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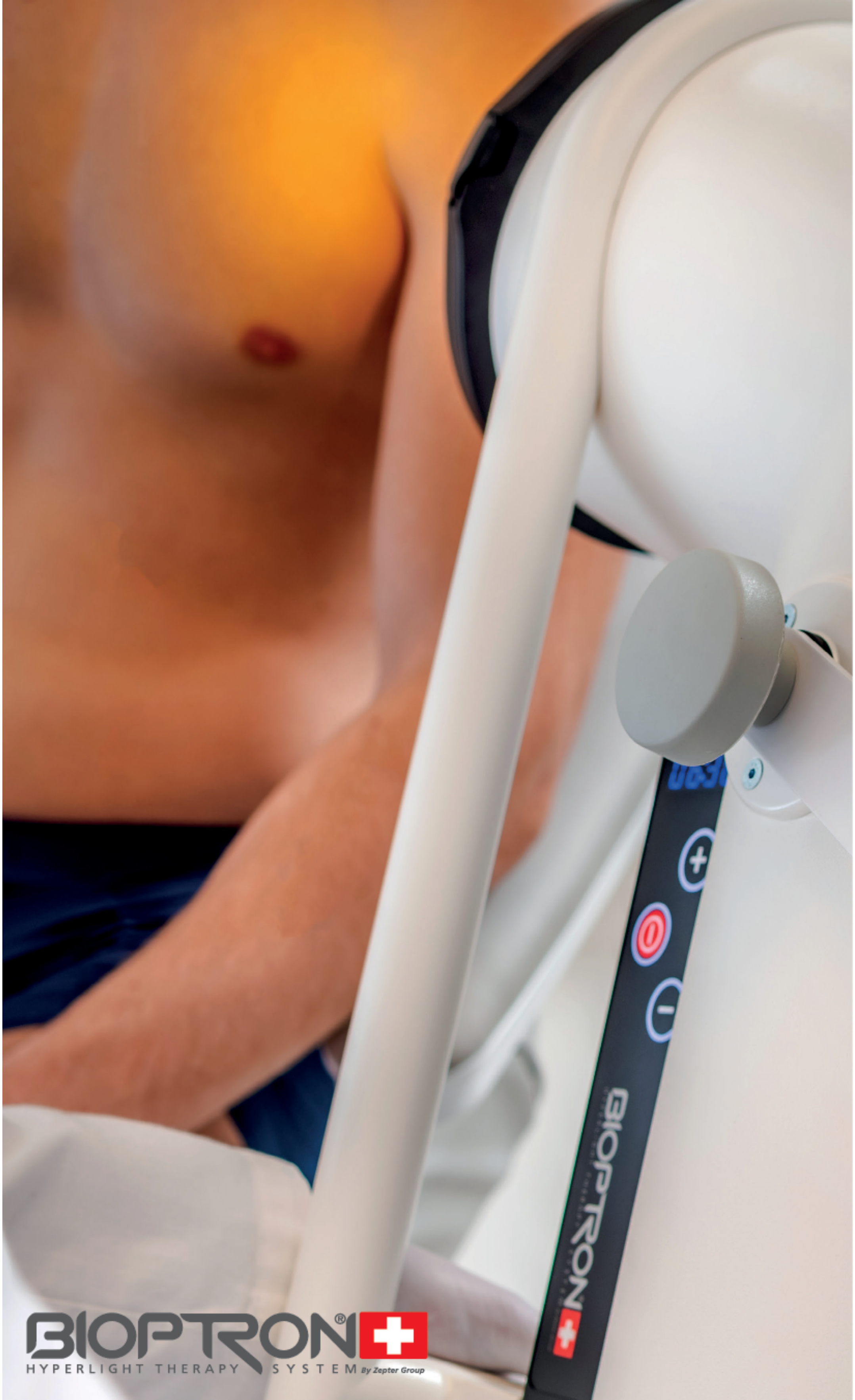

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Effect of different therapeutic modalities on cervical joint position sense, neck pain and dizziness in patients with cervical spondylosis: A randomized controlled trial

Wpływ różnych metod terapeutycznych na wyczucie pozycji stawu szyjnego, ból szyi i zawroty głowy u pacjentów ze spondylozą szyjną: randomizowane badanie kontrolowane

