"EFFECT OF VIRTUAL REALITY EXERCISES ON HANDGRIP STRENGTH, PAIN, ANXIETY AND DEPRESSION IN POST MASTECTOMY PATIENTS-AN EXPERIMENTAL STUDY."

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Abstract: **Background:**

Women are diagnosed with breast cancer every year more than 1.3 million. The most common consequences of breast cancer diagnosis and treatment is psychological stress with the symptoms of anxiety and depression. During the early postsurgical period leading to limitation in daily activities it has been reported that pain, fatigue, decreased range of motion (ROM) and decreased muscle strength have developed. Virtual reality (VR) that allows users to immerse themselves in a three-dimensional computer generated word has found a variety of application in health care over the last two decade and in particular has been shown efficacy as distraction to alleviate and pain including chemotherapy during medical procedure.

Purpose of Study:

The purpose of this study was to find out the effect of Virtual Reality Exercises on Handgrip strength, Pain, Anxiety and Depression in Post-mastectomy Patients.

Material And Methodology:

Following an explanation of the study to participants, signed agreement was obtained. 60 participants female were included. Pre assessment (Anxiety measured by using IES;

Depression measured by using CES-D; Pain measured by using VAS; Hand grip strength measured by using electronic hand dynamometer) were done. Post assessment (after 6 weeks Anxiety measured by using IES; Depression measured by using CES-D; Pain measured by using VAS; Hand grip strength measured by using electronic hand dynamometer) were done. Treatment was given one session daily, 6 days a week for 6 consecutive weeks.

Results:

The statistical analysis was done using paired t test, which showed significant improvement in post exercise protocol.

Conclusion:

The result of the study shows that VR exercises has excellent improvement in terms of hand grip strength, pain, anxiety and depression.

Keywords: **Virtual reality (VR), The impact of events scale (IES), The center for epidemiological studies depression scale (CES-D), Visual analogue scale (VAS), Handgrip strength (HGS), Range of motion (ROM), Electronic Hand Dynamometer (EHD).**

INTRODUCTION

Breast cancer is the most commonly diagnosed cancer among women worldwide and is the leading cause of cancer-related deaths. Women are diagnosed with breast cancer every year more than 1.3 million. [1]

It affects both physical and mental health severely. The most common consequence of breast cancer diagnosis and treatment is psychological stress with symptoms of anxiety and depression. [2]

While treating the cancer women deals with physical changes including fatigue, hair loss, early menopausal symptoms, lymphoedema and decreased libido. [3]

During the early postsurgical period leading to limitation in daily activities it has been reported that pain, fatigue, decreased range of motion (ROM) and decreased muscle strength have developed. [1]

Anxiety is an emotion characterized by subjectively unpleasant feelings of worries over future threats or anticipated events such as the feeling of close death. Anxiety is defined as "a subjective feeling of apprehension, a vague, tension, insecurity, and uneasiness, usually without a known, specific cause identifiable by the individual." Among cancer patients anxiety could arise from different reasons such as a reaction to cancer diagnosis, long-term treatments, severe pain, treatments side effect, feeling of dependence or burden, on others. [4]

A study was done by Shubham Mistry and they concluded that after radical mastectomy there is significant reduction of handgrip strength and hand function in women. [5]

Virtual reality (VR) that allows users to immerse themselves in a three-dimensional computer generated word has found a variety of application in health care over the last two decade and in particular has been shown efficacy as distraction to alleviate and pain including chemotherapy during medical procedure. [6]

Two categories of VR systems are divided into: immersive and non-immersive. Immersive VR is defined by filled immersion, which users' attention can be affected. Through a head-mounted exhibition a whole-immersive experience is achieved that obscures users' view of the real world and patient present with a computer-generated view instead. The headphones and head-mounted display remove available to sound and light from the outside. Thus, from the hospital-medical milieu patients can be personally isolated. This is what helps patients to focus on reduce unfavourable emotions and enjoyable stimuli. The non-immersive VR is characterised by computer screen, where the user is joined to the virtual world with the external environment but can still communicate. [2]

The Impact of Events Scale (IES) is a self-report measure which was planned to measure 'current subjective distress' in relation to a particular stressor. The IES is form on a 2 factor 'intrusion-avoidance' model of reactions to stressful life events. It measures the frequency of avoidant and intrusive phenomena. Intrusions are characterised by 'images and unbidden thoughts, strong pangs or waves of feelings, troubled dreams, and repetitive behaviour.' [7]

Avoidance responses are characterized by 'denial of the meaning, ideational constriction, and consequences of the event, behavioural inhibition or counterphobic activity and blunted sensation and awareness of emotional numbness.' [7]

The Impact of Events Scale (IES) is a 15- item scale that assesses intrusive thoughts or rumination and attempts to avoid such thoughts use to assess cancer-related anxiety. [3]

The Center for Epidemiological Studies Depression Scale (CES-D) is a 20-item scale used to assess depressive symptoms. [3]

In a cancer population, there are a few studies in which the psychometric properties of CES-D have been examined. [8]

NEED OF STUDY

• Studies have shown that there is weakness of hand grip strength in post mastectomy patients.

