The use of pre-operative virtual reality to reduce anxiety in women undergoing gynaecological surgeries: a prospective cohort study

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Abstract

Background: Virtual reality (VR) is a promising new technology that offers opportunities to modulate patient experience and cognition. There is limited work on VR effectiveness during the preoperative period in the local setting. We investigated the feasibility and practicability of employing VR in anxiety management for patients undergoing minor gynaecological surgery, with the primary outcome being the changes in preoperative anxiety levels before and after the VR experience.

Methods: A prospective cohort study was conducted in the KK Women's and Children's hospital between March 2019 and January 2020. Female patients undergoing gynaecological surgeries were recruited after obtaining informed consent. Patients were given a VR headset accompanied with a handphone loaded with VR experiences comprising sceneries, background meditation music and breathing exercises. The VR experience was administered for 10 mins and pre- and post-VR psychological assessments surveys were conducted.

Results: Data analysis from 108 patients showed that our patient population had moderate state anxiety (39.6 (SD 11.14) and trait anxiety 40.1 (9.07) on the State-Trait Anxiety Inventory (STAI). The use of VR before surgery could reduce both Hospital Anxiety and Depression Scale (HADS) anxiety (7.2 ± 3.3 down to 4.6 ± 3.0; p<0.0001) and depression (4.7 ± 3.3 down to 2.9 ± 2.5; p<0.0001) scores. EQ-5D-3Lshowed no significant change in dimensions of 'mobility' and 'self-care' but significant changes to reported 'usual activities', 'pain/discomfort' and anxiety/ depression' dimensions. Level 1 for 'usual activities' ("no problems with performing usual activities") increased from 102 (94.4%) to 107 (99.1%) (p= 0.0253), 'pain/discomfort' ("I have no pain/discomfort") increased from 72 (66.7%) to 84 (77.8%) and 'anxiety/ depression' ("I am not anxious/ depressed") increased from 62 (57.4%) to 90 (83.3%) between pre- and post-VR experience. About 82% of patients rated the VR experience as 'Good' or 'Excellent'.

Conclusions: Our study showed significant reduction in preoperative anxiety after VR experience and has positive patient satisfaction. The use of VR may be suitable for patients with high anxiety preoperatively without the use of anxiolytics. Future work could include implementation studies upon adoption in clinical practice and the use in other surgical populations. Trial registration: Clinicaltrials.gov NCT03685422. Registered 26Sep2018 https://clinicaltrials.gov/ct2/show/NCT03685422?term=NCT03685422&draw=2&rank=1

Background

Majority of patients undergoing selective surgery experience different levels of anxiety [1–4] and this is influenced by factors such as patient demographic characteristics, type of surgery, previous experiences with operational procedures, willingness to undergo the proposed intervention, perceived rapport with hospital personnel and personal stress threshold [2–5]. Anxiety has been shown to be correlated with acute postoperative pain and chronic post-surgical pain, which leads to an increased use of post-operative analgesia and slower recovery [6–8]. While pharmacological interventions such as opioid-based

analgesics are available, other methods to manage anxiety and distract patients from stressors (such as music, television, and virtual reality) have become more popular in the recent years due to their safety, low cost and effectiveness in improving overall patient experience [9–13].

Virtual reality (VR) is a promising new technology that offers opportunities to modulate pain experience and cognition. The recent advent of inexpensive consumer VR system has also made VR more accessible to the masses. In Singapore, VR has been used in neurosurgery for individualized surgery planning for patients with brain tumours, vascular malformations and skull based tumours [14]. However, there has been little done to investigate the effectiveness of VR during the pre-operative period in the local setting. We therefore aimed to investigate the feasibility and practicability of employing VR in anxiety and assess patient satisfaction from its use in women undergoing gynaecological surgery.

Methods

This study adheres to the applicable CONsolidated Standards Of Reporting Trials (CONSORT) guidelines. A prospective cohort study was conducted on women undergoing elective gynaecological surgery between March 2019 and January 2020 at KK Women's and Children's Hospital, Singapore. The study was approved by the SingHealth Centralized Institutional Review Board, Singapore (SingHealth CIRB Ref: 2018/2200), and registered on Clinicaltrials.gov (ID: NCT03685422). Written informed consent was obtained from women aged 21–70 years old, American Society of Anesthesiologist (ASA) physical status I or II, with no visual impairment. Patients with severe motion sickness, significant respiratory disease or obstructive sleep apnoea and obstetric patients were excluded. Women who were unable to communicate in English or unable to understand the administered questionnaires were also excluded from this study.