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Abstract

Background. Dizziness is a common symptom following cervical spondylosis which is due to disturbed sensory input from the neck proprioceptors. Both manual therapy and deep neck flexors training improve cervical joint position sense but yet there is no evidence about the most effective method for improving cervical joint position sense and dizziness in patients with cervical spondylosis. Purpose. To investigate and compare the effect of Mulligan sustained natural apophyseal glides (SNAGs), Maitland mobilization and deep cervical flexors (DCFs) training on cervical joint position sense, neck pain and dizziness in patients with cervical spondylosis. Methods. 56 patients with cervical spondylosis of both sexes aging from 40 to 55 years contributed in this study. Patients were chosen from Out-Patient Clinic, Faculty of Physical Therapy, Cairo University. They were randomly assigned to four groups (one control group and three study groups). Study group I received Mulligan SNAGs mobilization plus conventional physical therapy (Moist hot pack, Transcutaneous nerve stimulation (TENS), deep neck flexors exercises), study group II received Maitland passive mobilization plus conventional physical therapy, study group III received DCFs training plus conventional physical therapy and control group IV received conventional physical therapy only. Primary outcome was cervical joint position sense assessed by Head Repositioning Accuracy (HRA) measurement and secondary measures include assessment of dizziness intensity by dizziness- visual analogue scale (VAS), disability caused by dizziness using dizziness handicap inventory (DHI) and neck pain intensity using Numeric Pain Rating Scale (NPRS), all outcomes measures were assessed for each patient pre and post 6 weeks of treatment program in the four groups (3 sessions/week). Results. There was no significant difference in all measured variables (RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI) between group I and II post six weeks of the treatment ($p > 0.05$). While there was a significant decrease in all measured variables in both group I and II in comparison with that of group III and group IV post treatment ($p < 0.05$) and in group III in comparison with that of group IV post treatment ($p < 0.05$).Conclusions. The results showed that both Mulligan SNAGs and Maitland passive mobilization have similar effect on cervical joint position sense, neck pain and dizziness in patients with cervical spondylosis. Each of them was more effective than DCFs in improving these problems.

Key words:

Cervicogenic dizziness; Neck proprioception; Neck pain; Maitland mobilization, Mulligan mobilization; Deep cervical flexors training; Cervical spondylosis

Streszczenie

Informacje wprowadzające. Zawroty głowy są częstym objawem występującym po spondylozie szyjnej, spowodowanym zaburzeniami bodźców czuciowych z proprioceptorów szyi. Zarówno terapia manualna, jak i trening głębokich zginaczy szyjnych poprawiają wyczucie pozycji w stawie szyjnym, jednak nie ma dowodów na to, jaka metoda jest najskuteczniejsza w zakresie poprawy wyczucia pozycji stawu szyjnego i redukowania zawrotów głowy u pacjentów ze spondylozą szyjną. Cel. Zbadanie i porównanie wpływu przedłużonego naturalnego ślizgu oscylacyjnego Mulligana (SNAG), mobilizacji Maitlanda i treningu głębokich zginaczy szyjnych (DCF) na wyczucie pozycji stawu szyjnego, ból szyi i zawroty głowy u pacjentów ze spondylozą szyjną. Metody. W badaniu wzięło udział 56 pacjentów ze spondylozą szyjną obu płci w wieku od 40 do 55 lat. Pacjenci zostali wybrani z przychodni ambulatoryjnej Wydziału Fizykoterapii Uniwersytetu w Kairze. Zostali losowo przydzieleni do czterech grup (jedna grupa kontrolna i trzy grupy badane). Grupa badana I była poddawana mobilizacji SNAG Mulligana oraz konwencjonalnej fizjoterapii (gorący okład wilgotny, przezskórna stymulacja nerwów (TENS), ćwiczenia głębokich zginaczy szyjnych); grupa badana II była poddawana mobilizacji pasywnej Maitlanda oraz konwencjonalnej fizjoterapii; grupa badana III była poddawana treningowi głębokich zginaczy szyjnych oraz konwencjonalnej fizjoterapii; a grupa kontrolna IV była poddawana wyłącznie konwencjonalnej fizjoterapii. Pierwszorzędowym wynikiem było wyczucie pozycji stawu szyjnego oceniane za pomocą pomiaru dokładności repozycji głowy (HRA); pomiary drugorzędne obejmowały ocenę nasilenia zawrotów głowy za pomocą wizualnej skali analogowej (VAS) dot. zawrotów głowy, niepełnosprawności spowodowanej zawrotami głowy za pomocą kwestionariusza Dizziness Handicap Inventory (DHI) i nasilenia bólu szyi za pomocą Numerycznej Skali Oceny Bólu (NPRS); wszystkie miary wyników zostały ocenione dla każdego pacjenta przed i po 6 tygodniach programu leczenia w czterech grupach (3 sesje tydzień). Wyniki. Nie było istotnej różnicy we wszystkich mierzonych zmiennych (RT HRA, LT HRA, NPRS, skala zawrotów głowy VAS i DHI) między grupą I i II po sześciu tygodniach leczenia ($p > 0,05$). Natomiast nastąpił istotny spadek wszystkich mierzonych zmiennych w obu grupach I i II w porównaniu z grupą III i IV po leczeniu ($p < 0,05$) oraz w grupie III w porównaniu z grupą IV po leczeniu ($p < 0,05$). Wnioski. Wyniki wykazały, że zarówno metoda Mulligana SNAG, jak i pasywna mobilizacja Maitlanda mają podobny wpływ na wyczucie pozycji stawu szyjnego, ból szyi i zawroty głowy u pacjentów ze spondylozą szyjną. Każda z nich była skuteczniejsza niż trening głębokich zginaczy szyjnych w poprawie określonych wyżej problemów.