• There is lack of literature in the use of virtual reality exercises on handgrip strength, pain, anxiety and depression in post mastectomy patients.

• Thus, the need of this study is to see the effect of virtual reality exercises on handgrip strength, pain, anxiety and depression in post mastectomy patients.

AIMS AND OBJECTIVES

AIM

• To study the effect of Virtual Reality Exercises on Handgrip Strength, Pain, Anxiety and Depression in Post Mastectomy Patients.

OBJECTIVE OF THE STUDY

• To find out the effect of Virtual Reality (VR) exercises on handgrip strength using electronic hand dynamometer in post mastectomy patients.
• To find out the effect of Virtual Reality (VR) exercises on pain using visual analogue scale (VAS) in post mastectomy patients.
• To find out the effect of Virtual Reality (VR) exercises on anxiety using the impact of event scale (IES) in post mastectomy patients.
• To find out the effect of Virtual Reality (VR) exercises on depression using the center for epidemiological studies depression scale (CES-D) in post mastectomy patients.

REVIEW OF LITERATURE

1. Turabi et al. (2022)

The purpose of the study was to correlate between grip strength and rotator cuff strength in patient with atraumatic shoulder instability (ASI). Objective measure were used was jamar hydraulic hand dynamometer and universal goniometer. The result of the study demonstrate that grip strength is strongly associated with rotator cuff strength in patients with ASI.

2. Zhou Z (2021)

The purpose of this study was to develop a virtual reality upper limb rehabilitation system for patients after breast cancer surgery and to explore its usability. Outcome measure taken were the System Usability Scale and the Presence Questionnaire Scale and the Simulator Sickness Questionnaire. The results show that the VR rehabilitation system is available, feasible and easy to learn for breast cancer patients.

3. Mistry Subham (2021)

The aim of this study was on the objective assessment of hand function in women with lymphadenopathy after radical mastectomy. Objective measure were used such as a hand dynamometer and pinch gauge/pinch meter were used to measure power grip and precision grip strength and the Jebsen-Taylor hand function test (JTHFT) tool kit was used to assess hand function. The results of this study indicate a significant reduction of hand grip strength and hand function in women with BCRL.

4. Atef D et al (2020)

The aim of study was to comparing the PNF and VR therapy in the treatment of lymphoedema after mastectomy. Outcome measures taken were QuickDASH-19 scores. The study shows that VR has greater improvement than PNF in lymphoedema and upper limb functions.

5. Feyzio ˇglu et al (2020)

The purpose of this study was to evaluate the impact of VR therapy with the use of Kinect equipment on the functions of the upper limb in women after breast cancer surgery. Outcome measure used was Visual Analogue Scale (VAS), Hand DASH Questionnarie, Tampa Kinesiophobia Scale (TKS). The result suggest that Kinect therapy was more effective in improving the assessed parameters than standard therapy.

6. Andrea Chirico et al (2019)

The purpose of this study was between virtual reality and musical therapy to alleviate anxiety and improve mood states in patients with breast cancer during chemotherapy. Outcome measures used was Standard Self-Report Questionnarie, State Anxiety Inventory (SAI), Short Version of Profile of Mood States (SV-POMS) and Virtual Reality Symptom Questionnaire (VRSQ). In this study both VR and MT are useful interventions for alleviating anxiety and improving mood states in breast cancer patients during chemotherapy. The VR intervention seems more effective than MT in relieving anxiety, depression and fatigue.

7. Mohammad et al (2018)

The aim of the study was to assess of the effectiveness of immersive VR distraction technology in reducing pain and anxiety among female breast cancer patients. Outcome measure taken were Visual Analogue Scale (VAS) and the State Anxiety Inventory (SAI). The findings of this study suggest that immersive VR holds promise as an effective distraction intervention for managing pain and anxiety among breast cancer patients.

8. Sharma A (2017)

The present study was conducted to compare hand grip strength and pinch strength pre and post radiotherapy in patients following modified radical mastectomy. Objective measure were used by Jamar hand dynamometer. The result of this study shows decrease in hand grip and pinch grip strength post- radiotherapy following modified radical mastectomy in breast cancer subjects.

MATERIALS AND METHODOLOGY

MATERIALS

- Writing material.

- Electronic hand dynamometer.

