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Effect of a massage chair (BFM-M8040) on neck and shoulder pain in office workers: A randomized controlled clinical trial

Hongmin Chu [a], Soo-Ji Park [b], Yeongjin Jeong [c], Suhak Kim [c], Seung-Ryong Yeom [c], Sangkwan Lee [d], Bo-Young Youn [e,*]

[a] *Wollong Public Health Subcenter, Paju-si, Gyeonggi-do, 10924, Republic of Korea*
[b] *Clinical Trial Center, Gwangju Medical Center, College of Korean Medicine, Wonkwang University, Gwangju, 61729, Republic of Korea*
[c] *Department of Korean Rehabilitation Medicine, Gwangju Medical Center, College of Korean Medicine, Wonkwang University, Gwangju, 61729, Republic of Korea*
[d] *Department of Internal Medicine and Neuroscience, Gwangju Medical Center, College of Korean Medicine, Wonkwang University, Gwangju, 61729, Republic of Korea*
[e] *Department of Preventive Medicine, College of Korean Medicine, Kyung Hee University, Seoul, 02447, Republic of Korea*

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ABSTRACT

Background: With the increasing work-related musculoskeletal disorders, neck and shoulder pain among office workers has also increased. That said, this randomized controlled trial aimed to seek the potential effects of a massage chair (BFR-M8040) on neck and shoulder pain among office workers.

Methods: This was conducted at the Wonkwang University Gwangju Medical Center from April 2022 to December 2022. Sixty adult participants were randomly allocated. The mean age of male participants was 39.63 ± 8.09 years while female participants was 43.52 ± 8.27; women participated the most (86.67%). The control group received basic physical treatments, including a 10-min heat treatment for deep regions and a 10-min hot pack for the areas on the neck and shoulder of the complained discomfort. The experimental group received the same treatment as the control group and added 20 min of the electric massage chair's PEMF Neck Mode (XD module 3) (BFR-M8040, Bodyfriend Co., Ltd.). The participants received treatments twice per week. The primary outcome was measured using the numerical rating scale and the Korean version of the neck disability index. And the secondary outcome was measured using pressure pain threshold, range of motion, the Korean occupational stress scale, the Korean version of the Euro-quality of life-5 dimension, and safety evaluation.

Results: Fifty-eight participants completed a 6-week follow-up and analyzed (29 in the control group and 29 in the experimental group). There was a significant decrease in the experiment group in both scales for primary outcome measures. For secondary outcome measures, statistically significant increases were observed in pressure pain threshold. The experimental group only showed a slight increase in the quality-of-life measures. There were no reported adverse events.

Conclusion: The benefit of using a massage chair (BFR-M8040) was verified to alleviate neck and shoulder pain among office workers; future studies could involve participants from other countries for further investigation.

* Corresponding author.Department of Preventive Medicine, College of Korean Medicine, Kyung Hee University, 26 Kyungheedae-ro, Seoul, 02447, Republic of Korea.
E-mail address: james_youn@khu.ac.kr (B.-Y. Youn).

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1. Introduction

Work-related musculoskeletal disorders (WMSDs) are common among office workers. Office workers are recognized as a group with a risk of musculoskeletal problems that cause prolonged disability and discomfort due to the time spent using computers in poor work environments and work desks [1].

With the advancement of technology, the number of tasks performed by computers has been increasing; therefore, the prevalence of WMSDs also has been growing. According to a systematic review across countries, the one-year incidence of neck pain among office workers was reported to be 45% in Australia and 47% in India; of the 41% of musculoskeletal disorders collected in the United Kingdom, 27% were caused by keyboarding or repetitive tasks, and 14% were caused by awkward or uncomfortable postures in office environments [2]. In Japan, among more than 60% of office workers, 55% reported pain in the neck, 38% in the shoulder, 15% in the elbow, and 21% in the wrist. It was identified that the prevalence of pain in the neck and shoulder was the highest [3]. A recent survey study targeting 528 male and female office workers showed that more than half (52.5%) of the participants suffered from pain in the neck area [4].

Despite several treatment modalities to ease musculoskeletal pain, massage therapy (MT) has been known as a therapy applying various levels of pressure and movement using the hands to promote physical and psychological relaxation and improve circulation and range of motion of tense muscles and has been recommended as a treatment for diverse conditions including musculoskeletal damage and stress [5,6].

With the proven effectiveness of using MT, there has also been a growing phenomenon in massage service-related products. Among the numerous massage products, electric massage chairs have accounted for the largest share of the massage equipment market as the chairs have been shown to mimic the effects of traditional physical massage while being more cost-effective and convenient, along with a long-lasting history for positive impact on improving health [7].

Electric massage chairs are manufactured to mechanically implement hand massage techniques such as kneading, tapping, and acupressure and automatically massage the whole body using mechanical devices, including massage balls, rollers, and airbags; it reduces muscle tension, improves sleep quality, and improves mental fatigue recovery and cognitive ability [8]. One study concluded that the massage chair program is an easy-to-access and economical preventive measure, which can be part of the psychological and physical health prevention program for occupational diseases caused by lack of physical movement and work-related pain during long hours [9].

Although numerous studies have verified the efficacy of massage therapies for reducing musculoskeletal pain, studies evaluating the effectiveness of massage chairs are lacking. Hence, this study aims to conduct a randomized controlled to investigate the efficacy and safety of electric massage chairs, to alleviate muscle pain and functional limitations in the neck and shoulder area caused by work and stress, targeting office workers with a high risk of WMSDs.

