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# The effect of preoperative virtual reality distraction to reduce anxiety in pediatric patients undergoing general anesthesia

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## Abstract

**Background:** Children are very susceptible to preoperative anxiety due to limited cognitive abilities and greater dependence on others. Children's limited insight and understanding of the benefits of the medical procedures they will undergo, especially separation from their parents, medical procedures, thus worsening the anxiety they experience and potentially causing long-term effects. This is the reason for the development of therapies to reduce children's anxiety both pharmacological and non-pharmacological. This study focuses on non-pharmacological therapy using Virtual Reality (VR) to divert children's attention in terms of audio and visuals by playing their favorite cartoon films.

**Methods:** This study is an Unblinded Randomized Controlled Trial. Forty pediatric patients aged 5-12 years who met the eligibility criteria undergoing general anesthesia at Prof. Dr. IGNG Ngoerah General Hospital, Denpasar during the study period (September - October 2024), were recruited into the study. Subjects were then randomly allocated into 2 groups, where group P1 was given Virtual Reality (VR) and group P2 was not given VR. Then anxiety scoring was assessed with the Modified Yale Preoperative Anxiety Scale (mYPAS) in the reception room when the patient arrived and before entering the operating room.

**Results:** There were no significant differences in demographic characteristics and initial mYPAS scores between the two groups. Statistical tests showed a lower mean mYPAS score in the VR distraction treatment group compared to the standard treatment group (37.5 vs 59.4, $p < 0.001$).

**Conclusion:** The use of VR in the perioperative period can reduce anxiety in pediatric patients undergoing general anesthesia compared to patients who are not given VR.

**Keywords:** Virtual Reality; VR; General Anesthesia; mYPAS; Anxiety

## 1. Introduction

Children are particularly vulnerable to preoperative anxiety due to their limited cognitive abilities and greater dependence on others. The high rate of anxiety in pediatric patients undergoing surgery is the reason for the development of therapies to reduce children's anxiety, both pharmacologically and non-pharmacologically.[1] Pharmacological therapies commonly used to reduce anxiety are midazolam and ketamine, but they have the risk of short-term and long-term side effects. In addition to pharmacological therapy, non-pharmacological therapies have also been developed, one of which is by using technological developments, namely the Virtual Reality distraction technique by diverting children's attention through audiovisual media displayed through a VR headset level which shows good results in reducing anxiety. Several studies have explored distraction with VR audiovisual technology as a new

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alternative strategy and these studies have shown that this technique can reduce preoperative pediatric anxiety as measured by the mYPAS score. [1,2] In Indonesia, research to reduce anxiety in pediatrics with VR distraction who will undergo surgery under general anesthesia has never been conducted, so this topic is important to study.

## 2. Materials and methods

This study is a pure experimental research with a non-blind randomized control trial design. The subjects in this study were divided into two groups: one group received VR, while the control group didn't receive VR. To assign the subjects into either the first treatment group or the second treatment group, randomization was conducted. Next, each subject was assessed for their anxiety level (mYPAS score) while in the reception room and when being taken to the operating room. The study was conducted in the operating room of the Central Surgical Installation of a teaching hospital from June to October 2024.

*Inclusion Criteria includes* Pediatric patients aged 5-12 years undergoing surgery with general anesthesia with physical status ASA I-II patients. *Exclusion Criteria* includes Parents refuse to participate, side effects (cybersickness) occur when the patient is introduced to VR, history of head/facial injury/disorders that will interfere with the use of the VR device, patients with impaired consciousness, open wounds, lice , scabies or other skin infections on the head/face, symptoms and history of vertigo, Blindness (Vision <6/60; determined based on parental report and confirmed by an ophthalmologist if necessary), Developmental and cognitive retardation, patients who are not fit the device, patients with nutritional disorders (malnutrition) . *Drop Out Criteria* includes Patient/Family refuses, patient cannot tolerate side effects of intervention (cybersickness occurs.

### 2.1. Procedure

- The first anxiety assessment is then assessed using the mYPAS assessment sheet for the patient.
- The patient is allowed to be accompanied by a parent in the reception room until before the patient is taken to the operating room.
- While waiting in the reception room, subjects in group P1 will be fitted with a VR headset that displays audiovisual media as a distraction medium.
- The second anxiety assessment with the mYPAS sheet will be repeated shortly before the patient is taken to the operating room in groups P1 and P2. The assessment in group P1 is carried out while the patient is using the VR device and the VR device will be removed after the assessment is complete.
- After the second assessment, the patient will be given midazolam premedication 0.05 mg/kgbb IV.
- The patient is sent to the operating room.