- Xbox -KINECT

METHODOLOGY

- Type of study: - Experimental study
- Study setting: - Shri Siddhivinayak Ganpati Cancer Hospital, Miraj.
- Study duration: - 6 Months
- Type of sampling: - Purposive sampling
- Sample size: - 60
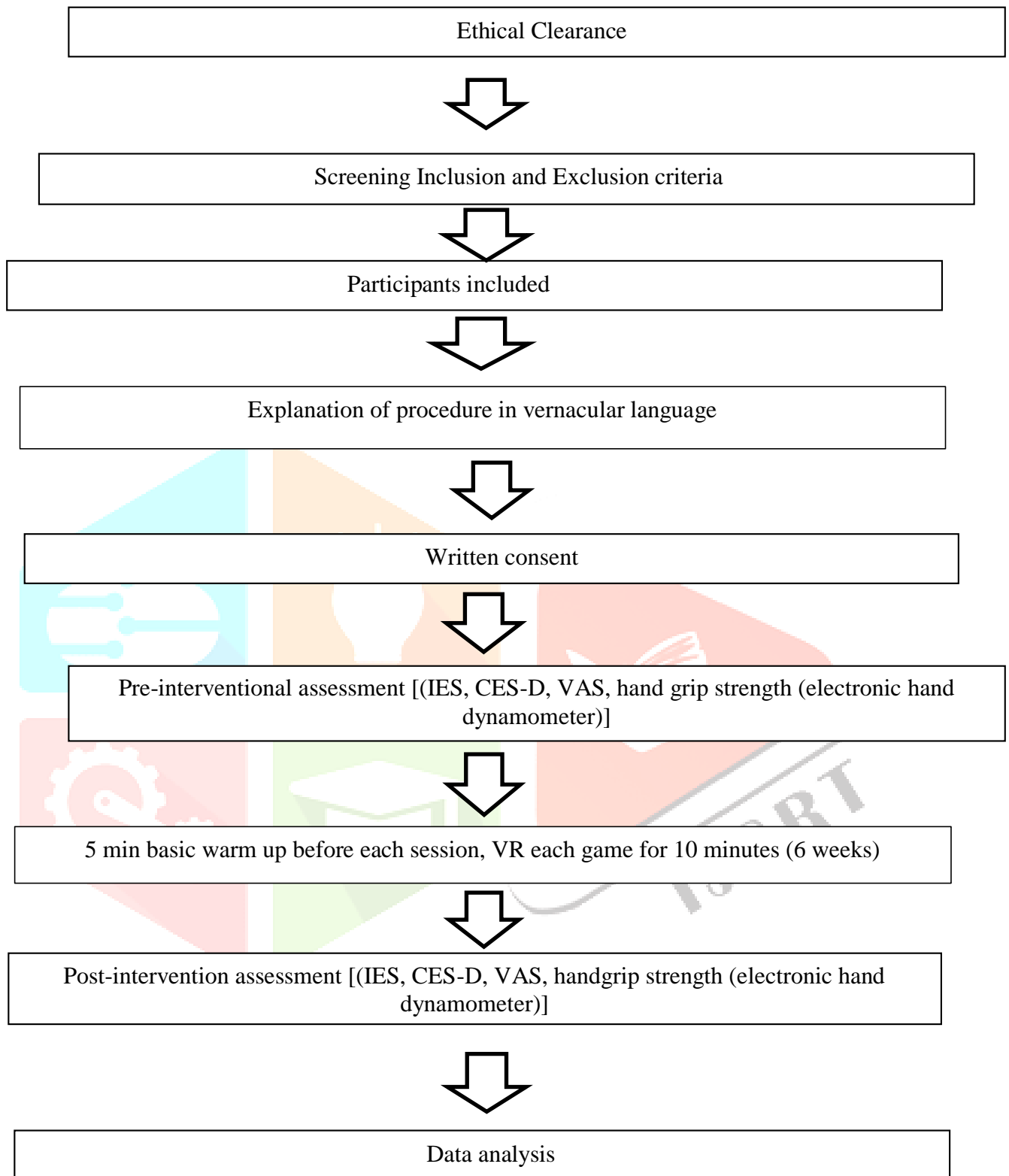
INCLUSION AND EXLUSION CRITERIA

Inclusion criteria

- Age group - 30 to 60 years of age.
- 14 days after surgery.
- Have undergone radical mastectomy surgery.

Exclusion criteria

- Previous breast cancer surgery on the present or contralateral side.
- Active or metastatic cancer focus.
- . Upper extremity ROM limitation before the surgery.
- Presence of pace-maker, infection, open wounds or wound drains, musculoskeletal neurological hemodynamic changes.

- Unco-operative patients.