Słowa kluczowe

Zawroty głowy pochodzenia szyjnego, propriocepcja szyi, Ból szyi, mobilizacja Maitlanda, mobilizacja Mulligana, Trening głębokich zginaczy

Introduction

Cervical spondylosis is defined as a chronic degenerative process of the cervical spine which affects the vertebral bodies and intervertebral discs and causes herniated intervertebral discs, osteophytes, and ligament hypertrophy [1]. It is commonly seen in patients between the ages of 40 and 60 [2]. Patients seeking medical help for this condition primarily complain of neck pain and/or stiffness. This pain is considered the second most common complaint post low back pain and increased by neck movements especially hyperextension and side-bending [3]. Also, cervicogenic dizziness is a very common condition which occurs in approximately 65% of patients with cervical spondylosis. It often causes many problems not only physical problems but also emotional, social and financial problems [4].

Dizziness in cervical spondylosis can be due to two main causes: 1) Abnormal mechanical stress placed on cervical facet joints [5] which are the most densely innervated of all the spinal joints with 50% of all cervical proprioceptors occurring in the C1 to C3 joint capsules [4]. So, cervical spondylosis is a major reason for dizziness which is associated with spinal degeneration, 2) Dysfunction of the deep flexor muscular proprioceptors in the upper cervical spine causing disturbed input to the vestibular nuclei. So, either deep cervical flexors (DCFs) or the cervical joint capsules were hypothesed to play a role in dizziness, if they are dysfunctional [5].

Mulligan sustained natural apophyseal glides (SNAGs) mobilization and Maitland passive joint mobilizations are two manual therapy techniques to the upper cervical spine which have been regarded as a beneficial treatment for cervicogenic dizziness. It is assumed that, the effect of such two techniques on cervicogenic dizziness is due to cervical proprioceptors stimulation in both joints and muscles. This stimulation normalizes the disturbed afferent inputs and thereby decreases the sensory mismatch between the proprioception, the vestibular and the visual systems [6-8].

Reid et al. [9] conducted a study to compare the effect of Mulligan SNAGs and Maitland mobilization on cervicogenic dizziness. They found that both SNAGs and Maitland mobilizations cause decrease in chronic cervicogenic dizziness intensity and frequency immediately post treatment and at12 weeks follow-up.

Deep cervical flexors training is another treatment method that has an effect on cervical motor control. This training specifically includes longus capitis and longus colli muscles and aims to enhance the activation of the DCFs and improve isometric endurance [10]. Falla et al. [11]found that specific training of the DCFs is effectively decreased neck pain and improved the DCFs activation in females who had chronic neck pain. In addition, a case control study showed that the deep neck flexors training for three months is effectively decreased neck pain and dizziness in a patient who had chronic neck pain and dizziness after immobilization [12]. Pinki et al. [13] concluded that both cervical SNAGs and DCFs exercises are an effective therapeutic method in cervicogenic dizziness treatment, but their study lack the assessment of neck prorioception disturbance leading to dizziness.

To our best knowledge, no randomized controlled study has yet carried out to determine and compare effect of manual therapy and DCFs training on cervical joint position sense and to determine which of them is the best intervention to decrease neck pain and dizziness in patients with cervical spondylosis. Thus, the current study was conducted to determine and compare the effect of Mulligan SNAGs, Maitland passive mobilization and DCFs training on cervical joint position sense, neck pain and dizziness in patients with cervical spondylosis.

Materials and Methods

Study design

This randomized controlled experimental trial was carried out at the Out- Patient Clinic of Faculty of Physical Therapy, Cairo University from August 2019 to March 2020. The aims of the study and the study protocol were explained for each patient before participation in the study. All patients signed an institutionally approved informed consent form for participation in this study.

This study was approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University (P.T.REC/012/0011893).

Participants

Seventy-four patients with cervical spondylosis of both sexes were initially screened for eligibility criteria. Patients were diagnosed and referred from a neurosurgeon as having cervical spondylosis based on a careful clinical evaluation. This diagnosis was confirmed by X rays of the cervical spine. Patients first underwent a comprehensive physical evaluation by a physical therapist to confirm the presence of dysfunction in the cervical spine and exclude other causes of dizziness.