2. Materials and methods

The study was performed in accordance with the principles of the Declaration of Helsinki and the Ethical Guidelines for Clinical Research and approved by the institutional review board (IRB) in Gwangju Korean Medicine Hospital of Wonkwang University (WKIRB 2022/3-2). The trial was registered with the Clinical Research Information Service (CRIS) of Republic of Korea (KCT0007340, registered on: April 08, 2022).

2.1. Study design

This study was designed as a randomized controlled trial of a single-center, longitudinal, 6-week-follow-up study to assess whether an electric massage chair (BFR-M8040, Bodyfriend Co., Ltd.) [10] is effective for reducing muscle pains around the neck and shoulder of office workers. A blinded trial was not feasible for this study due to the characteristics of the interventions. The trial was conducted from April 2022 to December 2022 in the Department of Korean Rehabilitation Medicine, Wonkwang University Gwangju Medical Center, Gwangju, Republic of Korea. The study aimed to seek clinical effects of the massage chair on neck and shoulder pain among office workers.

2.2. Participants

Recruited participants received detailed information, including objectives, interventions, and potential benefits and harms. Informed consent was acquired from the participants ahead of the screening process. The participants were initially assessed for eligibility in the study. Moreover, the participants were allowed to withdraw from the study at any time.

Inclusion criteria were: 1)age, 18–60 years; 2)continued participation for 12 weeks; 3)office workers who intensively operate the keyboard or mouse for more than 4 h a day and complain of non-specific neck and shoulder region muscle pain or discomfort for more than three months; 4)those who agreed not to take medication and related treatment in parallel with clinical research to relieve neck and shoulder discomfort during the study period (from screening to the end of the study); 5)had a numeric rating score of a four or higher; 6)informed consent.

Exclusion criteria were: 1)women who are pregnant or have given birth within 6 months; 2)participants who are taking medications or receiving treatment to relieve muscle pain or discomfort in the neck or shoulder region due to occupational problems; 3)

participants with a history of surgery or trauma within the last 6 months, especially involving the spine; 5)participants who attached or inserted implantable electronic medical devices; 6)participants who have infectious disease or skin disease, or a risk factor for thrombosis, embolism, or bleeding; 7)participants who have a history of psychiatric disease or uncontrolled epilepsy, long-term neurologic disorders including neurodegenerative disease or cerebrovascular diseases, or significant medical conditions, such as cardiopulmonary disease or chronic kidney disease; 8)participants who have a history of psychiatric disease or uncontrolled epilepsy, long-term neurologic disorders including neurodegenerative disease or cerebrovascular diseases, or significant medical conditions, such as cardiopulmonary disease or chronic kidney disease; 9)patients who have severe osteoporosis or are taking osteoporosis medications.

A total of 65 participants were enrolled after screening, with ten males and 55 females. Of the total, five participants were excluded due to exclusion criteria after the screening, and the clinical trial was carried out on 60 participants. The reasons for exclusion during screening were that three participants complained of mild neck and shoulder pain with an NRS score of less than four, one withdrew consent before randomization, and one was taking pain control medication. Finally, the analysis included eight males and 52 females as study subjects (Fig. 1).

Using a block randomization method, the 60 participants were randomly assigned to the experimental group (n = 31) and control group (n = 29). During the clinical trial, two participants from the experimental group dropped out, one at visit-5 and one at visit-12 due to coronavirus.

2.3. Interventions

After the initial screening process, the appropriate participants were randomly assigned to either the control or experimental groups. The participants were required to visit twice a week for six weeks (a total of 12 visits) and received the intervention, and if any participants were not able to visit on the scheduled date due to unavoidable circumstances, the reason was recorded, and the visit date was rescheduled within ±3 days of the initially scheduled date. The last follow-up survey was implemented by phone within seven days of the final visit. All participants were evaluated at the 1st, 6th, and 12th visits. Participants allocated to the control group received basic physical treatments, including a 10-min heat treatment for deep regions and a 10-min hot pack for the areas on the neck and shoulder of the complained discomfort. Participants in the experimental group received the same treatment as the control group and also provided 20 min of the Pulsed electromagnetic field (PEMF) Neck Mode (XD module 3) of the electric massage chair (BFR-M8040, Bodyfriend Co., Ltd.).

The PEMF system is a non-invasive and safe therapeutic approach that involves the application of low-frequency electromagnetic waves to specific body areas [11,12]. The PEMF system is widely applied for pain management and chronic inflammatory conditions such as rheumatoid arthritis and immune therapy [13].

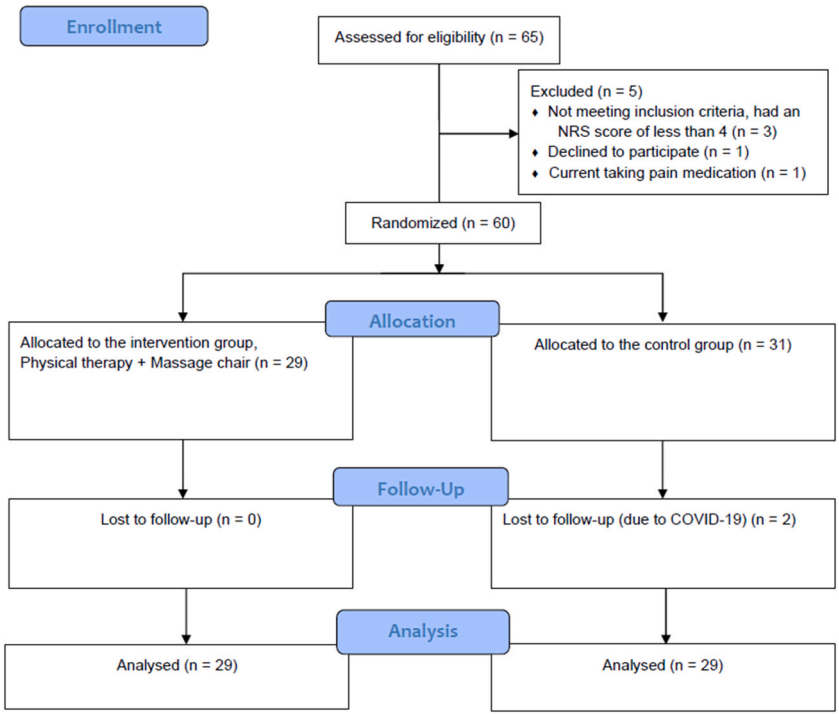

Fig. 1. Consort flow diagram of the study.