PROCEDURE

Ethical Clearance

⬇

Screening Inclusion and Exclusion criteria

⬇

Participants included

⬇

Explanation of procedure in vernacular language

⬇

Written consent

⬇

Pre-interventional assessment [(IES, CES-D, VAS, hand grip strength (electronic hand dynamometer)]

⬇

5 min basic warm up before each session, VR each game for 10 minutes (6 weeks)

⬇

Post-intervention assessment [(IES, CES-D, VAS, handgrip strength (electronic hand dynamometer)]

⬇

Data analysis

Electronic Hand Dynamometer (EHD): To assess the hand grip strength by measuring maximum hand grip pressure. Validity (ICC 0.983-0.986). Subjects are instructed to be in seated position. On affected side the maximum grip strength was measured in kilograms. The shoulder adducted with elbow 90degree flexion and wrist in neutral position. 3 times with one min intervals the test was performed and standard of three measurements was recorded.

- The Impact of Events Scale (IES) reliability (r = 0.79 to 0.89) internal consistency (Cronbach‟s α = 0.78 to 0.82).

• The Center for Epidemiological Studies Depression Scale (CES-D) reliability = (0.88), internal consistency = (0.89).

Center for Epidemiologic Studies
Depression Scale (CES-D), NIMH

Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the **past week**. Circle **one** number on each line.

	During the Past Week			
	Rarely or none of the time (less than 1 day)	Some or a little of the time (1–2 days)	Occasionally or a moderate amount of time (3–4 days)	All of the time (5–7 days)
1. I was bothered by things that usually don't bother me	0	1	2	3
2. I did not feel like eating; my appetite was poor	0	1	2	3
3. I felt that I could not shake off the blues even with help from my family or friends	0	1	2	3
4. I felt I was just as good as other people	0	1	2	3
5. I had trouble keeping my mind on what I was doing	0	1	2	3
6. I felt depressed	0	1	2	3
7. I felt that everything I did was an effort	0	1	2	3
8. I felt hopeful about the future	0	1	2	3
9. I thought my life had been a failure	0	1	2	3
10. I felt fearful	0	1	2	3
11. My sleep was restless	0	1	2	3

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TABLE 2.   Revised Impact of Event Scale

On _____ you experienced _____
    (date)   (life event)

Below is a list of comments made by people after stressful life events. Please check each item, indicating how frequently these comments were true for you DURING THE PAST SEVEN DAYS. If they did not occur during that time, please mark the "not at all" column.

FREQUENCY

|	Not at All	Rarely	Sometimes	Often
1. I thought about it when I didn't mean to.				
2. I avoided letting myself get upset when I thought about it or was reminded of it.				
3. I tried to remove it from memory.				
4. I had trouble falling asleep or staying asleep, because of pictures or thoughts about it that came into my mind.				
5. I had waves of strong feelings about it.				
6. I had dreams about it.				
7. I stayed away from reminders of it.				
8. I felt as if it hadn't happened or it wasn't real.				
9. I tried not to talk about it.				
10. Pictures about it popped into my mind.				
11. Other things kept making me think about it.				
12. I was aware that I still had a lot of feelings about it, but I didn't deal with them.				
13. I tried not to think about it.				
14. Any reminder brought back feelings about it.				
15. My feelings about it were kind of numb.				

Intrusion subset = 1, 4, 5, 6, 10, 11, 14; avoidance subset = 2, 3, 7, 8, 9, 12, 13, 15.

Visual Analogue Scale (VAS) reliability = 98

Fig: Vampire game performed by post mastectomy

Visual analog scale
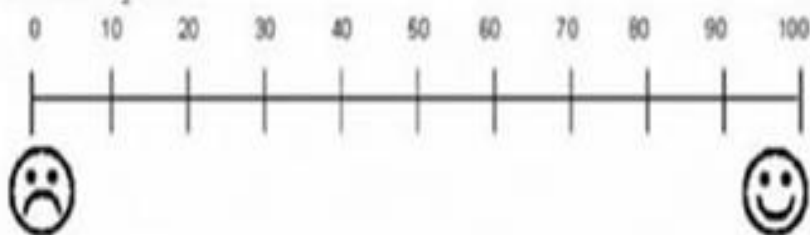
In the preoperative period

According to the scale above, grade questions 1 through 4 according to your degree of satisfaction:
1- How do you feel about your breast shape today?
2- How do you feel about your breast size today?
3- How do you feel about your breast symmetry today?
4- How do you feel about your breast consistency today?

In the postoperative period of the 1st month / 6th month / 12th month

According to the scale above, grade questions 1 through 4 according to your degree of satisfaction:
1- How do you feel about your new breast shape today?
2- How do you feel about your new breast size today?
3- How do you feel about your new breast symmetry today?
4- How do you feel about your new breast consistency today?
5- How do you feel about your breast scar today?