After the screening process, 56 patients were eligible to participate and complete the study as shown in Figure (1). Patients were eligible to participate in this study if they had (i) age ranging from 40 to 55 years [2], (ii) concurrent neck pain and dizziness for at least three months [9], dizziness was described as imbalance or unsteadiness related to neck position or movement, and (iii) moderate disability score on the Dizziness Handicap Inventory (DHI) (31-60 points) [14]. While patients were excluded if they had (i) pain and dizziness due to whiplash injury; (ii) cervical myelopathy; (iii) other causes of dizziness as vestibular disorders or ear disease; (iv) vertebrobasilar insufficiency (v) other causes of poor balance (eg, stroke, cerebellar disorders, multiple sclerosis, Parkinson's disease, syringomyelia); (v) congenital anomalies involving the cervical spine; (vi) systemic disease (eg, diabetes mellitus); (vii) poor vision and hearing; (viii) medications that cause dizziness; (ix) contraindication for manipulation such as osteoporosis, recent neck fracture or dislocation (in the last 3 months), infection in cervical spine, cancer, active inflammatory joint disease and pregnancy; (x) Psychiatric disease and (xi) previous surgery to the upper cervical spine and marked cervical spine disc protrusion.

After the screening process, 14 patients were excluded as they did not fulfill the inclusion criteria and four patients were excluded as they refused to participate in the study. A randomization process was performed for 56 patients; the allocation was performed using a computer-generated randomized table. Patient allocation was concealed using a random numerical sequence in sealed opaque envelopes. As each patient formally

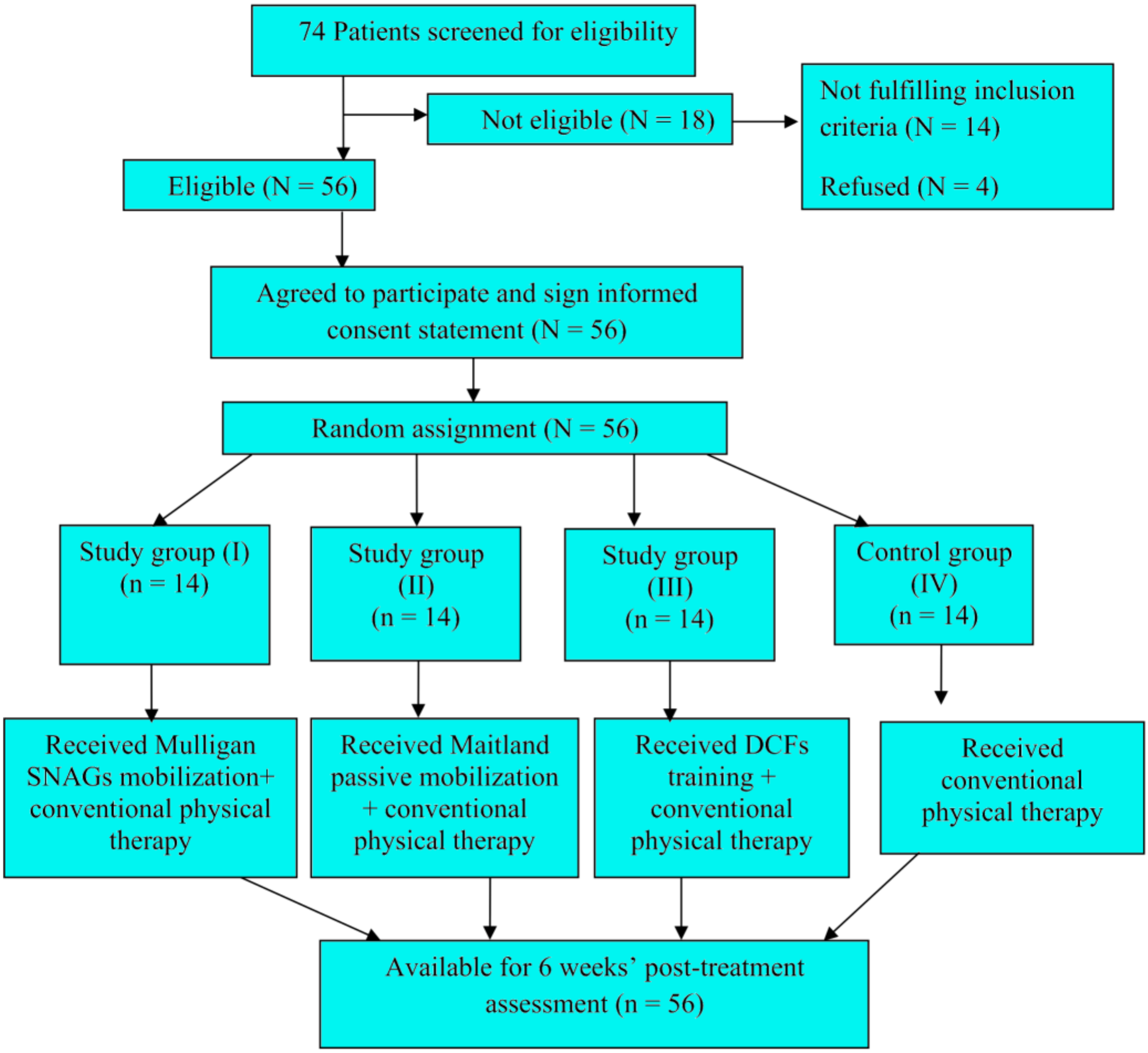

Figure 1. Flow chart of study participants

entered the trial, the researcher opened the next envelope in the sequence in the presence of the patient. A diagram of patient's retention and randomization throughout the study is shown in figure 1.

