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Effect of Interactive Virtual Reality Device on Cervical Pain and Neck Function in Forward Head Posture

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ABSTRACT
Background: One of the most prevalent postural abnormalities, forward head posture (FHP), is affecting 66% of the population of patients. Bad interaction between bodily components results in poor posture. These can result in muscle tightening and tension that will make it harder to move your joints properly and may even hurt.
Objective: This study was conducted to evaluate the impact of interactive virtual reality device on cervical pain and neck function in symptomatic forward head posture.
Patients and Methods. In this study, 30 patients of both sexes with symptoms of forward head posture, body mass index (BMI) between 18 and 25 kg/m^2, and ages between 20 and 24 years were enrolled in this study. They were randomized into two groups of equal number. **Group A** received taditional treatment (chin tuck exercise for posture correction); three sets of ten repetitions were carried out for three minutes each day for four weeks, with each repetition lasting five seconds**. Group B** obtained the same as group "A" in addition to VR training by Xbox Kinect 360 (15 min each session three times each week) for 4 weeks. Cervical pain “VAS” and neck disability “NDI” were measured pre and post treatment. **Results**. There was a substantial decrease in the VAS post treatment and there was a substantial decrease in the NDI among the two groups in favor of group B.
Conclusion Combining virtual reality with the chin-tuck exercise is an efficient way to treat cervical pain and neck disability in forward head posture.
Keywords: Forward Head, Virtual Reality, Neck disability, Xbox Kinect 360.

INTRODUCTION
Alignment of the body's parts at a given moment in time is known as posture, and it may provide you with valuable information about your overall health. It needs to be in line with a spatial posture of the body that reduces the negative effects of gravity on the tissues. Poor posture results from faulty connections between the body's components. Tense and contracted muscles restrict range of motion in the joints, causing pain and difficulty in performing daily tasks **(1).**

One of the most prevalent postural abnormalities is forward head position (FHP), which affects 66% of the patient population **(2)** with high prevalence among university students due to prolonged usage of computer, smartphones and faulty posture during lectures with lack of awareness about proper posture among them**(3)**.

Musculoskeletal issues in the neck maybe attributed to improper forward head position in a large percentage of the population. FHP is prevalent postural abnormality noted in the literature and is thought to contribute to the onset of neck pain. According to a recent study, over 61.3% of individuals who have neck pain while using a computer for work have FHP. Also, when individuals with chronic neck pain were distracted, they exhibited FHP and showed signs of weakening in their deep neck flexors **(4).**

Rehabilitative professionals have conducted evaluations and administered treatments using VR systems. Virtual reality (VR) can enable simulated practice of functional activities at larger doses than in traditional treatments, whether it is on a screen or through Head-mounted display for virtual reality (HMD- VR) **(5)**.

This study was conducted to evaluate the impact of interactive virtual reality device on cervical pain and neck function in symptomatic forward head posture.

PATIENTS AND METHODS
Design
This study included 30 patients of both sexes with symptoms of forward head posture. The study was a pre and post randomized experimental trial.

Ethical considerations:
Every patient signed an informed written consent for acceptance of participation in the study. The Helsinki Declaration's guidelines for research involving human participants were followed. Clinical trials registration database with identifier P.T.REC/012/003549; Research Ethics Committee, Faculty of Physical Therapy, Cairo University and the clinical trials registering database under the identification number NCT05579613.

Randomization
Participants were randomly assigned to one of two equally sized groups (A, B) by an independent observer who performed the randomization process by opening sealed envelopes enclosing index cards with sequential numbers created by a computer utilizing the statistical package for the social sciences (SPSS) program (version 25 for Windows; SPSS Inc., Chicago, Illinois, USA). After initial randomization, there weren't any participant dropouts.