Fig: Puncher game performed by post mastectomy

Fig: Cleaner game performed by post mastectomy

Fig: Hand grip strength measured by using electronic hand dynamometer on post mastectomy patient.

STATISTICAL ANALYSIS

Statistical analysis was done using: -

- Shapiro-Wilk test to assess normality of the data.

- paired t test to check pre- and post-data of a group.

RESULT

Normality test using Shapiro-Wilk

| Variable	Time frame	z-value	p-value
IES	Pre	0.985	0.684
	Post	0.962	0.062
CES-D	Pre	0.987	0.752
	Post	0.986	0.738
VAS	Pre	0.951	0.051
	Post	0.970	0.145
HGS	Pre	0.974	0.221
	Post	0.953	0.051

Table No. 1: Normality test using Shapiro-Wilk

Data set is normally distributed as all the variables have indicated non-significant outcome in the observation. The researcher shall use parametric test for data analysis purpose in the following sections.

Descriptive Statistics

Particular	Minimum	Maximum	Mean	SD
Age	30.00	60.00	46.68	9.85

Table No. 2: Descriptive Statistics
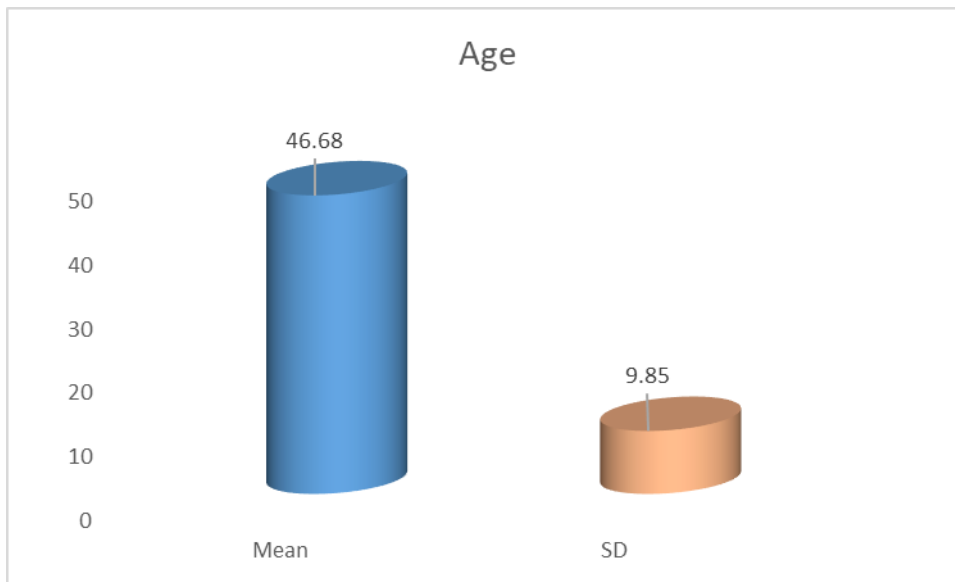
Graph no 1: Shows the Descriptive Statistics of age
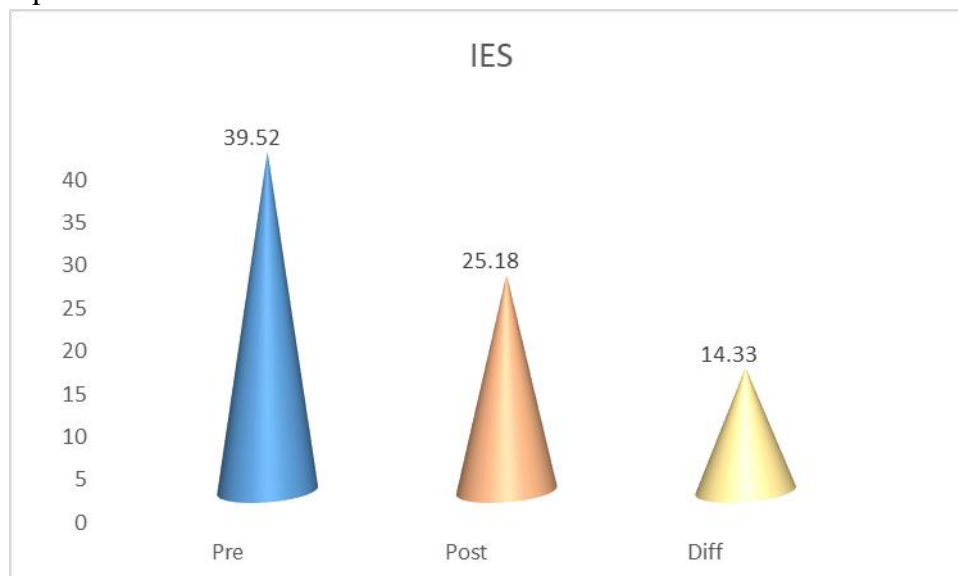
Pre and post analysis using paired sample t test

Variable	Pre		Post		Diff		Effect	t-	p-
	Mean	SD	Mean	SD	Mean	SD	size	value	value
IES	39.52	8.57	25.18	6.11	14.33	4.82	2.97	23.029	0.001*

Table no. 3: shows within group pre and post mean, standard deviation, difference, p-value of IES

The IES mean value indicated changes post treatment and lower values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value.

