

Research Articles

The Effect of Virtual Reality on Peri-Operative Anxiety during WALANT Hand Surgery: A Prospective Randomized Trial

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Objectives

Wide-awake local anesthesia no-tourniquet (WALANT) hand surgery is increasing in utilization due to increased perioperative efficiency and decreased costs and complications associated with systemic anesthetics. However, patient anxiety during WALANT hand surgery could be a concern. This study evaluated how virtual reality (VR) augmentation impacts the patient experience and anxiety during WALANT hand surgery.

Methods

A prospective randomized controlled trial of 59 patients undergoing WALANT hand surgery with patients randomized to VR and no VR augmentation. Pre-, intra-, and postoperative vitals, anxiety scores, and pain scores were collected. A satisfaction survey was completed after surgery.

Results

Preoperatively, there were no differences in mean anxiety scores. However, mean anxiety scores were significantly lower in the VR group intraoperatively and postoperatively. Within the control group, there were no differences in mean anxiety scores pre-, intra- or postoperatively. However, within the VR group, mean anxiety scores were significantly decreased intraoperative and postoperatively relative to preoperatively.

Conclusions

VR augmentation significantly lowers patient anxiety during the WALANT hand surgery experience. Patients expressed high satisfaction rates with the use of VR.

Wide-awake local anesthesia no tourniquet (WALANT) hand surgery is a trending technique in hand surgery due to the increased efficiency and cost savings over hand surgery performed under anesthesia.¹⁻³ WALANT hand surgery requires no systemic anesthetics, obviating the need for preoperative medical clearance, intraoperative anesthesia staff support, and postoperative recovery monitoring. However, a concern with WALANT hand surgery is patient anxiety from being awake during the procedure. A meta-analysis done to determine preoperative anxiety in the surgical setting showed nearly 50% of all surgical patients experienced preoperative anxiety.⁴

Virtual Reality (VR) has recently emerged as a surgical and patient training tool.⁵ Relative to WALANT hand surgery, VR offers a potential medium to alleviate perioperative anxiety in surgical patients through a realistic, calming experience during surgery to mitigate patient anxiety.⁶ Early studies utilizing VR have shown success in reducing anxiety, pain, and stress levels undergoing maxillofacial, plastic surgery, and head and neck surgery.^{7,8} The objective of this prospective randomized trial was to investigate the efficacy of VR augmentation in reducing perioperative anxiety in patients undergoing WALANT hand surgery. We hypothesized that those patients undergoing WALANT hand

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surgery with VR augmentation would have decreased anxiety and pain.

METHODS

STUDY DESIGN

Institutional Review Board (IRB) approval was secured from the Thomas Jefferson University Hospital's IRB in Philadelphia, Pennsylvania, and the study design complied with the ethical standards of the 1964 Declaration of Helsinki. Inclusion criteria included any patient 18 years or older scheduled to undergo WALANT hand surgery at a single outpatient surgical center. Specifically, patients undergoing carpal tunnel release, trigger finger release, and Dequervain release surgery were enrolled. After obtaining written informed consent, patients who agreed to participate were randomized to either the VR augmentation (experimental) or the control group. We conducted an a priori power analysis using a two-sample t-test. Assuming a medium effect size (Cohen's $d = 0.5$), an alpha level of 0.05, and a desired power of 0.80, the calculation indicated a minimum required sample size of 25 participants per group to detect a statistically significant difference. Because we enrolled all patients scheduled for WALANT surgery on the days of experimentation, our sample size was slightly larger than what was warranted by the power analysis.

All prospective patients were described using VR augmentation [Figure 1a],⁹ and the potential risks/benefits of the study were discussed. Patients randomized to the control (non-VR) group had no additional preoperative and intraoperative interventions. Patients randomized to the experimental (VR) group were given a brief orientation to the VR headset as well as the opportunity to choose a WAVR© (Wide Awake Virtual Reality, WAVR Technologies, Las Vegas, USA) video of their preference. The experimental group then chose a VR video provided by WAVR© to watch during their procedure. All patients in the experimental group were fitted with the WAVR goggles preoperatively and continued to wear them intraoperatively until surgery was completed. The control group underwent standard operative WALANT hand surgery. Both groups followed standard postoperative protocols in the post-anesthesia care unit (PACU).