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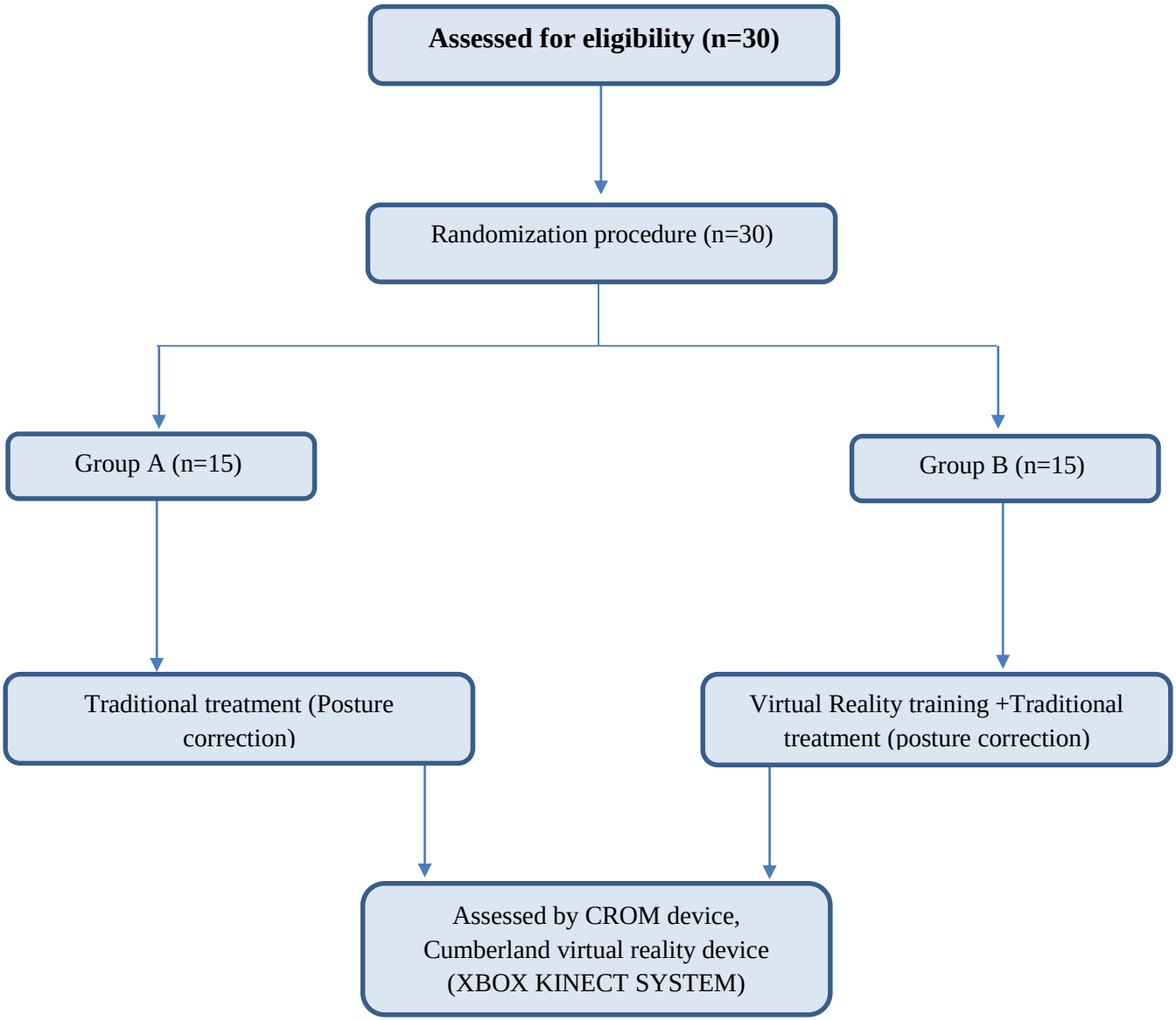

Figure (1): Randomization procedure.

Participants:

Sample Size Calculation:

The minimum proper sample size was 14 patients in each group. This calculation was designed to reveal an effect size of 0.5 with an alpha of 0.05 as well as a power of 80% considering the visual analogue scale (VAS) score. As the primary outcome 30 students from the Faculty \of Physical Therapy at Cairo University were recruited for this study; all genders were represented, and their average age ranged from 20 to 24. The participants' mean body mass index (BMI) ranged between 18.4 to 25.