#### *2.1.1. Statistical Analysis*

Descriptive analysis aims to describe the characteristics of subjects and research variables based on treatment groups. The normality test aims to assess whether variables such as age (years), height (cm), weight (kg), BMI ($kg/m^2$) follow a normal distribution. This analysis was conducted using the Shapiro-Wilk test at a significance level of 0.05, where data is considered normal if $p > 0.05$. The homogeneity test is used to evaluate whether the variances between groups are homogeneous. The homogeneity of variance is tested using Levene's test. Variances are considered homogeneous if $p > 0.05$ and not homogeneous if $p \leq 0.05$. The mean comparison test uses the independent t test if the data distribution is normal or the Mann-Whitney test if the data distribution is not normal. The effectiveness of the VR distraction technique to reduce children's anxiety levels in the mYPAS Score is assessed based on the mean difference. Categorical data is assessed using the Fisher's exact test. The entire data analysis process above uses the help of SPSS 26 statistical software.

## 3. Result

The sample's characteristics can be seen in Table 1. All the subjects between the case and the control group were comparable.

**Table 1**Subject Characteristics

| **Patient Characteristics** | **Group** | | **p-value** |
|---|---|---|---|
| | **Case** | **Control** | |
| Age (years), mean ± SD | 8.8 ( ±2.19) | 8.60 ( ±2.01) | 0.764 [T] |
| **Gender** | | | 0.148 [a] |
| Female, n (%) | 12 (54.5) | 10 (45.5) | |
| Male, n (%) | 8 (44.4) | 10 (55.6) | |
| Height (cm), mean ± S D | 40.6 ( ±11.03) | 39.95 ( ±11.2) | 0.854 [T] |
| Body Weight (kg), mean ± S D | 134.1 ( ±14.58) | 132.70 ( ±13,612) | 0.755 [T] |
| BMI (kg/ m2), mean ± S D | 22.16 ( ±2.3) | 22.18 ( ±2.55) | 0.977 [T] |
| **ASA Physical Status** | | | 0.327 [C] |
| I, n (%) | 14 (56) | 11 (44) | |
| II, n (%) | 6 (40) | 9 (60) | |
| Type of Surgery (%) | | | 0.155 [C] |
| Orthopedics | 6 (37.5) | 10 (62.5) | |
| Urology | 9 (75) | 3 (25) | |
| Digestive | 2 (33.3) | 4 (66.6) | |
| General Surgery | 2 (33.3) | 4 (66.6) | |

Description: a = *Independent T- test,* significant if p < 0.05

*3.1.1. Analysis of initial anxiety levels in each treatment group in the form of mYPAS scores*

An initial anxiety level evaluation was conducted in both treatment groups of research subjects when they arrived in the operating room. In the data normality test using the Shapiro-Wilk test, data were not normally distributed in all mYPAS components (p < 0.05) except for the total score data, so a Mann Whitney comparison test was conducted on data that was not normally distributed and an independent t test on data that was normally distributed.

**Table 1**Results of the analysis of mYPAS scores before treatment between the two groups

| **Characteristics** | **Group Intervention** | | ***p*- value** |
|---|---|---|---|
| | **P1 (n=20)** | **P2 (n=20)** | |
| **mYPAS Score** | | | |
| Activity | 2[1-2] | 2[1.25-3] | 0.114 [M] |
| Vocalization | 2[1.25-3] | 2[1-3] | 0.602 [M] |
| Expression emotional | 2[1-3] | 2[1-2] | 1,000 [M] |
| Awareness | 2[1.25-3] | 2[1-3] | 0.565 [M] |
| Interaction with family | 1.5[1-2] | 2[1-2] | 0.369 [M] |
| **Total score** | 43.42 ( ±12.66) | 45.17 ( ±12.77) | 0.666 [T] |

[T] Test *independent t-test* .[M] *Mann Whitney* Test. Numeric variable data are presented as mean (±SD) and median [IQR]. A p value < 0.05 was defined as significant.

Statistical analysis (Table 2) showed no statistically significant difference in anxiety levels between group P1 and group P2. From the results of this analysis, it can be concluded that the level of anxiety when patients arrived in the operating

room in group P1 (mean: 43.42, 95% confidence interval: 37.50 - 49.34) was equivalent to group P2 (mean 45.17, 95% confidence interval: 39.19 - 51.14).

Analysis of the relationship between VR distraction and standard therapy on anxiety levels was carried out by re-assessing the anxiety levels before patients were given premedication. In the data normality test using the Shapiro-Wilk test, data were obtained that were not normally distributed in all mYPAS components ($p < 0.05$) except for the total score data, so a Mann Whitney comparison test was carried out on data that was not normally distributed and an independent t test on data that was normally distributed.