2.4. Instruments

2.4.1. Numerical rating scale (NRS)

The NRS scale was used to measure pain intensity, ranging from no pain (0) to the worth pain imaginable (10); the pain intensity was measured in relation to pain at the present day [14].

2.4.2. Korean version of neck disability index (NDI)

The Korean version of the NDI was used to evaluate the degree of disability due to neck muscle pain, which was one of the widely used tools for evaluating disability due to neck pain [13]. The NDI consists of ten items assessing functional activity (seven items), symptoms (two items), and concentration (one item). The total score was divided into several categories: 0–4 for no disability, 5–14 for mild disability, 15–24 for moderate disability, 25–34 for severe disability, 35 or higher means complete disability. The factor analysis of Korean NDI extracted two factors with eigenvalues greater than 1. The intraclass-correlation coefficient of test-retest reliability was 0.93. Regarding reliability, estimated by internal consistency, it had a Cronbach alpha value of 0.82. Therefore, the Korean version of the NDI was reliable and valid for measuring disability in Korean patients with cervical problems [15].

2.4.3. Pressure pain threshold (PPT)

For the evaluation of pain intensity in the neck and shoulder area [16], digital algometry (Wagner instrument, Greenwich, USA) was utilized. Assessing PPTs were taken from the center of both upper trapezius and splenius capitis muscles [17]. All participants were instructed to press a button at the first pain sensation; then, the corresponding pressure reading on the instrument was recorded. PPT measurements were taken twice, and the higher value was utilized.

2.4.4. Range of motion (ROM)

The ROM was used to assess the neck; the angles of flexion, extension, lateral bending, and neck rotation with the universal goniometer (Jinsan Medical, Seoul, Korea) were measured. Depending on the patient's position, the axis of the goniometer was placed over the spinous process of C7 or at the sternal notch; aligned the patient's arms were appropriately to start at 0° and instructed to flex the neck laterally and recorded the goniometer readings at each motion extreme while ensuring the axis and stationary arm remain fixed throughout the movement. The ROM measurement was conducted through two repetitions. The larger value between the two measurements was chosen [18,19]. The established criteria for a normal range of motion are as follows: 38° for flexion, 38° for extension, 43° for lateral flexion, and 45° for rotation [20].

2.4.5. Korean occupational stress scale (KOSS)

The work-related stress level of participants was evaluated by KOSS, which was developed as a standardized measurement tool for a total of 43 questions, consisting of physical environment (3 items), job demand (8 items), job autonomy (5 items), relationship conflict (4 items), job instability (6 items), organization (7 items), inadequate compensation (6 items), workplace culture (4 items). The score was converted according to the following calculation method: conversion score for each area = (The actual score - the number of questions) *100/(The best-expected score – the number of questions), and total score. The sum of scaled scores in each of the eight areas divided by 8. Higher scores indicate a higher level of stress [21].

2.4.6. Korean version of the euro-quality of life-5 dimension (EQ-5D-5L)

The Korean version of EQ-5D-5L was used to evaluate the quality of life of office workers complaining of neck and shoulder discomfort. The EQ-5D-5L consists of 2 pages, including the EQ-5D descriptive system and the EQ VAS. The descriptive system comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has five levels: no problems, slight problems, moderate problems, severe problems, and extreme problems [22]. It was found that the EQ-5D-5L has a smaller ceiling effect than the EQ-5D-3L. The EQ-5D-5L has been known to be a valid and reliable instrument to measure health-related quality of life in the general population; the intraclass correlation coefficient of the EQ-5D-5L index was indicated as 0.75 [23]. The EQ-5D-5L has yet to use in patients with neck and shoulder pain.

2.4.7. Safety evaluation indicators

To assess overall clinical safety, the researchers investigated all adverse events (AEs) during each visit and recorded the name, date, severity, course, seriousness, causality, and treatment performed for the AE in the case report form. The severity was considered minor when the AEs did not cause specific symptoms or signs. The severity was considered moderate if the reported AEs were insufficient for the participant to drop out of the study. When the participant had to withdraw from the study to undergo treatment for the AE, the severity was considered to be highly severe.

2.5. Sample size

The study compared massage and routine physical therapy, and standard physical therapy consisting of ultrasound and TENS was performed in the control group. In contrast, three exercise treatments, paravertebral stretching, hamstring stretching, and dead bug exercise, were performed in the experimental group along with massage therapy. A total of 10 treatments were performed in both groups, and the NRS evaluation results before treatment were 7.33 ± 1.75 in the control group, 6.00 ± 1.92 in the experimental group; after treatment, results were 4.06 ± 2.98 in the control group, 1.80 ± 1.61 in the experimental group, and the common standard

deviation was 2.40. That being mentioned, 18 people per group were calculated as a result of calculating power (1-β) = 0.80 and significance level (α) = 0.05. According to Blangsted et al. [24], this study consisted of office workers, as participants indicated that the dropout rate was as high as 19%–26.6%. Based on the previous research, a dropout rate of 30% was determined, considering that the dropout rate would be higher with 12 visits over six weeks. Therefore, it was calculated that a total of 52 participants would be required, and it was decided to enroll 60 participants, 30 participants in the experimental group and 30 participants in the control group.