Outcome Measures:

A. Methods measured for assessment:

1. ***Measurement of for forward head position (FHP) by CROM device:*** The participants sat on a plinth with their hips and knees bent at a right angle (90 degrees), their feet level on the floor, and their hands on top of their thigh. “Sit in your usual position and stare blankly at a wall”, the instructions were read.

Between trials, the CROM's placement was double-checked after being put on the bridge of the nose and behind the ears. C7 was found by having participants flex, then extend, then rotate their cervical spine while feeling about for the most movable portion at the cervicothoracic junction; this was where the vertebral locating arm was positioned. The bubble inclinometer on the spinal locator was utilized to ensure the device was held at the correct height [(6)].

Figure (2): Measurement of forward head position (FHP) by CROM device

2-Cervical pain by VAS: Pain can be measured using the visual analog scale (VAS). Symptom severity is measured by having the patient make a single, handwritten mark anywhere along a 10-centimeter line that ranges from zero centimeters (representing no pain) to ten centimeters (representing the greatest pain imaginable) (10 cm). The distance in millimeters from the scale's origin (the left end) to each patient's mark was recorded and used to quantify the intensity of pain they are experiencing [(7)].

3-Functional neck disability index: It was measured by The NDI which is a 10-item questionnaire consists of pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping and recreation. The subject was instructed to circle one of the six options, which describe the severity of each item (0–5) **[(8)].**

B. Methods measured for treatment:

1- VR Training using Xbox Kinect:

Using an infrared camera, the Kinect sensor allows players to play games without the need for traditional controllers. Game play is managed by the console. A designated area was prepared for the VR instruction, complete with an Xbox Kinect, gaming console, and display screen. The recommended distance for the Kinect sensor from the patient is 1.5 to 2 meters.

Figure (3): Xbox Kinect 360 device

The Rally Ball game requires players to utilize their full bodies, and especially their heads, to deflect and strike the ball down the court. Balls will shoot down an area towards the player, and the player must knock the balls back to destroy objects at the end of the path. The player's visage is projected onto the screen while she stands in front of a Kinect sensor, so she must utilize her full body to navigate the screen and stop the balls, as seen in figure (4).

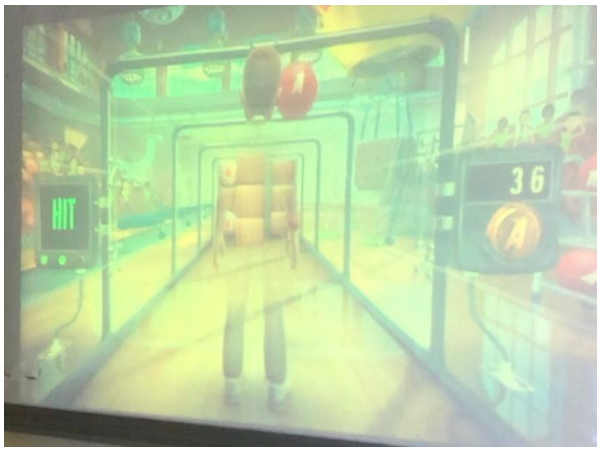

Figure (4): Rally Ball game in Kinect adventure

River Rush: Subjects play the game by standing in front of a Kinect sensor; their image appears on-screen, seated on a raft. Each lesson begins with the players being launched down a river, with the player controlling the raft with their own bodies. Players maneuver the raft side to side by flexing the muscles on each side of his neck, and they may propel themselves forward by leaping in front of the Kinect sensor. Player, keeping the raft moving by obstacle avoidance like

barrels and wood. Players get points by retrieving pins placed strategically around the course; unfortunately, these pins aren't always within reach as shown in figure (5).

