.28$, $P < 0.001$, $\eta^2 = 0.51$). The difference between groups on a linear combination of outcomes varies between pre-and post-intervention, as indicated by the interaction effect.

Before the intervention, there was no significant difference between groups regarding demographic or clinical features ($P > 0.05$, Table 1). After the intervention, a significant increase in CVA and decrease in ANDI in the two groups were noted compared with the baseline ($P < 0.0001$). However, regarding SSA, only the multimodal group showed a significant difference ($P < 0.001$). In terms of the differential effects of the two groups on CVA, SSA, and ANDI post-intervention, multiple comparison analyses showed a substantial difference between the two groups while the major changes were in the multimodal group. The mean differences between the two groups at 95% confidence interval were −9.73 to −2.43, −13.06 to −2.18, and 43.55–19.23 for CVA, SSA, and ANDI, respectively (Tables 2 and 3).

For the multimodal and control groups, the Wilcoxon signed-rank test showed a significant reduction in pain intensity post-intervention relative to the baseline ($Z = -3.96$, $P < 0.0001$ vs. $Z = -3.85$, $P < 0.0001$, respectively). However, the Mann–Whitney *U* test demonstrated that the multimodal group had a greater improvement in pain intensity ($P < 0.0001$, 4.65 ± 1.59 vs. 0.00 ± 0.00).

4. Discussion

In this study, the outcomes of CVA, SSA, ANDI, and VAS in patients with UCS were investigated in a group that received a multimodal-based intervention relative to a control group that received MET only. After the 4-week intervention relative to the baseline, significant changes in the two groups' CVA, ANDI, and VAS were observed, with greater improvement in the multimodal group. However, regarding SSA, only the multimodal intervention showed a significant change. For all parameters, between-group variations were noteworthy.

Normalization of the cervical curve is likely responsible for improving shoulder alignment. This finding is supported by previous reports that FHP could trigger RSP in the sagittal plane (**Seidi, 2014**). Reducing the sagittal head alignment improved the three-dimensional spinal posture of the thoracic region (**Diab, 2012**). In the current study, FHP could be corrected by reestablishing normal muscular balance by strengthening weak muscles and stretching tight ones (**Gillani et al., 2020**; **Lynch et al., 2010**).

DNF is responsible for maintaining normal cervical lordosis (**Kettler et al., 2002**). FHP places the DNF in a lengthened position, triggering a mechanical disadvantage and leading to deficient head and cervical spine motor control. Considering this association between FHP and DNF muscle performance, the motor control deficits in the DNF muscles may not be fully resolved by solely retraining head posture through MET. More specific training of the craniocervical flexor muscles can, therefore, effectively enhance DNF muscle activation and boost the ability to keep the upright posture of the cervical spine (**Gupta et al., 2013**). Similarly, RSP puts the main scapular stabilizers—the SA, rhomboids, and middle and lower trapezius muscles—in a lengthened position, thereby creating an abnormal scapulothoracic alignment and rhythm, which can also not be completely corrected by applying MET alone (**Lynch et al., 2010**; **Struyf et al., 2013**).

SA, lower trapezius, and UT work in synergy to produce scapular elevation and lateral rotation during the overhead elevation of the arm (**Kang et al., 2018**). In patients with UCS, UT is overactive, whereas SA and lower trapezius are underactive (**Lynch et al., 2010**). Cervical and scapulothoracic stabilization exercises and MET appear to normalize the tension of these muscles by changing the length-tension relationship. Thus, it enhanced scapulothoracic alignment and reestablished appropriate scapulothoracic rhythm (**Kang et al., 2018**; **Ludewig et al., 2004**).

UCS seems to be a multifactorial disorder since several risk factors might contribute to its development. One of the risk factors is the sustained adaptation of faulty posture in daily life (**Janwantanakul et al., 2012**); therefore, adopting a proper posture is mandatory. The efficacy of posture correction exercises and ergonomic advice in correcting postural abnormalities, such as FHP and RSP, has been reported in previous studies (**Shete and Shah, 2019**; **Ruivo et al., 2016**).

This study showed a significant decrease in pain intensity. The improvement in pain seems attributable to restoring the normal posture of the head, neck, and shoulders. FHP and RSP can increase the stress applied to the articular, neural, and muscular tissues of the neck and upper limbs, leading to pain based on central nervous system tolerance and adaptability (**Kim and Kim, 2016**). In addition, repeated mechanical stress over time may induce the development of algogenic materials, resulting in tissue hyperalgesia (**Merinero et al., 2017**).