2.6. Randomization

The block randomization method was used, and the block size was set as 4 targeting 1:1 allocation. Randomized control assignment was performed by a third party who is independent of the study utilizing the R program. Each number was placed in a separate, opaque envelope kept by an independent investigator who was not involved in this trial; each envelope contained the treatment allocation card (experimental group or control group). Then, the independent investigator distributed envelope to eligible participant.

2.7. Statistical analysis

The primary outcome was measured as the average change from baseline in NRS, PPT, NDI, and ROM. Descriptive statistics are presented for changes in NRS, PPT, NDI, and ROM, and the difference between groups was tested for significance using an independent two-sample *t*-test, and changes within groups are measured by paired *t*-test. The Chi-square test used to test the significance in the ratio of the categories was compared between groups.

The secondary outcomes measured the difference between groups in the mean change compared to the baseline value of the EQ-5D and KOSS immediately after the end of the intervention in the experimental group, using the independent two-sample *t*-test. The Chi-square test used to test the significance in the ratio of the categories was compared between groups.

For statistical analysis of this study, SPSS (Ver 23. IBM Co. USA), R studio (2021.09.2 + 32 version), and SAS (9.4 version) were used.

3. Results

3.1. General characteristics of the participants

The mean age of male participants was 39.63 ± 8.09 years, while that of female participants was 43.52 ± 8.27, indicating that the mean age of female subjects was higher. Analysis of the baseline characteristics of the study participants showed no statistically significant differences in age, height, weight, BMI, or other factors between the treatment and control groups, indicating that the randomization process was well performed (Table 1). With all datasets meeting the normality assumption, comparisons were conducted using t-tests.

The study population consisted entirely of office workers. Of the 60 participants, 25 were currently employed part-time, while 35 indicated full-time employment. To exclude participants with musculoskeletal problems, such as osteoporosis, cervical x-ray, and DXA bone density tests were conducted. Among the study population, 23 individuals showed no abnormalities on cervical x-ray, while 12 had a loss of normal curvature, 13 had bone spurs, 5 had retrolisthesis, and 2 showed calcification of ligaments or discs. DXA bone density tests were performed to measure the bone density of the lumbar spine and hip femoral head using Z-scores. None of the participants showed osteoporosis or signs of bone loss with a Z-score of −2.0 or less in both the lumbar spine and hip femoral head.

Among the participants, eight participants reported having underlying medical conditions, and only five provided detailed

Table 1
General characteristics of the participants measured at baseline.

	Total	Intervention		*p-value*
		PT + MC	PT	
Number (n, %)	58 (100.00%)	29 (50.00%)	29 (50.00%)	
Gender (n)				0.51
Women	52 (86.67%)	26 (83.87%)	26 (89.66%)	
Men	8 (13.33%)	5 (16.13%)	3 (10.35%)	
Age (years)	43 ± 8.43	43.484 ± 8.21	42.483 ± 8.78	0.86
Height (cm)	161.32 ± 6.55	160.98 ± 6.84	161.69 ± 6.44	0.68
Weight (kg)	62.95 ± 10.78	63.48 ± 10.89	62.40 ± 11.02	0.70
BMI (kg/m^2)	24.10 ± 3.46	24.50 ± 3.93	23.74 ± 2.90	0.40
BMI group (n, %)				0.55
Underweight (BMI>18.5)	2 (3.33%)	1 (3.23%)	1 (3.45%)	
Normal Weight (≥18.5, <25)	33 (55.00%)	15 (48.39%)	18 (62.07%)	
Overweight (≥25)	25 (41.67%)	15 (48.39%)	10 (34.48%)	

PT, physical therapy; MC, massage chair; BMI, body mass index.
Values are expressed as mean ± standard deviation (SD) unless otherwise indicated; statistical significance was set at $p < 0.05$.

Table 2
Baselines of the primary outcomes in the experimental and control group.

	PT + MC group (n = 29)	PT group (n = 29)	*p-value*
NRS (Screening)	5.00 ± 0.89	5.31 ± 1.07	0.23
NRS (Visit 1)	4.68 ± 0.92	5.28 ± 1.00	0.11
NDI (Visit 1)	14.35 ± 4.78	11.97 ± 6.25	0.11
PPT (Lt Splenius Capitis) (Visit 1)	194.52 ± 47.24	239.81 ± 100.35	0.03*
PPT (Rt Splenius Capitis) (Visit 1)	200.38 ± 43.32	238.55 ± 97.60	0.06
PPT (Lt Trapezius) (Visit 1)	333.72 ± 79.33	359.29 ± 116.92	0.33
PPT (Rt Trapezius) (Visit 1)	319.62 ± 83.81	336.77 ± 109.54	0.50
ROM Flexion	42.58 ± 8.74	40.51 ± 9.48	0.384
ROM Extension	49.36 ± 10.39	49.14 ± 11.96	0.940
ROM Rt Lateral Flexion	37.74 ± 8.55	35.69 ± 9.33	0.378
ROM Lt Lateral Flexion	36.94 ± 9.01	36.21 ± 9.42	0.760
ROM Rt Rotation	57.42 ± 8.15	54.57 ± 11.01	0.272
ROM Lt Rotation	55.97 ± 8.89	54.66 ± 11.72	0.625
KSS Total	39.01 ± 10.68	41.74 ± 8.99	0.290
EQ-5D-5L index	0.80 ± 0.07	0.70 ± 0.10	0.740
EQ-VAS	66.86 ± 15.74	60.09 ± 16.55	0.110