The effect size or Cohen's D indicates 2.97 value which is assumed to be very high in effect size as per the standard parameters of reference.

Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. 0.001 < 0.05) in the study and therefore it justifies the improvements in health outcome post intervention.

Graph no. 2: shows within group pre and post mean, standard deviation and difference of IES

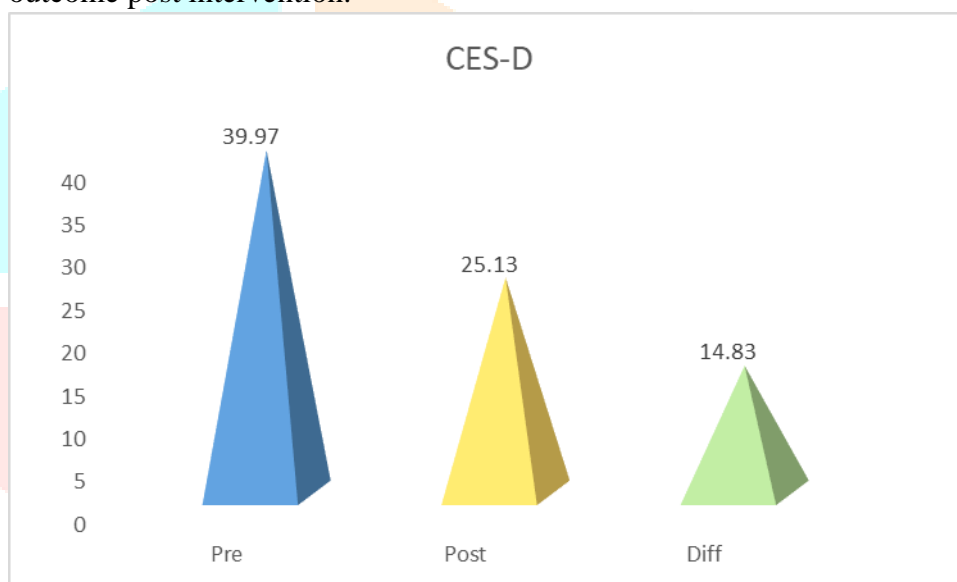**Pre and post analysis using paired sample t test**

Variable	Pre		Post		Diff		Effect size	t-value	p-value
	Mean	SD	Mean	SD	Mean	SD			
CES-D	39.97	8.16	25.13	6.67	14.83	5.39	2.75	21.303	0.001*

Table no. 4: shows within group pre and post mean, standard deviation, difference, p-value of CES-D

The CES-D mean value indicated changes post treatment and lower values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value.

The effect size or Cohen's D indicates 2.75 value which is assumed to be very high in effect size as per the standard parameters of reference.

Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e $0.001 < 0.05$) in the study and therefore it justifies the improvements in health outcome post intervention.

Graph no. 3: shows within group pre and post mean, standard deviation and difference of CES-D
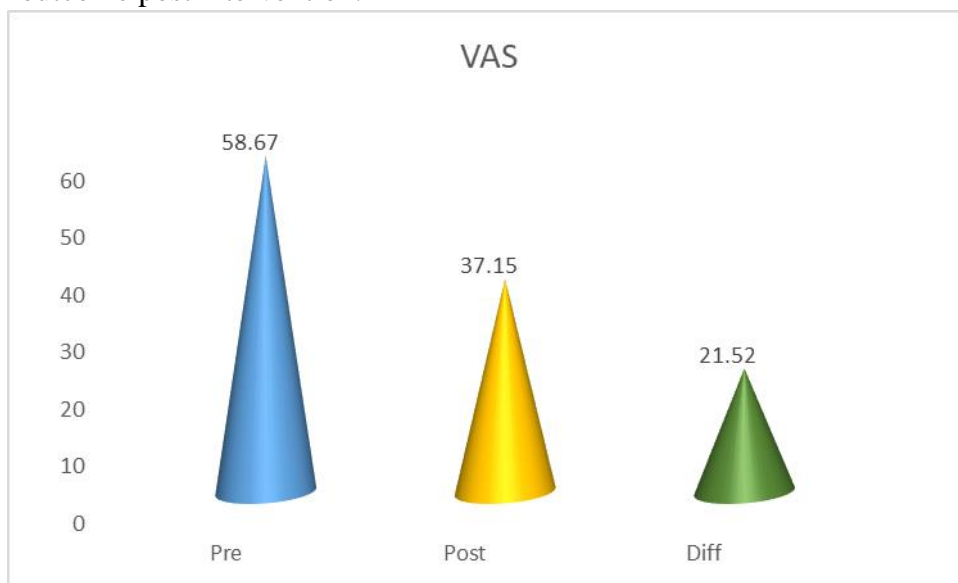
Pre and post analysis using paired sample t test