The findings of this study are consistent with those of several previous studies that demonstrated a substantial beneficial impact on neck and shoulder pain from specific interventions intended to decrease FHP and RSP (**Ruivo et al., 2016**; **Moustafa et al., 2018**). Furthermore, preliminary studies in patients who use devices to

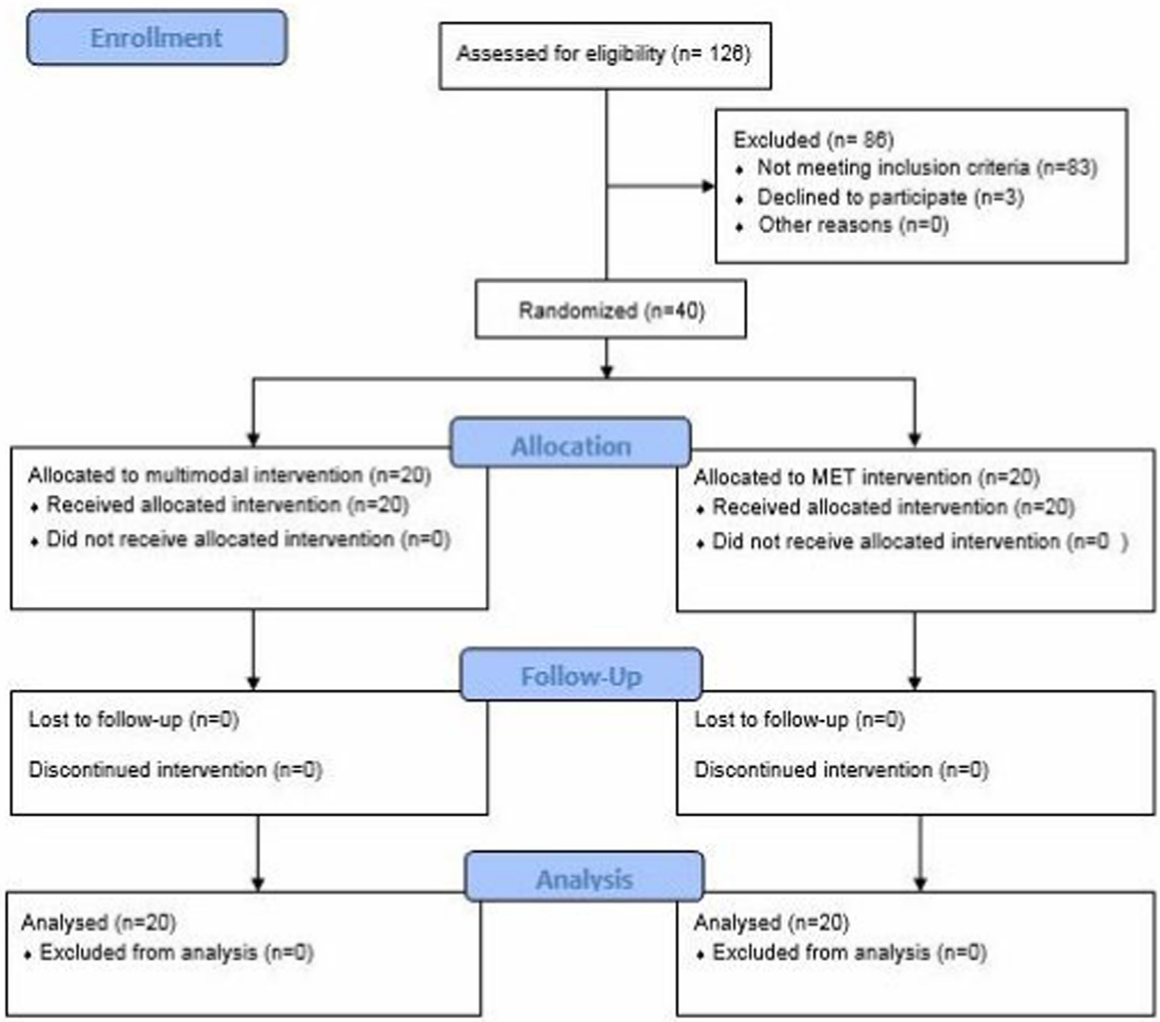

Fig. 2. Flow diagram of the study.

Table 1
Baseline demographic and clinical characteristics of patients.

Characteristics	Multimodal group Mean ± SD	Control group Mean ± SD	Mean difference	95% CI	*P*-Value
Age (years)	42.90 ± 8.52	44.45 ± 10.10	−1.55	(-7.53, 4.43)	0.603
Height (cm)	167.75 ± 9.50	161.65 ± 4.80	6.10	(1.27, 10.92)	0.201
Weight (kg)	87.05 ± 11.94	83.40 ± 15.45	3.65	(-5.19, 12.49)	0.409
BMI (Kg/m^2)	30.90 ± 3.11	32.06 ± 5.23	−1.16	(-3.91, 1.59)	0.818
CVA (deg.)	40.34 ± 4.25	41.49 ± 4.01	−1.14	(-3.79, 1.50)	0.387[a]
SSA (deg.)	46.53 ± 3.99	44.74 ± 6.02	1.78	(-1.48, 5.06)	0.276[a]
ANDI (%)	48.89 ± 16.13	55.06 ± 14.46	−6.16	(-15.97, 3.64)	0.211[a]
VAS	7.85 ± 1.26	7.65 ± 1.81			0.841*

CVA = Craniovertebral angle; SSA = sagittal shoulder angle; ANDI = Arabic version of the neck disability index; VAS = visual analogue scale; SD = standard deviation; deg. = degrees; CI = confidence interval; [a] = adjustment for pairwise multiple comparison: Bonferroni; * = value estimated by the Mann-Whitney *U* test. Level of significance at $P < 0.05$.

restore the cervical curve have shown improved neck pain, dizziness, disability, positioning sense, and somatosensory evoked potentials (Moustafa et al., 2017, 2018). Therefore, restoring the normal sagittal configuration is likely to reduce abnormal stresses.