**Table 3** The results of statistical analysis of mYPAS scores after treatment between the two groups

| **Characteristics** | **Group Intervention** | | ***p*- value** |
|---|---|---|---|
| | **P1 (n=20)** | **P2 (n=20)** | |
| **mYPAS Score** | | | |
| Activity | 1[1-2] | 2.5[2.0-3.75] | <0.001 [M] |
| Vocalization | 2[1-3.75] | 3[2.25-3.75] | 0.081 [M] |
| Expression emotional | 1[1-2] | 2.5[2-3] | 0.002 [M] |
| Awareness | 1.5[1-2] | 2.5[2-3] | 0.002 [M] |
| **Total score** | 37.5 (±10.0) | 59.4 (±14.4) | <0.001 [T] |

[T] Test *independent t-test* .[M] *Mann Whitney* Test. Numeric variable data are presented as mean (±SD) and median [IQR]. A p value <0.05 was defined as significant.

Statistical analysis (Table 5.3) showed a statistically significant difference in anxiety levels between group P1 and group P2 in the components of activity, emotional expression, awareness and total score. Based on the results of the statistical analysis, it can be concluded that the VR distraction technique can reduce anxiety levels (mean mYPAS 37.5, 95% confidence interval: 32.82 - 42.18), while the group without VR showed a higher level of anxiety (mean mYPAS 59.38, 95% confidence interval: 52.64 - 66.11)

## 4. Discussion

Anxiety is a common problem in the perioperative period of children. To reduce children's anxiety levels, pharmacological and non-pharmacological anxiolytic methods have been developed, one of which is the development of VR distraction techniques. This study aims to evaluate the effect of VR distraction techniques on children's anxiety levels in the preoperative stage in the operating room. In this study, there was 1 subject who refused to participate in the study because when the VR introduction was carried out, the patient felt dizzy when using the device. The use of VR devices can indeed cause side effects of cybersickness. [2,3] Information about the factors that cause side effects of cybersickness can help reduce the risk of these effects. In one study, factors that could cause cybersickness were divided into 3 groups, namely: hardware, content and users.[4]

In early studies of cybersickness, the symptoms that appeared were often thought to be due to poor performance of the hardware used. The type of VR Head Mounted Device that was installed on the head showed a higher level of discomfort. Although the use of VR with stereoscopic images can provide a more realistic impression, this can cause more severe symptoms due to the mismatch between the expected and obtained sensory information, one of which is through vestibular input. [5] The delay in the device's response to changes in patient movement can cause discomfort, especially if the time delay varies, making it difficult for users to adapt.[6] In this study, the VR device used was the Bobo VR Z6® Head Mounted Device with the Xiaomi 12 lite® smartphone as a screen, which may affect the level of acceptance of research subjects due to the side effects caused. The level of acceptance of subjects with hardware that integrates the screen with the VR device may increase the subject's acceptance of the research treatment.

Content presented to subjects through VR affects the subject by creating an illusion of vection, where the subject who still feels like moving. [7,8] A virtual world that is increasingly similar to the real world can cause higher discomfort than a lower level of realism. It is suspected that users can quarantine unreal visual stimuli, making them less susceptible to side effects. [9]Long duration of use can trigger uncomfortable body conditions, so the time of use should be limited. In addition, the freedom of user movement (at least, the upper extremities of the body) can help users adapt to conflicting sensory information. In this study, cartoon videos were used that did not match the real-world display without requiring

movement that could trigger the illusion of vection, in addition to the use of interactive content involving hand movements in bed may increase patient acceptance of the VR content.

Different users of VR devices for the same content may experience different experiences. Younger user populations (<35 years) have higher complaint rates than older groups (≥35 years), but studies are mostly limited to populations >20 years. Women may experience higher levels of discomfort than men due to differences in visual field, hormone levels and history of motion sickness. [10] The more frequently users use VR, the less complaints they will experience. [11] Patients who are prone to motion sickness will experience higher discomfort. [12] Subjects with refractive disorders (myopia and astigmatism) are at higher risk of experiencing cybersickness. [13] In this study, the selection of female subjects may increase the risk of cybersickness, but the risk of cybersickness can be reduced by providing repeated exposure if the subject tolerates it. In a study on motion sickness symptoms, it was found that the symptoms of dizziness and nausea felt were related to anxiety due to claustrophobia, possibly due to head. 1[4] Cybersickness has a significant relationship with anxiety conditions during exposure and may have implications for intolerance to VR use. These findings suggest that high levels of anxiety and certain fears of patients such as claustrophobia can affect patient tolerance to VR use. At high levels of anxiety, the use of VR can actually worsen the symptoms of cybersickness that appear and may prevent the use of VR which is intended to reduce the level of anxiety itself.