Variable	Pre		Post		Diff		Effect size	t-value	p-value
	Mean	SD	Mean	SD	Mean	SD			
VAS	58.67	6.65	37.15	6.28	21.52	5.65	3.81	29.486	0.001*

Table no. 5: shows within group pre and post mean, standard deviation, difference, p-value of VAS

The VAS mean value indicated changes post treatment and lower values are recorded for post treatment outcome and also the standard deviation shows the consistency with post treatment value which is less than pre value.

The effect size or Cohen's D indicates 3.81 value which is assumed to be very high in effect size as per the standard parameters of reference.

Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e. $0.001 < 0.05$) in the study and therefore it justifies the improvements in health outcome post intervention.

VAS

58.67

37.15

21.52

60

50

40

30

20

10

0

Pre   Post   Diff

Graph no. 4: shows within group pre and post mean, standard deviation and difference of VAS

Pre and post analysis using paired sample t test

| Variable	Pre		Post		Diff		Effect	t-	p-
	Mean	SD	Mean	SD	Mean	SD	size	value	value
HGS	12.47	2.58	19.43	2.47	6.96	1.48	4.70	36.410	0.001*

Table no. 6: shows within group pre and post mean, standard deviation, difference, p-value of HGS

The HGS mean value indicated changes post treatment and higher values are recorded for post treatment outcome and also the standard deviation shows the limited consistency with post treatment value which is more than pre value.

The effect size or Cohen's D indicates 4.70 value which is assumed to be very high in effect size as per the standard parameters of reference.

Based on the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level (i.e.$0.001 < 0.05$) in the study and therefore it justifies the improvements in health outcome post intervention
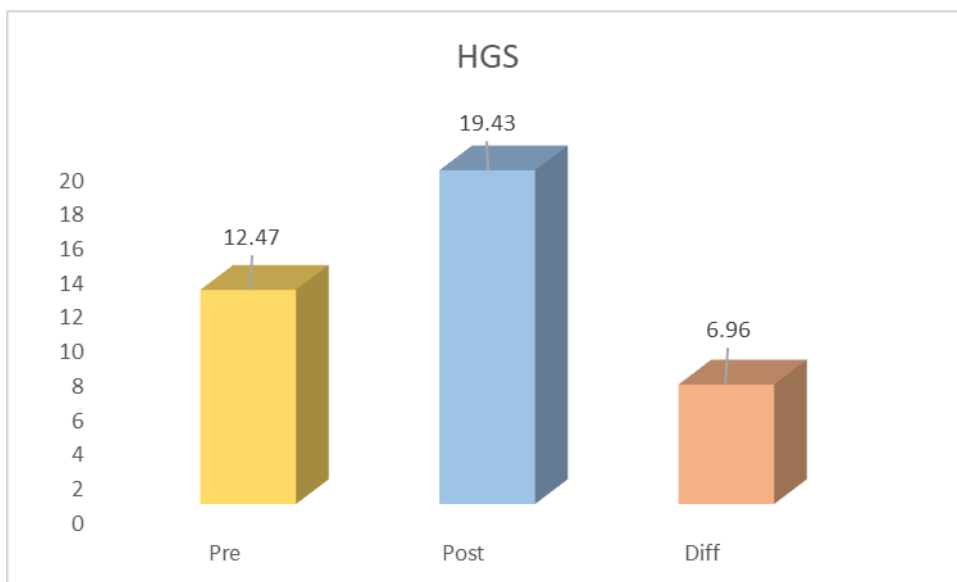
Graph no. 5: shows within group pre and post mean, standard deviation and difference of HGS

DISSCUSSION

The purpose of the current study was to assess the effect of Virtual exercises on hand grip strength, pain, anxiety and depression among post-mastectomy patients. 60 patients were involved in the trial. Female volunteers between the ages of 30 to 60 were included in this study and the hand grip strength, pain, anxiety and depression on post-mastectomy patients were assessed by 1. Visual Analogue Scale, 2. Impact of Event scale 3. The Centre for Epidemiological studies depression scale and 4. Electronic hand dynamometer, respectively. The post-mastectomy patients hand grip strength was measured using electronic hand dynamometer, their pain was measured with visual analogue scale, anxiety was measured with impact of event scale and their depression was measured with the centre for epidemiological studies depression scale.