Patients were randomly assigned to one of the following four groups: Mulligan mobilization group which included 14 patients (6 males and 8 females), Maitland mobilization group which included 14 patients (6 males and 8 females), DCFs training group which included 14 patients (7 males and 7 females), and control group which included 14 patients (5 males and 9 females). All patients signed an institutionally approved informed consent form for participation in this study.

Procedures

Evaluation Procedure

All outcome measures were conducted for every patient individually before and after physical therapy intervention by the outcome assessor. The outcome assessor was not masked during the study.

Assessment of cervical joint position sense

Cervical joint position sense was tested by measuring Head Repositioning Accuracy (HRA) using the Cervical Range of Motion (CROM) instrument. This instrument is a type of goniometer designed specifically for measurement of range of motion (ROM) of the cervical spine [15]. It consists of a plastic frame that is mounted over the subject's nose bridge and ears and secured to the head by a felcro strap. Three independent inclinometers attached to the frame and arranged orthogonally to one another indicate the subject's cervical ROM. This device has good criterion validity (r = 0.89 – 0.99) and reliability (ICC = 0.92 - 0.96) [16]. For testing, the patients were sitting upright with their feet flat on the ground and their head in a neutral position. Patients were asked to close their eyes and actively move the head from the Neutral Head Position (NHP) to the midpoint of their maximum rotation range, which was called the "target position". After 5 secs, the patients return their head to NHP, then they were asked to rotate their head to the target position. The difference between the target position and the achieved position was recorded 3 times for both right and left rotation and the average taken for each direction of rotation movement according to Saleh et al. [17].

Assessment of neck pain
The neck pain intensity was assessed by a 10-point Numeric Pain Rating Scale (NPRS), ranging from 0 = "no neck pain" to 10 = "neck pain as bad as it can be. The patient reported an average value over the last 3 days. Numeric Pain Rating Scale has been shown to exhibit acceptable reliability in patients with neck pain [18].

Assessment of dizziness intensity
Dizziness intensity (an average level over the previous week) was assessed by a 100 mm horizontal visual analogue scale (VAS). Dizziness- VAS has been used successfully to assess dizziness intensity [7].

Assessment of disability caused by dizziness
Disability caused by dizziness was evaluated by DHI. The dizziness Handicap Inventory is a questionnaire composed of 25 questions, with seven questions related to physical aspects, nine questions related to emotional aspects, and nine questions related to functional aspects. For each question, patients respond "yes," "sometimes," or "no," corresponding to four, two, or zero points, respectively. The maximum score for the physical aspect questions is 28 points and 36 points each for the emotional and functional aspects. The total score is of 100 points. The higher the score, the worse the impact of dizziness on the quality of life of the patient; the lower the score, the lower the impact [19]. The dizziness Handicap Inventory has been shown to be a highly reliable and responsive tool [20].

Treatment Procedure
All patients in the four groups received the same conventional physical therapy treatment including [Moist hot pack, Transcutaneous nerve stimulation (TENS), deep neck flexors exercises]. Each patient was instructed to sit with head resting on pillow placed on a table in front of him. Hot packs were placed on cervical region for 15 minutes [21]. Then, TENS was administered at a frequency of 80 Hz with 10-30 mA intensity for 20 minutes using Intelect Advanced (REF2773MS; Chattanooga: Mexico). Four surface electrodes, 5x5 cm each, were placed over the painful neck area [22]. After that, deep neck flexors exercise was done to each patient: The patient was lying supine and the cervical spine was placed in a neutral position. Each patient was instructed to flatten the curve of the neck via nodding the head. This position was held for 10 seconds and repeated 10 times. The therapist or patient monitors the sternocleidomastoid muscle to ensure that this muscle not or minimally activated during the deep neck flexors contraction as described by Petersen [23]. This conventional physical therapy treatment was repeated 3 times a week for 6 weeks. The patients in the control group (group IV) received this conventional treatment only.

Study groups received the same program of control group in addition to the following:

Study group (I) was given SNAGs mobilization as described by Mulligan [24].
The patient was instructed to sit and move his head in the direction which caused his dizziness. As the patient moved his head, the physical therapist performed a sustained anterior gliding movement (using his thumbs one over the other) to the C1 or C2 vertebra (directed toward patient's eyeballs). If flexion or extension movement provoke the dizziness, an anterior glide was applied to the C2 spinous process. If rotation provoke dizziness, then an anterior glide should be applied to applied to the C1 transverse process. The patient should be free from the symptoms and should be instructed to stop movement if any dizziness occurred during the glide application. At the first treatment session, this movement was repeated six times. At the subsequent treatment sessions, Mulligan SNAGs was performed 10 times and gentle over pressure could be applied as long as no dizziness was felt.