Patients were given a Samsung Gear VR3 headset fitted with a Samsung 8 smartphone running 'Oculus Relax VR' program. They were given a choice of 1 out of 11 scenarios with background meditation music and breathing exercises. The scenarios were applied for 10 minutes in a quiet pre-operative waiting area. The Spielberger's State-Trait Anxiety Inventory (STAI) was applied before VR experience only. The Hospital Anxiety and Depression Scale (HADS), EQ-5D-3L questionnaires were conducted before and after the VR experiences and satisfaction scores were collected after the VR experience. Intra- and post-operative care were done as per local hospital standards and at clinician discretion. Data on analgesic use and pain scores were collected post-operatively.

Sample size calculation and statistical analysis

Tan et al [15] reported difference in mean (SD) HADs anxiety between pre- and post-intervention in music experiences as 4.61 (4.08). The calculated sample size of 70 was based on the following assumptions: considering a conservative mean (SD) HADS difference as 2.0 (8.0), level of significance as 5%; power as 90%. After adjusting for 30% loss to follow up, ineligibility and withdrawal we needed to recruit 100 patients. The primary outcome of the study was change in HADS scores pre- and post-VR experience.

Secondary outcomes measured were patient satisfaction scores and pain scores in numerical rating scale for the VR experience.

Categorical and continuous variables were summarized as frequency (proportion) and mean ± standard deviation (SD) respectively. Difference between pre and post VR experiences were compared using paired t – test and McNemar test for paired continuous and paired categorical data respectively. P-value < 0.05 was considered as statistical significance and all the tests were two – sided. Analyses were done using SAS version 9.4 software (SAS Institute; Cary, North Carolina, USA).

Results

A number of 110 patients were recruited but only 108 patients' data were analysed as 2 patients withdrew prior to the intervention (Fig. 1). Table 1 shows the demographic data for the patients. Patients were of mean age 43.6 ± 6.7 years old, mean weight of 64.6 ± 12.5 kg and mean height 158.6 ± 6.0 cm and underwent mean duration of surgery 26.4 ± 42.0 minutes.

Table 1
Patient Demographics

Characteristics	**Mean ± SD/ n (%)**
Age (years)	43.6 ± 6.7
Race	
Chinese	76 (70.4)
Malay	15 (13.9)
Indian	4 (3.7)
Others	13 (12.0)
ASA status	
Class 1	78 (72.2)
Class 2	30 (27.8)
Weight (kg)	64.6 ± 12.5
Height (cm)	158.6 ± 6.0
Duration of Surgery (min)	26.4 ± 41.9
Values are represented as mean ± standard deviation (SD) or number (%).	
ASA American Society of Anesthesiologists	

Pre- and post-VR psychological outcomes are displayed in Table 2. Mean STAI scores for both state and trait anxiety were moderate at 39.6 ± 11.1 and 40.1 ± 9.1 respectively. HADS anxiety scores were significantly reduced between pre-VR 7.2 ± 3.3 and post-VR 4.6 ± 3.0 ($p < 0.0001$). HADS depression scores were also significantly reduced pre-VR 4.1 ± 3.3 and post-VR 2.9 ± 2.5 ($p < 0.0001$).

Table 2
Pre-Virtual Reality and Post-Virtual Reality psychological outcomes

Variables	Pre-VR	Post-VR	P value
STAI S-anxiety score	39.6 ± 11.1	–	–
STAI T-anxiety score	40.1 ± 9.1	–	–
STAI total score	79.7 ± 18.8	–	–
HADS score			
Depression	4.1 ± 3.3	2.9 ± 2.5	< 0.0001
Anxiety	7.2 ± 3.3	4.6 ± 3.0	< 0.0001
EQ-5D-3L dimensions anxiety/ depression			< 0.0001
Not anxious/ depressed	62 (57.4)	90 (83.3)	
Having anxious/ depressed	46 (42.6)	18 (16.6)	
EQ-5D-3L dimensions Pain/ Discomfort			0.0073
No pain/discomfort	72 (66.7)	84 (77.8)	
Having pain/discomfort	36 (33.3)	24 (22.2)	
EQ-5D-3L health state	71.6 ± 17.8	76.0 ± 15.1	< 0.0001
Values are represented as mean ± standard deviation (SD) or number (%)			
HADS Hospital Anxiety and Depression Scale, *STAI* State-Trait Anxiety Inventory, *VR* Virtual reality			