We designed this study to investigate the effect of VR exercises using Xbox Kinect™ on hand grip strength, pain, anxiety and depression in the early phases after breast cancer surgery. In addition, we aimed to investigate the potential use of the Kinect video game program as treatment. Considering the results of this study, treatment approaches showed significant improvement in all clinical parameters. When the treatment approaches were done, the VAS, IES, CES-D score was inferior and HGS was superior in all parameters and it was more significant after treatment.

To our knowledge, there have been limited studies investigating the efficacy of VR in the treatment of patients with breast cancer that have focused on the effects of VR on pain, anxiety, cognitive function, and its role as a distraction from chemotherapy. Kinect has been used to assess upper limb ROM and to monitor movement components. Our study was the first experimental study of VR exercises on hand grip strength, pain, anxiety and depression in the early phases after breast cancer surgery.

Pain is one of the most prevalent symptoms associated with breast cancer treatment. Hidding et al. reported the rates of postoperative shoulder and chest pain following breast cancer surgery as 75% and 82%, respectively, and the risk of developing pain has been demonstrated with level of evidence 1 in patients undergoing axillary lymph node dissection (ALND), radiation therapy, and chemotherapy or receiving targeted medicines. In our study, all patients had undergone radical mastectomy and were undergoing adjuvant therapy. At baseline, the mean pain score was calculated as 58.67 ± 6.65. In our study, the mean reduction in VAS scores was found to be 37.15 ± 6.28 for the pain. Previous study by Turabi et al. (2022) the purpose of the study was to correlate between grip strength and rotator cuff strength in patient with atraumatic shoulder instability (ASI). Objective measure were used was jamar hydraulic hand dynamometer and universal goniometer. The result of the

study demonstrate that grip strength is strongly associated with rotator cuff strength in patients with ASI. In our study, the shoulder internal and external rotation was performed by using Xbox Kinect game in which mean pre-test of hand grip strength was 12.47 ± 2.58 there was a significant difference seen in hand grip strength post-test, with the mean 19.43 ± 2.47, respectively.

Furthermore, Sharma A (2017) the present study was conducted to compare hand grip strength and pinch strength pre and post radiotherapy in patients following modified radical mastectomy. Objective measure were used by Jamar hand dynamometer. The result of this study shows decrease in hand grip and pinch grip strength post- radiotherapy following modified radical mastectomy in breast cancer subjects.

Anxiety and Depression further increases the risk of decline in hand grip strength in breast cancer survivors. Hand grip strength dysfunction may be further aggravated by avoidance of movements that may induce pain. There are no studies evaluating the effect of VR on anxiety and depression in breast cancer patients. Virtual gait effect integrated to a physiotherapy program might reduce anxiety and depression compared to physiotherapy alone in nonspecific low back pain. The VR-based Wii Fit yoga program has also been demonstrated to reduce kinesiophobia. In our study, the level of anxiety and depression significantly decreased. The mean change in the IES and CES-D scores $(0.001 < 0.05)$. No complications occurred during Xbox Kinect VR training performed early in the postoperative period after breast cancer surgery. The present study result has shown the significant changes on anxiety and depression.

CONCLUSION

Present study was done in Shri Siddhivinayak Ganpati Cancer Hospital, Miraj among the post-mastectomy patients to assess the Effect of virtual reality exercises on hand grip strength, pain, anxiety and depression brain gym with the help of VISUAL ANALOGUE SCALE, IMPACT OF EVENT SCALE, THE CENTER FOR EPIDEMIOLOGICAL STUDIES DEPRESSION SCALE, ELECTRONIC HAND DYNAMOMETER. The study concluded that the results of the test analysis at 5% significance level, there is a significant statistical reliable difference between the pre & post treatment values with p-value is less than the 5% significance level $0.001 < 0.05$ in the study and therefore it justifies the improvements in health outcome post intervention.

LIMITATIONS AND SUGGESTIONS

LIMITATIONS

• The study can be performed on other age groups.
• The research couldn't include other types of mastectomy eg:- simple mastectomy, bilateral mastectomy, skin-sparing mastectomy, mastectomy with breast reconstruction & modified radical mastectomy.
• The duration of the study was constraint.

SUGGESTIONS

• Other Virtual reality exercises involving other shoulder muscle can be added.
• Study can also be done on male patients. (as per 2020s research revealed that 23,149 male patients have been diagnosed for breast cancer in Tamilnadu).

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