Study group (II) was given Maitland mobilizations.
The Maitland mobilization technique was performed passively by a physical therapist. The patient was lying in a prone position. The therapist stood at the head of the patient and used his thumbs (one over the other) to rhythmically apply anterior pressure to a vertebra. This passive joint mobilization was applied at the three most painful joints for 30 s and 3 times at every level (Maitland et al. [25].

Study group (III) was given deep neck flexors training using Pressure Biofeedback Unit (PBU).
Deep neck flexors training is low load training of the DCFs. This training followed the protocol described by Saleh et al. [17]. This exercise specifically targets the DCFs (longus capitis and longus colli), while aiming to reducing the superficial cervical flexors activation (sternocleidomastoid and anterior scalene). Initially, each patient was lying supine and was taught to do the craniocervical flexion (CCF) movement slowly and in a controlled manner, with the head and neck in a neutral position. Once CCF motion was achieved by the correct way, patients started to hold progressively increasing ranges of CCF using PBU (Stabilizer TM Chattanooga Group Inc., Tennessee, USA). This unit was placed behind the neck just next to the occiput and was inflated up to a baseline pressure of 20mm Hg. The patients performed CCF movement to sequentially reach 5 pressure targets in 2 mmHg increments from a baseline of 20 mmHg to the final level of 30 mmHg. For each target level, the patients were instructed to maintain the contraction for 10 s for 10 repetitions with brief period of rest between each contraction (~3–5 s). Once an achievement of set of 10 repetitions of 10 s at one target level, the patient was asked to progress the exercise to train at the next target level up to the final target level at 30 mmHg.

Sample Size and Statistical Analysis

Before the study, sample size was determined using G* power 3.1 software. To avoid type II error, a preliminary power analysis [F test, MANOVA: special effects and interaction, power (1-α error P) = 0.80, α = 0.05,.effect size f2 (V) = 0,22] determined a sample size of 14 patients for every group. The effect size was calculated according to a pilot study on 20 patients (5 in every group) considering HRA as a primary outcome.

Statistical package for social studies (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA) was used for analyzing data of this study. Mean, standard deviation and frequencies were calculated for descriptive statistics. Statistical significance was defined as $P < 0.05$. Age and duration of dizziness were compared among four groups using ANOVA and sex distribution was compared among four groups using Chi-squared test. Before data analysis, Shapiro–Wilk test was used for checking the normality of data and Levene's test for homogeneity of variances was performed to check the homogeneity among four groups. Within and between group comparison were carried out using mixed design MANOVA. Partial squared eta was considered as the effect size. Post-hoc tests using the Bonferroni correction were performed for subsequent multiple comparison.

Results

Base line patient's characteristics

Demographic and clinical data of patients were shown in table 1. No statistically significant differences regarding age, duration of dizziness and sex distribution ($p > 0.05$) were observed among four groups ($p > 0.05$).

Table 1. Baseline patient demographic and clinical characteristics in the four groups

	Group I Mean ± SD	Group II Mean ± SD	Group III Mean ± SD	Group IV Mean ± SD	p-value
Age [years]	47.14 ± 5.4	45.28 ± 5.34	47.21 ± 5.3	46.71 ± 4.02	0.72
Duration of dizziness [weeks]	15.71 ± 5.23	16 ± 5.13	17.57 ± 5.5	16.85 ± 5.43	0.78
Sex, n (%)					
Females	8 (57%)	8 (57%)	7 (50%)	9 (64.3%)	0.9
Males	6 (43%)	6 (43%)	7 (50%)	5 (35.7%)	

GI: SNAGs mobilization group; GII: Maitland mobilization group; GIII: Deep neck flexors training; Group IV: Control group; SD: Standard deviation

Effect of treatment on Dizziness-VAS, DHI, NPRS, RT HRA and LT HRA scores

Mixed MANOVA showed that there was a significant interaction of treatment and time (Wilks' Lambda = 0.09; F = 12.28, p = 0.001, $\eta^2 = 0.55$). There was a significant main effect of time (Wilks' Lambda = 0.01; F = 492.03, p = 0.001, $\eta^2 = 0.98$). There was a significant main effect of treatment (Wilks' Lambda = 0.27; F = 5.36, p = 0.001, $\eta^2 = 0.35$).

Within group comparison

The results revealed that a statistically significant decrease in the mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI, after treatment in comparison with that before treatment in the four groups ($p < 0.05$) as shown in table 2.

Between group comparison

At baseline, no statistically significant differences were observed among four groups in all measured variables ($p > 0.05$). Post-treatment, there was no statistically significant difference in the mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI between group I and II ($p > 0.05$). While, there was a significant decrease in the mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI of group I and II in comparison with that of group III after treatment ($p < 0.05$). Also, there was a significant reduction in the mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI of group I and II in comparison with that of group IV after treatment ($p < 0.05$). There was a significant decrease in the mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS and DHI group III in comparison with that of group IV after treatment ($p < 0.05$) as showed in table 3.