Table 3 displays values of EQ-5D-3L for all 5 dimensions and 3 levels. For 'Usual activities', the number of patients reporting Level 1 ('no problems with performing my usual activities') significantly increased from 102 (94.4%) to 107 (99.1%) between pre- and post-VR. For the dimension of 'Pain/discomfort', the number of patients reporting Level 1 ('I have no pain/discomfort') also significantly increased from 72 (66.7%) to 84 (77.8%) between pre- and post-VR. For the dimension of 'Anxiety/Depression', the number of patients reporting Level 1 ('I am not anxious/depressed') significantly increased from 62 (57.4%) to 90 (83.3%) between pre- and post-VR. Mean EQ health state score showed significant difference pre-VR 71.6% (SD 17.8%) to post-VR 76.0% (SD 15.1%) ($p < 0.0001$).

Table 3
EQ-5D-3L individual dimensions

	Mobility		Self-care		Usual Activities		Pain/ Discomfort		Anxiety/ Depression	
	pre	post	pre	post	pre	post	pre	post	pre	post
Level 1	106 (98.1)	107 (99.1)	108 (100)	108 (100)	102 (94.4)	107 (99.1)	72 (66.7)	84 (77.8)	62 (57.4)	90 (83.3)
Level 2	1 (0.9)	1 (0.9)	0	0	6 (5.6)	1 (0.9)	36 (33.3)	24 (22.2)	46 (42.6)	18 (16.7)
Level 3	1 (0.9)	0	0	0	0	0	0	0	0	0
P value	0.3173		-		0.0253		0.0073		< 0.0001	
Values are represented as number (%)										

The mean pain scores pre-VR was 0.4 (SD 1.2) and 0.6 (SD 1.2) post-VR. The mean pain scores, analgesic use and satisfaction scores are shown in Table 4. 32.4% of patients rated the 14.8% of patients needed fentanyl for pain in recovery, 5.6% of patients needed Morphine while 8.3% of patients had paracetamol in recovery. Mean maximum pain scores in recovery was 2.2 (SD 2.4) with mean duration of stay in recovery at 64.5 (SD 31.9) minutes.

Table 4
Pain and Satisfaction Scores

Characteristics	Mean ± SD/ n (%)
Pain score pre-VR	0.4 ± 1.2
Pain score post-VR	0.6 ± 1.2
Patient satisfaction on VR experience Excellent Good Fair Poor	35 (32.4) 54 (50.0) 17 (15.7) 2 (1.9)
Maximum Pain scores in recovery	2.2 ± 2.4
Mean dose of Fentanyl used intra-operatively (mcg)	84.5 ± 19.5
Mean dose of Morphine used intra-operatively (mg)	5.8 ± 2.72
Paracetamol use intra-operatively	56 (51.9)
Duration of stay in the recovery unit (min)	64.5 ± 31.9
Fentanyl use in the recovery unit	16 (14.8)
Morphine use in the recovery unit	6 (5.6)
Paracetamol use in the recovery unit	9 (8.3)
Values are represented as mean ± standard deviation (SD) or number (%).	
VR Virtual Reality	

The collated choice of relaxation scenarios chosen by patients are displayed in Table 5. ‘Wine Glass Bay Australia’ was the highest selected scenery (22.2% of patients selected) while ‘Northern Lights USA’ was the second highest preferred scenery (18.5% of patients selected).