Due to the abnormal positioning of the head and neck joints and muscles, FHP can affect neck proprioception (**Yong et al., 2016**). Proprioceptive feedback loss contributes to functional disability, wherein it affects head and neck muscle function, muscle spindles, reaction time, postural control, and postural stability (**Armstrong et al., 2005**). The findings of this study are consistent with those of previous studies (**Yip et al., 2008**; **Ghamkhar and Kahlaee, 2019**), wherein we identified a statistically significant improvement in CVA and a consequent improvement in ANDI after the 4-week intervention. Such findings support the assumption that neck disability can eventually be reduced by normalizing head posture.

Table 2
Craniovertebral angle, sagittal shoulder angle, functional disability, and pain intensity post-intervention.

Characteristics	Multimodal group Mean ± SD	Control group Mean ± SD	Mean difference	95% CI	*P* Value
CVA (deg.)	50.07 ± 2.63	43.92 ± 4.38	6.14	(3.83, 8.46)	0.0001[a]
SSA (deg.)	59.60 ± 6.31	46.92 ± 6.46	12.67	(8.58, 16.76)	0.0001[a]
ANDI (%)	5.34 ± 2.96	35.83 ± 11.91	−30.48	(-36.04, −24.93)	0.0001[a]
VAS	0.00 ± 0.00	4.65 ± 1.59			0.0001*

CVA = Craniovertebral angle; SSA = sagittal shoulder angle; ANDI = Arabic version of the neck disability index; VAS = visual analogue scale; SD = standard deviation; deg. = degrees; CI = confidence interval; [a] = adjustment for pairwise multiple comparison: Bonferroni; * = value estimated by the Mann-Whitney *U* test. Level of significance at $P < 0.05$.

Table 3
Craniovertebral angle, sagittal shoulder angle, functional disability, and pain intensity pre-and post-intervention.

Characteristics		Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean difference	95% CI	*P*-Value
CVA (deg.)	Multimodal group	40.34 ± 4.25	50.07 ± 2.63	−9.73	(-11.09, −8.36)	0.0001[a]
	Control group	41.49 ± 4.01	43.92 ± 4.38	−2.43	(-3.80, −1.07)	0.001[a]
SSA (deg.)	Multimodal group	46.53 ± 3.99	59.60 ± 6.31	−13.06	(-15.30, −10.83)	0.0001[a]
	Control group	44.74 ± 6.02	46.92 ± 6.46	−2.18	(-4.42, 0.05)	0.055[a]
ANDI (%)	Multimodal group	48.89 ± 16.13	5.34 ± 2.96	43.55	(38.07, 49.04)	0.0001[a]
	Control group	55.06 ± 14.46	35.83 ± 11.91	19.23	(13.74, 24.71)	0.0001
VAS	Multimodal group	7.85 ± 1.26	0.00 ± 0.00			0.0001*
	Control group	7.65 ± 1.81	4.65 ± 1.59			0.0001*

CVA = Craniovertebral angle; SSA = sagittal shoulder angle; ANDI = Arabic version of the neck disability index; VAS = visual analogue scale; SD = standard deviation; deg. = degrees; CI = confidence interval; [a] = adjustment for pairwise multiple comparison: Bonferroni; * = value estimated by the Wilcoxon signed-rank test. Level of significance at $P < 0.05$.

This study has some limitations. First, the patients were chosen based on convenience sampling, which could not represent the whole population with UCS. Moreover, follow-up details on the participants' health status that would better track the long-term effects of the multimodal approach are not available; therefore, it would be beneficial to address this in future studies.

5. Conclusion

In patients with UCS, a 4-week multimodal treatment incorporating MET, cervical and scapulothoracic stabilization exercises, and postural correction training with ergonomic advice resulted in significant improvements in CVA, SSA, pain intensity, and functional disability, suggesting it as a preferable choice.

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CRediT authorship contribution statement

Yasser M. Aneis: Conceptualization, Methodology, Software, Data curation, Writing – original draft, preparation, Supervision, Software, Validation, Writing – review & editing. **Noha M. El-Badrawy:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, Visualization, Investigation, Supervision, Software, Validation, Writing – review & editing. **Abd-Elrahman A. El-Ganainy:** Data curation, Writing – original draft, preparation, Visualization, Investigation, Writing – review & editing. **Hanaa Kenawy Atta:** Conceptualization, Methodology, Software, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Software, Validation, Writing – review & editing.

Declaration of competing interest

The authors have declared no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbmt.2022.05.011.

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