Table 2. Comparison between pre and post-treatment mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS, and DHI in the four groups

	Group I			Group II			Group III			Group IV		
	pre Mean ± SD	post Mean ± SD	p-value	pre Mean ± SD	post Mean ± SD	p-value	pre Mean ± SD	post Mean ± SD	p-value	pre Mean ± SD	post Mean ± SD	p-value
Right HRA	9.3 ± 0.86	3.67 ± 0.72	**0.001**	9.55 ± 1.09	3.8 ± 0.8	**0.001**	9.62 ± 1.08	5 ± 0.82	**0.001**	9.77 ± 0.74	6.7 ± 0.86	**0.001**
Left HRA	8.82 ± 1.03	3.5 ± 0.93	**0.001**	8.74 ± 1.12	3.65 ± 0.93	**0.001**	9.27 ± 1.07	4.57 ± 0.65	**0.001**	9.1 ± 0.53	7.52 ± 0.85	**0.001**
NPRS	7.5 ± 1.65	1.92 ± 0.73	**0.001**	7.5 ± 1.82	2.07 ± 0.82	**0.001**	7.35 ± 1.78	3.28 ± 0.91	**0.001**	6.78 ± 1.42	4.78 ± 1.18	**0.001**
Dizziness-VAS	43.28 ± 8.86	23.57 ± 6.04	**0.001**	45.85 ± 8.08	24.78 ± 8.81	**0.001**	48.92 ± 11.71	33.85 ± 5.97	**0.001**	46.64 ± 9.73	39.28 ± 9.33	**0.01**
DHI	44.92 ± 7.05	25.64 ± 4.9	**0.001**	46.14 ± 9.13	25.71 ± 5.46	**0.0001**	40.92 ± 6.47	32.78 ± 3.86	**0.001**	42.57 ± 9.47	39.78 ± 9.14	**0.02**

Group I: SNAGs mobilization group; Group II: Maitland mobilization group; Group III: Deep neck flexors training; Group IV: Control group; SD: standard deviation; HRA: Head Repositioning Accuracy; NPRS: Numerical Pain Rating Scale; DHI: Dizziness Handicap Inventory.

Table 3. Comparison of post treatment mean scores of RT HRA, LT HRA, NPRS, Dizziness-VAS, and DHI among four groups

	Right HRA P value	Left HRA P value	NPRS P value	Dizziness-VAS P value	DHI P value
Group I vs group II	0.97	0.95	0.97	0.97	1
Group I vs group III	0.001	0.009	0.002	0.006	0.02
Group I vs group IV	0.001	0.001	0.001	0.001	0.001
Group II vs group III	0.001	0.03	0.007	0.02	0.02
Group II vs group IV	0.001	0.001	0.001	0.001	0.001
Group III vs group IV	0.001	0.001	0.001	0.02	0.02

Group I: SNAGs mobilization group; Group II: Maitland mobilization group; Group III: Deep neck flexors training; Group IV: Control group HRA: Head Repositioning Accuracy; NPRS: Numerical Pain Rating scale; DHI: Dizziness Handicap Inventory

Discussion

This study was carried out to examine and compare the effect of Mulligan SNAGs, Maitland mobilization and DCFs training on cervical joint position sense, neck pain and dizziness measures in patients with cervical spondylosis. The study demonstrated that, the three experimental groups had a significant improvement in all measured variables than the control group, but SNAGs mobilization group (I) and Maitland mobilization group (II) were found to be more effective than DCFs training group (III).

The findings of this research revealed a significant improvement regarding cervical joint position sense, neck pain intensity and dizziness measures in DCFs training group in comparison with control group post treatment. This was in accordance with Saleh et al. [17] who found that DCFs training using PBU is superior to conventional physical therapy treatment in improving neck proprioception, pain and dizziness measures in patients with cervical spondylosis.

This significant difference between DCFs training group and control group might be attributed to more DCFs activation using PBU [26]. This is because PBU give patients constant feedback during every exercise repetition that promotes patients to do exercises by the correct way [27] and increase the deep neck flexors activation [28]. These DCFs have a relatively high concentration of muscle spindles, which generally agreed as being the primary cervical receptors responsible for the sense of position [29, 30]. Therefore, repeating deep neck flexors contractions during training using CCF exercises may improve the function of muscle spindle translating to improved cervical proprioception.

Also, the significant improvement regarding neck pain intensity in DCFs group compared with control group might be explained by more significant improvement of the strength of DCFs. This justification was supported by the findings of Ylinen et al. [31] who indicated that DCFs weakness causes neck pain. Furthermore, the significant improvement of neck pain in DCFs training in comparison with control group might be explained by neuromuscular control improvement between superficial and deep neck flexors as continuous imbalance between the superficial and deep neck muscles leads to further forward head position from the body causing neck pain [32]. This justification was consistent with the finding of Gallego Izquierdo et al. [33] who mentioned that retraining of the DCFs using CCF exercises causes significant improvements in neuromuscular coordination between the deep and superficial neck flexors. Restoration of the supporting capacity of DCFs parallels decrease in neck pain [32].