**Statistically significant difference <0.05 Values are expressed as mean ± standard deviation (SD) unless otherwise indicated.

information about conditions. The conditions included hypertension (3 cases), hyperlipidemia (2 cases), reflux esophagitis (1 case), thyroidectomy due to thyroid cancer (1 case), diabetes (3 cases), and calcific tendinitis of the shoulder (1 case). One participant had undergone a thyroidectomy due to thyroid cancer. Table 2 shows the mean baseline NRS, NDI, PPT, ROM, and EQ-5D for the experiment and control group.

3.2. Primary outcome

When analyzing the NRS, the mean difference between the experimental and control groups was found to be significant. When comparing the NRS values within each group at visits 1 and 12, a statistically significant decrease was observed in the experimental group after the intervention compared to the baseline, while in the control group, although the mean value decreased, there was no statistically significant difference. When comparing the visit 12 measurements between groups, the experimental group had a lower mean value than the control group, and there was a statistically significant difference between the groups. The intergroup NRS change (Δ1st-12th) was 1.796 in the experimental group and 0.414 in the control group, and the difference was statistically significant ($p < 0.001$**) (Fig. 2 (A)).

For NDI, a decrease in the values was observed within each group at visits 1 and 12, and the experimental group showed a greater mean difference than the control group, which was statistically significant. When comparing the visit 12 measurements between groups, the experimental group had a more considerable mean difference, but there was no statistically significant difference. Additionally, the intergroup NDI change (Δ1st-12th) was 3.69 in the experimental group and 3.034 in the control group. The difference in the change was not statistically significant ($p = 0.554$) (Table 3, Fig. 2 (B)).

3.3. Secondary outcome – pain and functional rating analysis

The PPT values of the left/right suboccipital and left/right upper trapezius were measured, and paired t-tests were conducted to compare the PPT values between visit 1 and visit 12 for each group. Statistically significant increases were observed in all measured areas of the experimental group, whereas the control group showed a decreasing trend in most threshold values, but this trend was not statistically significant (Fig. 3 (A-D)).

When comparing the visit 12 measurements between groups, it was found that the experimental group had higher pain thresholds than the control group in all measured areas, and this difference was statistically significant. Furthermore, when comparing the PPT changes (Δ1st-12th) between groups, there was no statistically significant decrease in pain threshold in the left suboccipital region for the experimental group compared to the control group. However, the experimental group showed larger changes in the right suboccipital area and left/right upper trapezius, and the difference in the change in threshold values was also statistically significant (Table 4, Fig. 3 (B-D)).

The ROM of participants was evaluated by measuring flexion, extension, right lateral bending, left lateral bending, rotation to the right, and rotation to the left. Upon comparing the ROM measurement results between visit 1 and visit 12 within each group, a statistically significant increase was observed solely in the experimental group for flexion, with an increase of approximately 6.2°, while

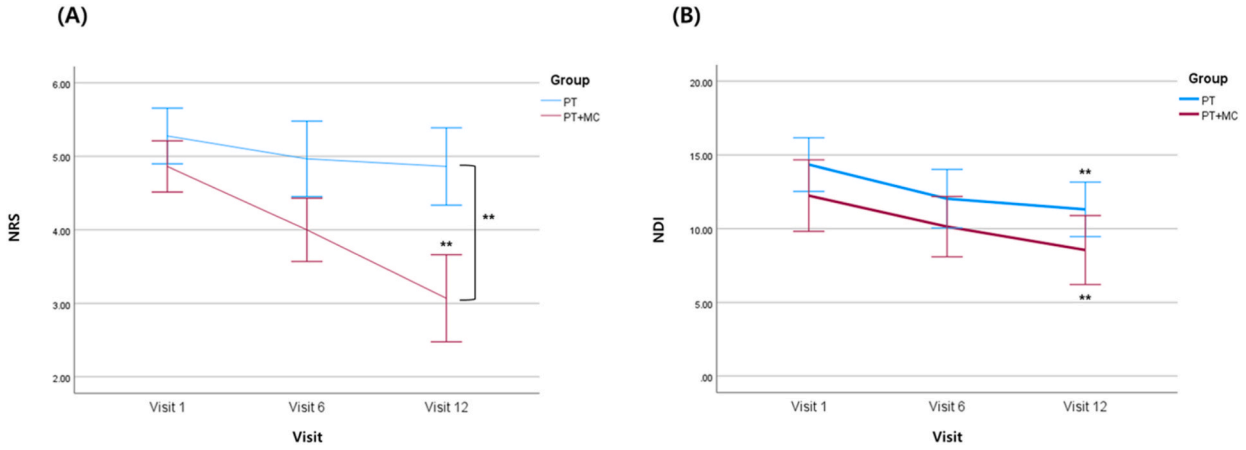

Fig. 2. Change of mean and standard deviation of the Primary outcome, (A) Change of NRS during treatment, (B) Change of NDI during treatment, Intra-group changes and inter-group differences are marked with asterisks (*): $*p < 0.05$, $**p < 0.01$.

Table 3
Changes in NRS and NDI scales in the experimental and control group.