Pain and anxiety levels were measured preoperatively, intraoperatively, and postoperatively as secondary endpoints to evaluate pain as a potential confounding factor. Pain level was assessed using a Wong-Baker FACES pain scale, which uses a combination of facial expressions and numerical scales to represent pain in a range of 1-10, with 1 being the least pain and 10 being the maximum amount. Instead of the American Preoperative Anxiety and Information Scale (APAIS) used in Abd Hamid *et al.*'s study, we used a Visual Analog Scale (VAS) to measure anxiety as the procedures done in that study were for plating distal radial fractures with a mean time of 61 minutes.¹⁰ In our study, most of the procedures were WALANT carpal tunnel releases, which have been shown in a systematic review to take a mean operating time of 22 minutes. Thus, we deter-

mined that using the APAIS scale for this study was infeasible.¹¹ Previous research has shown that VAS is valid in assessing anxiety in surgical patients.¹² Anxiety levels were measured perioperatively using a Visual Analog Scale (VAS) with ranges from 1-10, 1 being the least amount of anxiety and 10 being the highest amount of anxiety. Patients were also asked to describe their anxiety based on a subjective scale of ('completely relaxed,' 'somewhat relaxed,' 'somewhat anxious,' 'very anxious'). Blood Pressure (BP) and Heart Rate (HR) were also measured preoperatively, intraoperatively, and postoperatively at the time of anxiety and pain evaluation. A postoperative survey evaluating satisfaction was completed in PACU.

INTERVENTION

This clinical trial used a VR headset provided by Wide Awake Virtual Reality (WAVR)© [Figure 1b],¹³ pre-programmed with various interactive VR videos for entertainment. The video programs chosen by the patients included a wide variety of themes ranging from tours of natural landmarks to cooking sessions in a restaurant. To provide optimal comfort, the VR headset was adjusted before the surgery and placed upon the patient's head along with noise-canceling headphones to provide an optimal immersive experience.

A tablet provided by WAVR© maintained the progress and maintenance of the VR experience. The tablet included a mirroring program, allowing the researcher to have a live time feed of what the patients were viewing in their headset. This allowed calibration of the patients' focal point so that their immersive experience could be enjoyed in the correct field of view, as well as the option to adjust the volume setting and progress of the video should the patients request a stop for any reason.

SURGICAL SITE

All surgeries were performed by a hand fellowship-trained orthopaedic surgeon at a single outpatient surgical center attached to a teaching hospital. All surgeries were performed in a "procedure room" dedicated to only wide-awake surgeries. The surgeon was accompanied by one scrub nurse and one circulating nurse. There was no anesthesia staff. Patients were injected with a local anesthetic mixture of 9.0cc of 1.0% lidocaine with epinephrine and 1cc of 8.4% bicarbonate delivered in the surgical site with a 27-gauge needle in the preoperative area. For this study, one research assistant was also present for VR management and data collection preoperatively, intraoperatively, and postoperatively. The surgeon and nursing staff did not collect any data, and the research assistants analyzed the collected data.

STATISTICAL ANALYSIS

Welch's two-sample t-tests were used to compare data for significance between the VR and control groups as well as the data within each group (VR and Control). For all analyses, a two-tailed p-value ≤ 0.05 was considered significant.



Figure 1. a) Brochure provided to the patients in the VR group. b) A headset was provided to the patients in the VR group.

Table 1. Demographic data of the two groups. Data is presented as mean $\pm$ standard deviation unless otherwise specified.

Category	VR (N=30)	Control (N=29)	P-value
Age	64 $\pm$ 15	62 $\pm$ 14	0.65
Gender			
Male	13 (43%)	8 (28%)	0.32
Female	17 (57%)	21 (72%)	

VR=Virtual reality

Chi-squared analysis was also done on the categorical data, with $p \leq 0.05$ considered significant. All statistical analysis was done on *R Studio*.