On the other side, both SNAGs and Maitland mobilization groups were found to be more effective than DCFs training group regarding all measured variables. The result of the current study concerning the significant improvement of neck pain and dizziness in SNAGs mobilization group compared with DCFs training group agreed with the findings of Pinki et al. [13] who mentioned that SNAGs mobilization group showed more decrease of pain and better improvement in cervicogenic dizziness than DCFs training group. The significant improvement of all measured variables in both SNAGs and Maitland mobilization groups than the DCFs training group might be explained by stimulation of proprioceptors in both cervical joint and muscles. This stimulation normalizes the disturbed afferent inputs and thereby decrease the sensory mismatch between the proprioception, the vestibular and the visual systems [6-8].

Mulligan SNAGs technique can stretch and stimulate mechanoreceptors present in the facet joint capsule and also end range overpressure performed with SNAGs technique stimulate the muscles and ligaments mechanoreceptors [34]. This explanation was supported by the findings of Said et al. (2017) [35] who showed that Mulligan SNAGs mobilization improved joint position sense. Also, manual therapy restore facet joints normal movement and decease pain, and thereby restoring normal proprioceptive and biomechanical functioning of the cervical spine [36]. Stimulation of mechanoreceptors might have a role in pain modulation. So, passive joint mobilization might give explanation for pain modulation through gate control mechanism [35].

Another explanation for this significant difference between manual therapy groups (SNAGs and Maitland mobilization groups) and DCFs training group regarding neck pain could be attributed to sympathoexcitatory effect [37]. The afferent nerve endings activation through manual contact have an effect on the spinal cord neurons, inhibiting nociception and motor neuron pool [38]. Moreover, mobilization affect pain through descending pain-inhibitory systems and release of certain chemicals like serotonin and noradrenaline which reduce muscle spasm in the neck, increase neck movement and improve function of the neck [39].

Accessory glide gives more explanation for neck pain improvement in both SNAGs and Maitland mobilization groups compared with DCFs training group as it applied to the cervical vertebrae spinous process, increases the circulation and nutrition to the joint, causing washing out of nociceptive metabolites and healing of minor soft tissues by the best way, thereby causing smooth physiological movements without pain [40].

The results of this study revealed a significant improvement regarding the severity of dizziness and DHI post-treatment in both SNAGs and Maitland mobilization compared with DCFs training group. This might be attributed to the mentioned significant improvement of cervical joint position sense and neck pain intensity as measured by NPRS in the manual therapy group than DCFs training group. This explanation is based on the fact that, neck pain causes dizziness, unsteadiness and disturbed cervical proprioception [8] and also confirmed by the findings of Clark et al.[41] who found that there is a relationship between neck pain, proprioceptors of the cervical spine and dizziness.

Regarding the similar effect of SNAGs and Maitland mobilization techniques on neck pain and dizziness. This result agreed with the finding of Reid et al.[9] who found that both SNAGs mobilization and Maitland decreased dizziness intensity and pain after treatment and no differences were observed in dizziness intensity, disability caused by dizziness and neck pain between two manual therapy techniques.

While the non significant difference between the effect of both Maitland and SNAGs mobilization on pain disagreed with the findings of Gautam et al. [21] who compared effect of Mulligan and Maitland mobilization on neck pain and showed that Mulligan mobilization was better than Maitland mobilization in improving neck pain. Also, this result was in contrast with Tanveer et al. [42] who compared effect of SNAGs mobilization and Maitland manual therapy on non-specific chronic neck pain and showed that SNAGs glide had more effect than Maitland in improving pain. The difference among mentioned studies might be attributed to different methodology, different age and different social factors. The age of patients in this study ranged from 40 to 55 years but in the study conducted by Gautam et al. [21], the age of patients ranged from 20 to 45 years. In the study conducted by Tanveer et al. [42], the age of patients ranged from 20 to 40 years.

Limitations

There are some limitations to this study. The main one was lack of followup to determine the long term effects of these three therapeutic modalities on cervical joint position sense, neck pain and dizziness in patients with cervical spondylosis. In addition, it was impossible to blind the physiotherapist due to the nature of used interventions which require direct communication between the therapist and the patients. Moreover, the results of the present study can't be generalized as the sample was convenient rather than random to represent the whole population.

Conclusions

The study results indicated that both SNAGs and Maitland passive mobilization lead to similar improvement in cervical joint position sense, neck pain intensity and dizziness measures in patients with cervical spondylosis. Each of them was more effective than DCFs training in improving these problems. Hence, adding SNAGs or Maitland passive mobilization to the conventional physical therapy is useful for patients with cervical spondylosis suffering from concurrent neck pain and dizziness.

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