	Intervention		*p-value*	
	PT + MC (n = 29)	PT (n = 29)	Intra-group (PT + MC/PT)	Inter-group
NRS				
1st visit	4.86 ± 0.92	5.28 ± 1.00	<0.001**/0.065	0.105
12th visit	3.07 ± 1.56	4.86 ± 1.38		<0.001**
△1st −12th	1.793 (1.242–2.344)	0.414 (−0.129 to 0.957)		<0.001**
NDI				
1st visit	12.24 ± 6.37	14.35 ± 4.78	<0.001/<0.001	0.160
12th visit	8.55 ± 6.15	11.31 ± 4.86		0.063
△1st −12th	3.69 (2.111–5.268)	3.034 (1.422–4.647)		0.554

p-value *<0.05, **<0.01.
PT, physical therapy; MC, massage chair; NRS, numeric rating scale; NDI, neck disability index.
Values are expressed as mean ± standard deviation (SD) unless otherwise indicated.

the control group displayed an increase of about 0.9°. For extension, a statistically significant difference was observed between the two groups, with an increase of approximately 6.7° in the experimental group and approximately 4.6° in the control group.

Regarding right lateral bending, the experimental group exhibited a statistically significant increase of approximately 4.1°, whereas the control group demonstrated an increase of about 3.6°, although the difference was not statistically significant. Concerning left lateral bending, the experimental group displayed a statistically significant increase of approximately 5.0°, while the control group showed an increase of about 1.6°, but the difference was not statistically significant. Both groups demonstrated a statistically significant increase of approximately 5.0° for both right and left rotation. Both groups exhibited a statistically significant increase of roughly 6.2–6.3° for left rotation.

When comparing the visit 12 measurements between the groups, the experimental group exhibited a larger increase in flexion than the control group, and the difference was statistically significant. However, no statistically significant difference was observed for extension, left and right lateral bending, and left and right rotation despite the average difference in the measured values.

Furthermore, when comparing the changes in ROM measurement methods (Δ1st-12th) between the groups, statistically significant differences were observed for flexion, extension, right lateral bending, and right and left rotation, while no statistically significant difference was observed for left lateral bending (see Supplement files).

3.4. Secondary outcome – quality of life

For measuring the improvement in the quality of life of research participants based on the progress of neck and shoulder pain, using KOSS and EQ-5D-5L (analyzed using EQ-5D-5L index and EQ-5D-5L VAS). The analysis of KOSS scores indicated no statistically significant difference in the change between visit 1 and visit 12 results for either the experimental or control group. The experimental group showed a slight increase of 0.4 points, while the control group decreased by 0.5. The difference in change between the groups was also not statistically significant.

For the EQ-5D-5L index, the experimental and control groups showed a slight increase of 0.03 and 0.02 points, respectively, from visit 1 to visit 12. The difference within the groups was statistically significant only in the control group, but there was no statistically