RESULTS

PATIENT DEMOGRAPHICS

Patients 18 years or older who were scheduled to undergo WALANT hand surgery at a single outpatient surgical center from November 2023 to January 2024 were enrolled and randomized to either VR augmentation ($n=30$) or control ($n=29$). Patient age ranged from 20-83 years of age, with a mean age of 63 ± 15 for the entire cohort and no statistical differences in age between cohorts. The VR cohort had fewer females (57% vs 72%) [Table 1].

VITAL SIGNS

There were no statistical differences in heart rate between cohorts in the pre-operative period. However, the control group had a significant heart rate elevation for both the intra-operative and postoperative periods, with a mean elevation of 11 beats per minute at both time points [Table 2]. Blood pressure showed no statistical differences between cohorts.

PAIN

Patients in both cohorts experienced relatively little pain throughout the surgical process, with a mean pain score <1 at all time points for both groups. On average, The control cohort reported a higher pain score at all time points; however, this was not statistically significant [Table 1].

ANXIETY

The results of the study demonstrated that patients using VR during wide-awake surgery had significantly lower anxiety scores compared to the control group both during (mean difference = 3.1, 95% CI: 1.7 to 4.5) and after surgery (mean difference = 2.04, 95% CI: 0.99 to 3.2), while no significant difference was observed before surgery (mean difference = 1.2, 95% CI: -0.29 to 2.7, $P = 0.11$). Within the VR group, anxiety scores significantly decreased from before to during surgery (mean difference = 1.3, 95% CI: 0.21 to 2.3) and from before to after surgery (mean difference = 2.0, 95% CI: 1.08 to 2.9). At any stage, no significant reductions were observed within the control group [Figure 2].

PATIENT SATISFACTION

Overall, 92% of patients said they would choose WALANT hand surgery again. Within the VR group, 97% said they would select WALANT hand surgery again, compared to 86% of participants in the control group. Of patients in the

Table 2. Vital signs and anxiety scores of the two groups.

Category	VR (N=30)	Control (N=29)	P-value
Preoperative			
BP	137/72 ± 18.28/8.84	139/72 ± 16.64/9.5	0.67/0.94
HR	73 ± 10.91	71 ± 11.14	0.62
Pain Scale (0-10)	0.2 (2%)	0.7 (7%)	0.19
Anxiety Scale (0-10)	2.27, 95% CI (1.37-3.17)	3.45, 95% CI (2.25-4.65)	0.11
Anxiety Scale			0.03
Completely Relaxed	9 (30%)	9 (31%)	
Somewhat Relaxed	14 (46.6%)	8 (27.5%)	
Somewhat Anxious	5 (16.6%)	11 (37.9%)	
Very Anxious	2 (6.6%)	1 (3.4%)	
Intraoperative			
BP	138/71 ± 17.81/6.83	140/73 ± 17.4/9.4	0.67/0.29
HR	72 ± 10.1	83 ± 16.69	0.04
Pain Scale (0-10)	0.3 (3%)	0.7 (7%)	0.25
Anxiety Scale (0-10)	1.0, 95% CI (0.41-1.6)	4.1, 95% CI (2.9-5.4)	0.01
Anxiety Scale			0.04
Completely Relaxed	18 (60%)	4 (14%)	
Somewhat Relaxed	11 (36.6%)	12 (41.3%)	
Somewhat Anxious	1 (3.3%)	10 (34.3%)	
Very Anxious	0	3 (10.4%)	
Postoperative			
BP	135/74 ± 14.86/9.34	138/731 ± 16.30/13.29	0.50/0.77
HR	73 ± 9.53	84 ± 15.57	0.03
Pain Scale (0-10)	0.3 (3%)	0.6 (6%)	0.60
Anxiety Scale (0-10)	0.27, 95% CI (0.03-0.51)	2.3, 95% CI (1.2-3.4)	<0.001
Anxiety Scale			0.07
Completely Relaxed	25 (83%)	15 (52%)	
Somewhat Relaxed	4 (13%)	11 (38%)	
Somewhat Anxious	1 (4.0%)	2 (7.0%)	
Very Anxious	0	1 (3.0%)	

VR=Virtual reality, BP=Blood pressure, HR=Heart rate

VR cohort, 97% were satisfied or very satisfied with the VR experience, 97% indicated they would probably or definitely recommend VR during surgery, and only 7% indicated they would not choose VR again. There were no statistical differences in patient satisfaction scores between the groups ($P=0.74$) [Table 3].