Table 5

Collation of VR scenario preferences

Scenario	N (%)
Tropical Beach Philippines	19 (17.6)
Rice Terrace Philippines	2 (1.9)
Wine Glass Bay Australia	24 (22.2)
12 Apostles Australia	9 (8.3)
Fern Bern New Zealand	6 (5.6)
Forrest Creek Germany	6 (5.6)
Daisy Garden Germany	15 (13.9)
Grand Canyon USA	2 (1.9)
Northern Lights USA	20 (18.5)
Up in the Clouds	3 (2.8)
Moon Outer space	2 (1.9)
Values are represented as number (%)	
VR Virtual Reality	

Discussion

Our study showed a significant reduction in preoperative anxiety after VR experience. Patients had overall positive patient satisfaction on the use of VR prior to gynaecological surgery.

STAI designed by Speilberger et al. [16] has been used extensively in research and clinical settings. It has been used to measure the presence and severity of current symptoms of anxiety and a generalised propensity to be anxious. Our study showed moderate anxiety for both state and trait anxiety in pre-operative gynaecology patients. Surgery is a daunting experience that comes with emotional vulnerabilities. These emotions are often intensified moments before surgery causing overwhelming anxiety and even depressive moods [17]. Increased preoperative anxiety can lead to postponement or even cancellation of planes surgeries, and increase in dose requirements of anaesthetic drugs or use of anxiolytics, prolonged hospital stay and poorer overall patient satisfaction [18, 19].

HADS has also been widely used to assess severity of anxiety and depression disorder in hospital practice as well as primary care patients and the general population [20]. In our study, significant reduction in anxiety and depression scores were seen pre- and post-VR before gynaecological surgery. EQ-5D-3L was introduced by EuroQol group in 1990 and involves a descriptive system comprising 5 dimensions with self-reporting of 3 levels in each dimension. Our study showed significant improvement of self-reported pain/ discomfort and anxiety/ depression dimensions pre- and post-VR before gynaecological surgery. In addition, self-reported perception of ‘usual activities’ dimension also showed significant improvement post-VR.

In previous studies, patients who received VR treatment reported a reduction in pain and anxiety [21], faster wound healing [22], decreased chronic pain intensity [23] and other neuro-rehabilitation improvements [24]. Our study showed congruence in reduction in anxiety and possibly pain. Interestingly,

despite a mild increase in mean pain scores pre- and post-VR, there was still a self-reported perception of improvement in the dimension of ‘pain/discomfort’ in the EQ-5D-3L. The pain score changes are likely attributed to pre-surgical administration of vaginal or oral prostaglandins for cervical softening.

We acknowledge several limitations of our study. All pain and psychological assessments pre- and post-VR were done within a short duration apart due to the short intervention time of 10 minutes. Most of our findings were gathered from questionnaires largely on anxiety. The results could have been affected by patient’s willingness to participate in the study and this could be different from routine clinical practice. The ability to read and understand English in the questionnaires resulted in a selected patient population. Pre-operative anxiety could have multiple source and reasons unrelated to surgery per se. As an example, we did not investigate interactions between study team investigator and the patient that may have affected the patient’s mood and anxiety. Mechanisms on how anxiety could be associated with pain should be explored in future studies.

Conclusions

VR relaxation technique is a promising method for anxiety and pain distraction that could be extended for hospital use (rehabilitation, outpatient procedures, diagnostic scanning and perioperative period). This strategy can increase patient satisfaction while providing non-pharmacological anxiolytic effects with minimal side effects.

Abbreviations

ASA: American Society of Anesthesiologists; HADS: Hospital Anxiety and Depression Scale; SD: standard deviation; STAI: State-Trait Anxiety Inventory; CONSORT: CONsolidated Standards Of Reporting Trials; VR: virtual reality

Declarations

Ethics approval and consent to participate

The study was approved by the SingHealth Centralized Institutional Review Board, Singapore (SingHealth CIRB Ref: 2018/2200), and registered on Clinicaltrials.gov (NCT03685422). The authors declare that all the recruited patients provided informed consent, and that this work was conducted in accordance with the Declaration of Helsinki.

Consent for publication

All patients provided informed consent on the use of their de-identified data for publication purpose.

Availability of data and materials

The datasets generated and analyzed in this work are available for anyone who wishes to access the data by contacting the corresponding author.

Competing interests

Ban Leong Sng is an associate editor of BMC Anesthesiology. All other authors report no conflicts of interest in this work.