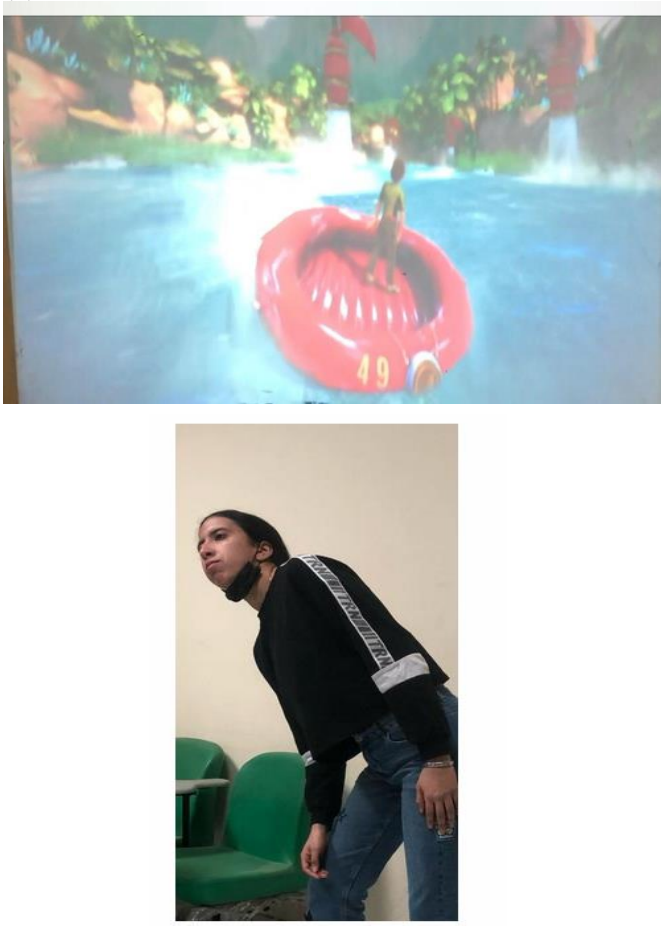

Figure (5): River Rush game in Kinect adventure

Virtual Reality program: The Subjects have been received 12 sessions for 15 min each session, 3 times per week for 4 weeks [9].

2-Traditional exercise (posture correction exercise):

There were several techniques for posture correction. Chin tucks is one of the procedures. Subjects are to stand with their backs against the wall and their feet hip-width apart. Hold for 5 seconds, then repeat 10 times with the chin tucked in. It is recommended to return to the initial location and repeat the process several times. The resulting neck stretches may be beneficial [9].

Figure (6): Chin Tuck for posture correction in FHP.

Statistical analysis

Independent-test was used to evaluate differences in subject characteristics between experimental groups. The VAS and NDI were compared before and after therapy in each group using a dependent t-test. All statistical tests were performed at a p-value of 0.05, which is considered statistically significant. The Windows version of the statistical package for the social sciences (SPSS) version 25 was used for all analyses.

RESULTS

When comparing the basic demographics of the participants in each group, we found no statistically significant differences in mean age, weight, height, or body mass index (Table 1).

Table (1): Demographic data of subjects in both groups

	Group A (N=15)	Group B (N=15)	MD	t- value	p-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD				
Age (years)	20.46±0.74	20.13 ± 0.52	0.33	1.42	0.16	**NS**
Weight (kg)	65.4 ± 8.02	65.13 ± 10.44	0.27	0.07	0.93	**NS**
Height (cm)	163.06 ± 5.76	166.53 ± 6.79	-3.47	-1.51	0.14	**NS**
BMI (kg/m²)	24.63 ± 3.23	23.49 ± 3.43	1.14	0.93	0.35	**NS**

$\overline{X}$: Mean, SD: Standard deviation, MD: Mean difference, NS: Nonsignificant

Table 2, shows that there was a substantial decline in the VAS of the group B post treatment in comparison with group A

Table (2): Mean VAS pre and post treatment of the group A and B

VAS	Pre treatment	Post treatment	MD	% of change	t-value	p-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD					
Group A	6 ± 1.34	2.4 ± 0.43	3.6	60	9	0.001	**S**
Group B	6.06 ± 1.27	1.27 ± 0.23	4.8	79.21	16.21	0.001	**S**
MD	-0.06	1.13					
t- value	-0.13	8.97					
p-value	0.9	<0.001					
Sig	**NS**	**S**					

$\overline{X}$: Mean, SD: Standard deviation, MD: Mean difference, NS: Nonsignificant

Table 3, show that there was a substantial decline in the NDI of the group B post treatment in comparison with group A.