DISCUSSION

Virtual reality is a powerful tool that can closely simulate perceived reality and provide a distraction from otherwise undesirable experiences. This ability has been recently utilized with WALANT hand surgery to target patient anxiety associated with wide-awake procedures. The current study hypothesis was partially upheld as patients in the VR group were found to have less anxiety during WALANT hand

surgery. Still, there was no difference in pain experience compared to the control group.

This study had several relevant findings. First, the use of VR augmentation during WALANT hand surgery resulted in statistically significant decreased anxiety during surgery. Second, patients in the VR group maintained their resting heart rate throughout surgery. Third, the VR group patients' subjective and self-reported experience of anxiety, from both the qualitative and quantitative surveys, found significant decreases in anxiety levels relative to the control group's experience. Although not performed in this study, VR could also be utilized during the time of local anesthetic injections as these procedures can be an equal source of anxiety for the patient. Naturally, VR can also be used in simple office injections, regardless of the associated surgery.

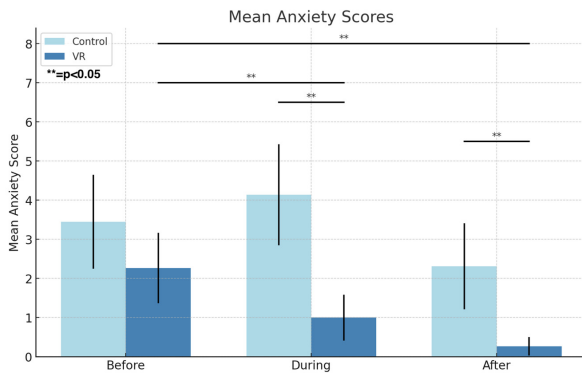


Figure 2. Bar graph of anxiety scores on a 0-10 scale between patients using VR and those not during WALANT hand surgery, with time points preoperatively, intraoperatively, and postoperatively.

Relative to patient satisfaction, two separate findings were identified. First, both groups had high patient satisfaction with WALANT hand surgery, as nearly all patients indicated they would have wide-awake surgery again. However, looking specifically at VR-specific satisfaction, the VR

group demonstrated a statistically insignificant higher satisfaction trend with VR augmentation and the likelihood of undergoing WALANT hand surgery using VR. Although we did not investigate why some patients were unsure or would not choose VR/WALANT again, we understand that some people may be less comfortable using this type of technology. Further, some people may prefer to have no awareness of being in surgery at all, which should be addressed in the preoperative phase.

Potential benefits of wide-awake surgery are increased perioperative efficiency, decreased preoperative medical evaluation, less intraoperative resources utilization, and expeditious postoperative discharging without the sequelae of general anesthetics to recover from.^{2,14} However, with the patient awake during their surgical procedure, the patient may naturally feel nervous or anxious – emotions that are otherwise mitigated when undergoing surgery under anesthesia.¹⁰ Managing patient anxiety during wide-awake surgery falls on the staff, including the surgeon and nurses, to manage while also executing the surgery. Hence, the results of this study of using VR during surgery show promise in addressing this intraoperative anxiety and the responsibility of the surgical staff. In a study following the effects of VR on carpal tunnel release, results showed that in patients

Table 3. Satisfaction with WALANT with and without using the VR.