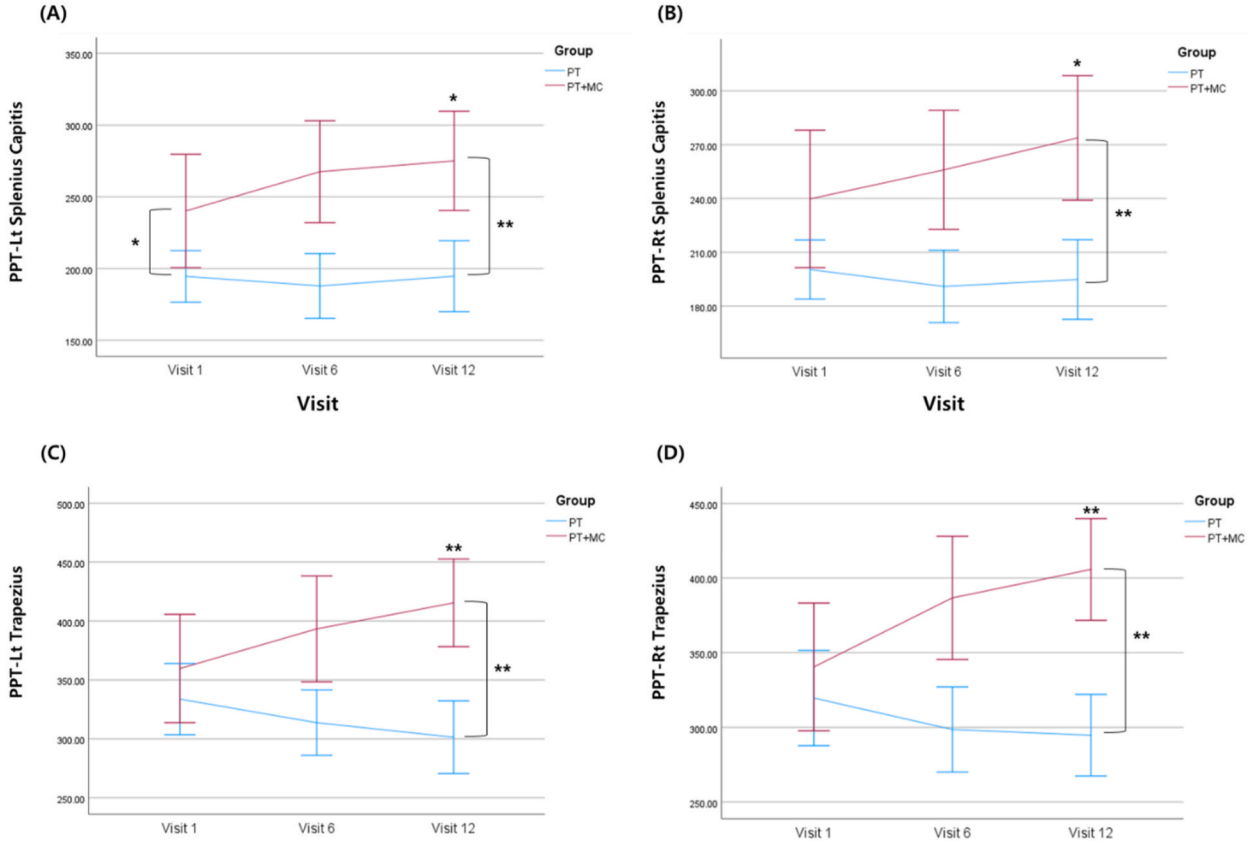

Fig. 3. Change of mean and standard deviation of the PPT, score (A) Lt splenius capitis (B) Rt splenius (C) Lt trapezius (D) Rt splenius, Intra-group changes and inter-group differences are marked with asterisks (*): *$p < 0.05$, **$p < 0.01$.

Table 4
Changes in the PPT scale in the experimental and control group.

	Intervention		*p-value*	
	PT + MC (n = 29)	PT (n = 29)	Intra-group (PT + MC/PT)	Inter-group
PPT (Lt Splenius Capitis)				
1st visit	240.14 ± 103.86	194.52 ± 47.24	0.011*/0.994	0.031*
12th visit	275.04 ± 90.91	194.62 ± 64.98		<0.001**
△1st −12th	−34.90 (−61.00 to −8.81)	−0.10 (−29.05 to 28.84)		0.072
PPT (Rt Splenius Capitis)				
1st visit	239.76 ± 100.78	200.38 ± 43.32	0.021*/0.667	0.058
12th visit	273.76 ± 91.22	194.83 ± 58.38		<0.001**
△1st −12th	−34.00 (−62.53 to −5.47)	5.55 (−20.60 to 31.71)		0.040*
PPT (Lt Trapezius)				
1st visit	359.66 ± 120.69	333.72 ± 79.33	0.002**/0.067	0.329
12th visit	415.31 ± 97.63	301.41 ± 80.97		<0.001**
△1st −12th	−55.66 (−88.33 to −22.98)	32.31 (−2.40 to 67.02)		<0.001**
PPT (Rt Trapezius)				
1st visit	340.45 ± 112.42	319.62 ± 83.81	<.001**/0.160	0.501
12th visit	405.72 ± 89.62	294.76 ± 71.75		<0.001**
△1st −12th	−65.28 (−93.84 to −36.71)	24.86 (−10.43 to 60.15)		<0.001**

PT, physical therapy; MC, massage chair; NRS, numeric rating scale; NDI, neck disability index
Values are expressed as mean ± standard deviation (SD) unless otherwise indicated; statistical significance was set at $p < 0.05$.

significant difference between the groups. The change in the EQ-5D-5L index between the experimental and control groups was not statistically significant.

Regarding EQ-5D-5L VAS, the experimental group showed an average increase of 5 points at Visit 12, but this increase was not statistically significant. The control group showed a significant average increase of 6.9 points. There was no statistically significant difference in the change of EQ-5D-5L VAS between the experimental and control groups (Table 5).

3.5. Adverse events

There were no indications of adverse events during this study. Only two participants mentioned the symptoms of coronavirus.

4. Discussion

The aim of the study was to seek the effects of using massage chairs for office workers with neck and shoulder pain. The most commonly reported symptom among office workers with musculoskeletal disorders is neck and shoulder pain, with a higher incidence noted in office and computer workers compared to the general population [25,26]. With the recent increase in the use of massage chairs, two randomized controlled trials examining effects on stress measures and low back pain [27,28] and one study examining the improvement of heigh growth in children [8] have been conducted so far to seek effectiveness of using massage chairs. To the best of the authors' knowledge, this is the first randomized controlled trial study to investigate the efficacy of using a massage chair for improving neck and shoulder pain.

The present study revealed significant improvements in the experimental group in every aspect of the proposed measurement; the study results aligned with a few previous studies. Findings from a randomized controlled trial in the workplace using massage therapy showed that the experimental group who received weekly massage treatments for four weeks significantly reduced muscle strain and blood pressure compared to the control group, supporting the effectiveness of massage therapy for office workers [28]. Another clinical trial investigating the effect of a corporate chair massage program on musculoskeletal discomfort in office workers revealed that massage sessions per week for a month were effective in decreasing the duration of musculoskeletal aches, pain, or discomfort [29]; it is notable that range of motion for cervical lateral flexion among the participants, which is parallel to the result of the experimental group of this study. Furthermore, a systematic review of massage therapy for neck and shoulder pain, reviewing 12 high-quality studies, stated that the meta-analyses showed immediate effects of massage therapy for neck and shoulder pain with concerns for benefits only would last short-term [30].

As this study indicated, the participant rate was dominantly higher in females; this may be related to the results from the fact sheet by the American massage therapy association, which stated that there was a higher percentage of females seeking a massage last year than males [31]. The intervention group has shown clinically significant improvement in the NDI for this study; the study by Sherman et al. [32] indicated a similar result when therapeutic massage was applied to patients with chronic neck pain that the NDI index was higher after the ten weeks (39% vs. 14% of the self-care book group), and the massage group tended to report improved function after 26 weeks, suggesting potential clinical benefits for treating chronic neck pain at least during the short-term. Additionally, a systematic review regarding the efficacy of massage therapy on pain and dysfunction in patients with neck pain found that six different trials have shown decreased NDI scores in the massage therapy groups [33].