Table (3): Mean NDI pre and post treatment of the group A and B

NDI (%)	Pre treatment	Post treatment	MD	% of change	t- value	p-value	Sig
	$\overline{X}$ ±SD	$\overline{X}$ ±SD					
Group A	13.33 ± 3.24	8.26 ± 1.91	5.07	38.03	6.97	0.001	**S**
Group B	12.73 ± 2.71	4.06 ± 0.84	8.67	68.11	13.59	0.001	**S**
MD	0.6	4.2					
t- value	0.55	7.80					
p-value	0.59	<0.001					
Sig	**NS**	**S**					

$\overline{X}$: Mean, SD: Standard deviation, MD: Mean difference, NS: Nonsignificant

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DISCUSSION

Several studies have demonstrated a connection between FHP and neck discomfort. Long-term FHP use is associated with neck pain because of the low-intensity physical stress that is put on the neck. In FHP, the proprioception in the neck might be impaired because of the abnormal positioning of the head and neck joints and muscles. Muscle length in the cervical spine, anterior and posterior shoulders, and hips all alter as a result of FHP, with the superficial muscles becoming short and the deep muscles becoming long and weak [(10)].

The VAS scores of the group B patients post treatment decreased significantly compared to those of the group A patients. In the end, there was a 4.2% difference in NDI seen between two treatment groups. After treatment, the NDI of those in Group B was significantly lower than that of those in Group A. Our current study demonstrated that VR training (15 min per session- 3 days per week) and chin tuck for posture correction 3 min per day for four weeks has revealed statistically substantial decline in the VAS and NDI.

We hypothesized that the impact of virtual reality training (VRT) on deep cervical muscles is responsible for the reduction in pain and impairment in the VRT group. Even though it was not measured, the activity of the cervical muscles appears to play a major role in the enhancement of deep cervical muscular function and coordination among these and superficial muscles. There is hope that greater support for the cervical segments and less strain on cervical components might alleviate neck discomfort. The unique capability of VR for pain distraction may account for VRT's superior efficacy in lowering pain. The player is required to pay close attention to the game at all times. Due to the finite nature of human attention, the participant's cognitive capability to comprehend pain reduces throughout play, resulting in a diminished perception of it [(11)]. Consistent with a prior research that also assessed the effects of VRT on individuals with neck pain conducted by **Bahat *et al.*** [(11)], the present study found that it did not

significantly reduce either pain or disability. It is possible that changes in the virtual reality (VR) setup, the game itself, or the research design account for the different findings, even though patients in the two experiments got equivalent quantities of VRT.

Patients suffering from non-traumatic chronic neck pain can benefit from using a virtual reality (VR) equipment in addition to traditional rehabilitation methods. Sensorimotor training with a VR device may be more successful at reducing pain than a pure regular rehabilitation program, and patients in the VRG saw substantial improvements in their neck pain, headaches, ACROM in flexion, extension, as well as left rotation, along with self-reported disability. Detected improvements in the NDI scores suggest that sensorimotor improvement by the VRT may have related to the decline in self-reported disability [(12)].

The recent study of **Son** also showed the positive effect of FHP correction on balance. They also reach the conclusion that patients with FHP should benefit from the more extensive movement patterns caused by the VR games rather than the simple posture correction exercises [(9)].

In contrast to a previous study by **Roijezon *et al.*** [(13)], which found no significant change in VAS scores for pain after 8 sessions of training using a unique type of neck coordination exercises, the current study found a substantial improvement, the possible cause of this is insufficient exercise.

Limitations of this study: The study's limitations include its small sample size, the difficulty in selecting games due to an inadequate quantity of virtual reality games for medical reasons, the exhaustion of the subjects after treatment, and the lack of any follow-up to determine its long-term effects.

CONCLUSION

It can be concluded that Virtual Reality training combined with posture correction exercise is an efficient treatment method for decreasing cervical pain and neck disability in subjects with symptomatic forward head posture.

RECOMMENDATIONS

It was recommended that further studies should be investigated to determine the efficacy of this program on other postural abnormalities and comparison between the effect of VR training and another program on cervical pain and neck function should be conducted in the future.

Conflict of interest: The authors declare no conflict of interest.

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Author contribution: Authors contributed equally in the study.

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