Category	VR (N=30)	CONTROL (N=29)	P-value
Satisfaction Scale (0-10)	9.7 ± 0.83	9.8 (98%) ± 0.49	0.74
Satisfied with WALANT?			0.90
Very Satisfied	24 (80%)	22 (76%)	
Satisfied	6 (20%)	7 (24%)	
Dissatisfied	0	0	
Very Dissatisfied	0	0	
Choose WALANT again?			0.27
Yes	29 (97%)	25 (86%)	
No	1 (3.0%)	2 (7.0%)	
Unsure	0	2 (7.0%)	
Satisfied with VR?			
Very Satisfied	21 (70%)	-	
Satisfied	8 (26.6%)	-	
Dissatisfied	1 (3.3%)	-	
Very Dissatisfied	0	-	
Choose VR again?			
Yes	24 (80%)	-	
No	2 (6.6%)	-	
Unsure	4 (13.3%)	-	
Recommend to others?			
Definitely	24 (80%)	-	
Probably	5 (16.6%)	-	
Probably not	1 (3.3%)	-	
Definitely not	0	-	

VR=Virtual reality, WALANT=wide awake local anesthesia no tourniquet

using VR, those reporting anxiety disorder had a significantly greater decrease in anxiety levels (79%) when compared to those without anxiety (47%).¹⁵ Additionally, in a randomized clinical trial using VR for colorectal surgery, patients using VR were found to have significantly reduced values on the Hospital Anxiety and Depression Scale (HADS-A) and State-Trait Anxiety Inventory (STAI-S).¹⁶ Furthermore, a study focusing on the effects of VR during an axillary plexus block before elective hand surgery found that the Amsterdam Preoperative Anxiety and Information Scale (APAIS) and Visual Analog Scale (VAS) scores were significantly reduced after a VR session, from 16 to 9 and 5 to 2 on the scales, respectively.¹⁷

VR augmentation during surgery relies on technology, which inherently introduces complexities. Implementation of VR augmentation can be costly relative to the purchase of the equipment and the purchase of VR software or programs to be viewed. In addition, VR equipment requires knowledge of the equipment and necessary maintenance and updating, as would be the case with any hardware or software. Lastly, using VR augmentation involves the facilitation of the equipment during surgery, including applying and adjusting it preoperatively, adjusting the equipment and selecting programming intraoperatively, and troubleshooting issues as they may arise. This all requires capable staff who are trained and available during surgery.

This study had several limitations. Although this was a randomized controlled trial, a single surgeon performed all procedures at the same surgical center and had a small sample size. This was intentional as it created a uniform surgical experience, but it does limit the generalizability of the results. In addition, all surgeries were performed wide-awake but in a surgical center, not an office setting, potentially affecting generalizability. However, the surgeon is an experienced WALANT hand surgeon, having performed over 5000 hand surgeries wide-awake, avoiding the learning curve bias and increasing the study finding's applicability to WALANT hand surgery. Another limitation is that there was dedicated research staff to manage the VR equipment, and any malfunctions were able to be quickly addressed so as not to affect the surgeries and hence does not capture the potential demand on the surgical staff to manage a patient's VR equipment and experience while also executing the surgery. Finally, the data in the study relied largely on subjective patient responses to questions. However, the surveys were administered in the immediate preoperative, intraoperative, and postoperative periods, which would limit any potential recall bias. The same research staff

members administered all surveys, creating a uniform response setting.

CONCLUSIONS

Our study supports using VR augmentation during WALANT hand surgery to decrease intraoperative patient anxiety and increase patient satisfaction. Further, objective measurements such as heart rate were statistically favored when implementing the VR system. Thus, VR augmentation may be useful to mitigate patient anxiety during wide-awake surgery.

DECLARATION OF CONFLICT OF INTEREST

The authors do NOT have any potential conflicts of interest for this manuscript.

DECLARATION OF FUNDING

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

This study was reviewed and approved by the IRB at Thomas Jefferson University in Philadelphia, PA. This study was approved on (06/01/2023) with the approval number (iRISID-2023-1975).

DECLARATION OF INFORMED CONSENT

No protected health medication is contained in this manuscript. Written informed consent was obtained from all participants in this study.

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