### 4.1. Initial anxiety levels in both treatment groups

Based on comparative data on mYPAS scores in the operating room, it can be concluded that the anxiety levels between the two groups are equivalent to an average mYPAS score of 43.4 in the VR treatment group and 45.17 in the standard treatment group. These findings indicate a relatively high level of preoperative anxiety in both groups compared to the outside population. Studies in the northeastern and southwestern United States showed anxiety levels in the receiving room of 35.9-36.75, [4] studies in Korea showed mYPAS scores in the preoperative room of 33-40, [10] and studies in India on children in the preoperative room before premedical showed mYPAS scores of 45.[8] In Indonesia, a study at Dr. Hospital. Soetomo showed that the proportion of children who had mYPAS scores > 30 at the preoperative stage was quite high (66.6%). [5] Several factors can influence high levels of anxiety such as socioeconomic status, high levels of parental anxiety, previous surgical experience, number of siblings and child temperament.[15]

### 4.2. The effect of VR distraction techniques on anxiety levels

Based on comparative data on mYPAS scores after subjects received treatment, it can be concluded that VR distraction techniques can reduce anxiety levels with an average mYPAS score of 37.5, while the group without VR increased anxiety with an mYPAS score of 59.4. The results of a study at Anhui Medical University Hospital in China showed a lower incidence of anxiety ( mYPAS > 40) upon entering the operating room, during induction and upon leaving the PACU in the group using VR with individual cartoon videos compared to the control group (20% vs 80%, 40% vs 88%, 50% vs 85%). [9] Similar studies using the immersive tour method with VR in Korea and the interactive game distraction method with VR in the United States also support similar results where the use of VR distraction techniques will reduce perioperative anxiety levels.[10,14] Although previous studies comparing the use of portable music players compared to VR devices with electronic games have shown that the use of VR is superior, [11] there have been no studies that have assessed in detail whether the use of interactive games with VR are better than using VR with cartoons alone.

The use of VR in this study reduced anxiety levels by distracting subjects from the source of fear by displaying cartoons on the VR device used by the subjects. Compared to distraction techniques by watching cartoons with a free screen, the use of VR videos can help patients focus on the intervention (the video displayed) and reduce distraction to the surrounding environment.[5] Distraction can reduce anxiety and pain levels by diverting attention to specific stimuli, activating other brain areas and causing competition between distraction signals and pain or anxiety sensations. Based on competition theory, distraction methods that require a higher cognitive load or use more of the patient's sensory organs can reduce pain and anxiety levels better. The use of VR devices will cause a large cognitive load because these devices can provide a more immersive experience in 3 dimensions than 2-dimensional views. In the use of 3D VR, patients feel present in the virtual space and this plays an important role in the effectiveness of anxiety therapy. The effects of VR therapy are contributed by the activation of different areas in the cerebral and midbrain areas that function in the process of attention, emotion and pain modulation. [5] In addition to distraction techniques, the use of VR can also be used to: (1) introduce patients to the environment and procedures that will be undergone during surgery in a comprehensive manner, thereby reducing fear of the unknown[9]; (2) improve the quality of sleep of patients with the help of relaxation and meditation videos.[7]

This study assessed mYPAS at 2 points in time, namely when the patient arrived in the reception room and when the patient was about to be separated from their parents to the operating room. Other studies have found that anxiety levels peak at 2 points in time, namely when the patient is separated from their parents and when induction is about to be

performed. [8] The limitations of the measurements carried out in this study were due to the consideration of midazolam administration before the patient was sent to the operating room in both treatment groups which could cause changes in the mYPAS score due to pharmacological agents.

The findings of anxiety have other influences on the perioperative period, one of which is on the patient's perception of pain. High levels of preoperative anxiety have a strong correlation with pain felt after surgery. [2] This may be due to the influence of psychological stressors that cause modulation of the nociceptive response, the phenomenon of stress induced hyperalgesia. The level of anxiety in children can be studied further because it has implications for postoperative pain.

Perioperative anxiety has short-term and long-term effects. Short-term effects include increased need for anesthetic drugs, increased postop pain and increased risk of delirium upon awakening, all of which can have an impact on reducing patient and parent satisfaction. After the perioperative period, children with unmanaged anxiety may develop postoperative maladaptive behaviors including separation anxiety, sleep disturbances (nightmares and terrors), bedwetting, defiance of authority, and symptoms of post-traumatic stress disorder.[9,11]

The use of distraction techniques with VR devices is a non-pharmacological anxiety therapy that is easy to do, clinically useful for reducing anxiety.

## 5. Conclusion

The use of VR in perioperative periods can reduce anxiety in pediatric patients undergoing general anesthesia compared to patients who are not given VR.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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