Furthermore, the PPT values were higher in the experimental group in all aspects. According to a preliminary study evaluating the short-term effects of classic massage and connective tissue massage, one classic massage treatment demonstrated pain reduction, mentioning the improvement of the PPT of the sternocleidomastoid muscle among the classic massage group ($P < 0.05$) [34]. Another trial was conducted to determine the acute effect of rolling massage on PPT in 150 participants with tender spots in plantar flexor muscles; the results have illustrated that the heavy rolling massage on the calf that exhibited the higher tenderness group indicated the highest PPT and the heavy rolling massage on the contralateral calf group was the next highest [35]. In addition, another study noted that manual pressure release may be an effective therapy for myofascial trigger points in the upper trapezius muscle; the PPT was recorded pre- and post-intervention, and a significant increase was showed in the mean PPT of the myofascial trigger points in the upper trapezius along with a reduction in perceived pain [36].

Even though the quality-of-life measurements were found to be minimally significant in this study, a clinical trial investigated in the

Table 5
Changes in KOSS, EQ-5D-5L index, and EQ-5D-5L VAS in the experimental and control group.

~	Intervention		*p-value*	
	PT + MC (n = 29)	PT (n = 29)	Intra-group (PT + MC/PT)	Inter-group
KSS (Total)				
1st visit	39.27 ± 10.88	41.74 ± 8.99	0.69/0.615	0.29
12th visit	39.67 ± 10.34	41.20 ± 8.72		0.55
△1st −12th	−0.40 (−2.45 to 1.65)	0.54 (−1.64 to 2.72)		0.52
EQ-5D-5L (index)				
1st visit	0.80 ± 0.10	0.79 ± 0.071	0.05/0.04*	0.74
12th visit	0.82 ± 0.08	0.81 ± 0.05		0.73
△1st −12th	−0.03 (−0.05 to 0)	−0.02 (−0.05 to 0.00)		0.94
EQ-5D-5L (VAS)				
1st visit	67.22 ± 15.93	60.09 ± 16.55	0.09/0.04*	0.11
12th visit	72.41 ± 15.01	67.07 ± 17.55		0.11
△1st −12th	−5.19 (−11.24 to 0.86)	−6.98 (−13.46 to −0.51)		0.68

p-value *<0.05, **<0.01; Values are expressed as mean ± standard deviation (SD) unless otherwise indicated.
PT, physical therapy; MC, massage chair; KOSS, Korean occupational stress scale; EQ-5D-5L, Euro-Quality of Life-5 Dimension; VAS, visual analogue scale.

general population in which a massage followed by rest or Reiki was revealed to reduce stress levels and improve the quality of life compared to the control group [37]. Although there are no trials specifically involving neck and pain shoulder patients using massage therapy, participants from a clinical trial of massage therapy for osteoarthritis of the knee responded that massage therapies helped to perform better in daily activities, enhancing the quality of life with the majority of the participants consenting the positive quantitative changes on standard osteoarthritis measurements [38].

Considering the results of the present study regarding the use of massage chairs on neck and shoulder pain, expanding the use of massage chairs for other musculoskeletal problems may also be effective. According to an evidence map for massage for pain, including 49 systematic reviews, there may be potential benefits across multiple conditions, such as labor, shoulder, neck, low back, cancer, postoperative, arthritis, delayed onset muscle soreness, and musculoskeletal pain [39]. Even though there is insufficient evidence to evaluate the effectiveness of a multifunctional massage chair, it could be cost-effective when compared to therapies or treatments. A study indicated that massage chairs were cost-effective compared to conventional physiotherapy for treating lower back pain [40].

Furthermore, this study took on a preliminary nature before conducting large-scale multicenter clinical trials, as there had been no prior research directly comparing the effects of conventional physical therapy and mechanical massage through massage chairs with the PEMF system on a one-to-one basis. Hence, the experimental group was designed as an add-on of massage chairs to conventional physical therapy. In order to assess the effectiveness of massage chairs compared to the effects of physical therapy, additional clinical research will be necessary. The limitation of this study is that a relatively small number of participants were recruited. More research is needed to understand the more concrete stability and effectiveness of massage chairs with a larger sample for a more extended trial period. Another limitation of this clinical trial is that 85% of the participants were females. A larger and more diverse sample of participants would be necessary to apply the findings to the general population. Despite this limitation, this study has the strength of exploring the potential positive effects of combining conventional and massage chair therapy on neck and shoulder pain and function in office workers in the short term. Another strength could be the well-designed protocol with strict criteria and minimal loss during the trial period.

5. Conclusion

This study preliminarily verified the effect of a massage chair on neck and shoulder pain among office workers. It is noteworthy that the primary and secondary results have shown positive effects in every aspect of using a massage chair in this study despite the minor differences in the measurements. This study further suggested that the effectiveness of relieving neck and shoulder pain as well as improving range of motion. That being said, healthcare professionals could consider utilizing massage chairs as a means of preventing WMSDs; additionally, massage chairs could be placed in the workplace as well as a home to relieve the pain of WMSDs while improving quality of life. Further studies with a larger sample size of participants and a more extended trial period with more diversified workers to clarify the long-term effects of massage chairs on neck and shoulder pain are needed for seeking the dramatic potential to use massage chairs to apply for other musculoskeletal symptoms.

Ethics statement

This study was reviewed and approved by the institutional review board (IRB) in Gwangju Korean Medicine Hospital of Wonkwang University, with the approval number: WKIRB 2022/3-2.

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Author contribution statement

Hongmin Chu: Conceived and designed the experiments, Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Soo-Ji Park, Yeongjin Jeong and Suhak Kim: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Seung-Ryong Yeom, Sangkwan Lee and Bo-Young Youn: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper <p/>.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e20287.

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