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Authors' contributions

JJI Chan reviewed the literature, planned the study, oversaw patient recruitment, data analysis and interpretation, and wrote the manuscript. YCT reviewed the literature, helped in patient recruitment, managed the raw data, helped in data analysis and interpretation. KHM helped in patient recruitment, data management, data analysis and interpretation. CW reviewed the literature, helped in funding, oversaw data management, data analysis and interpretation. SR reviewed the literature, helped in the study design, performed data analysis and interpretation. SATH reviewed the literature, helped in the study design, and reviewed the data analysis and interpretation. SBL reviewed the literature, planned the study, and oversaw the study including the design, data analysis and interpretation. All authors approved the final version of the manuscript, and agree to be accountable for all aspects of this work.

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Figures

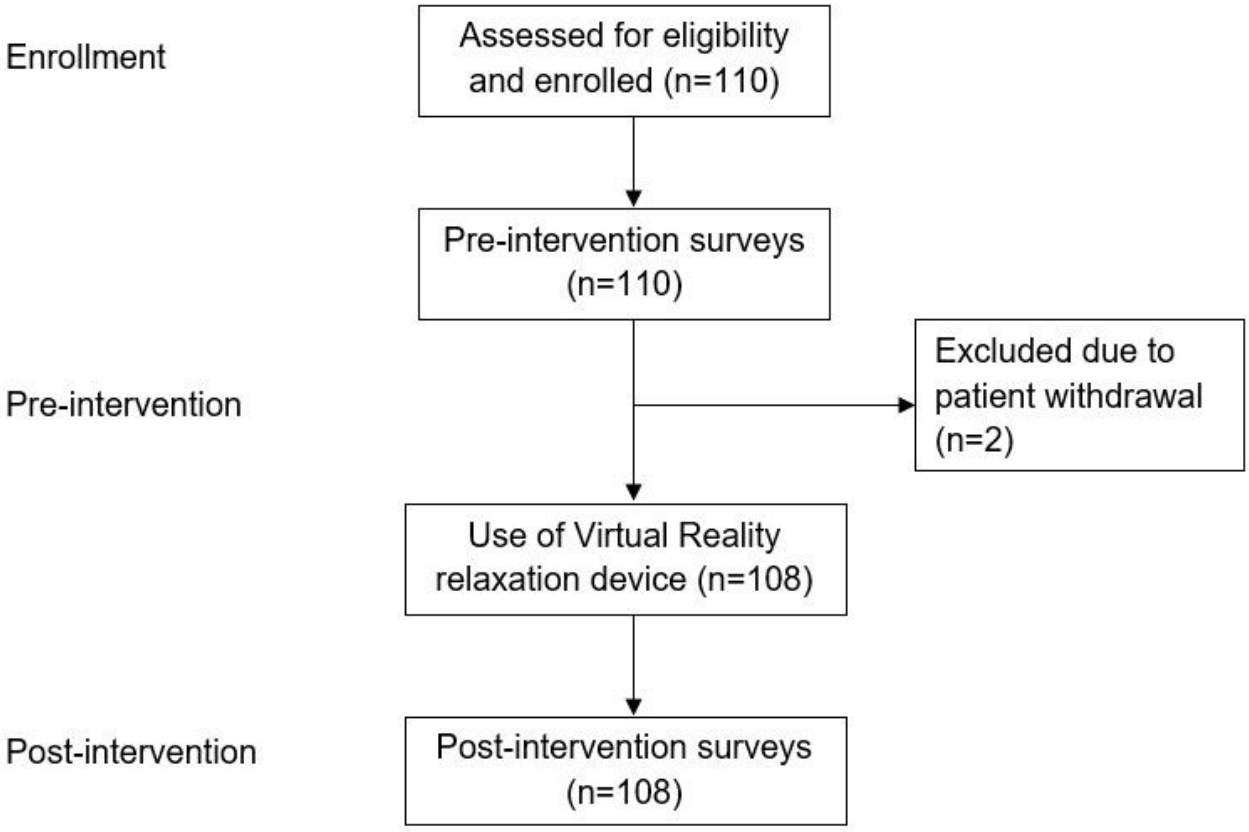

Figure 1

Study flowchart

Supplementary Files

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- CONSORTChecklistVR.doc