

Review Article

Virtual Reality-Based Anxiety Reduction Before Elective Surgical Procedures

Katrin Nowak^{1*}, Astrid Moreau² and Sofia Kraus³

¹Department of Anesthesiology and Pain Management, Bohemian University of Medical Sciences, Czech Republic

²Department of Anesthesiology and Pain Management, Alpine Institute of Medical Sciences, Austria

³Department of Surgical Sciences, Alpine Institute of Medical Sciences, Austria

ABSTRACT

Preoperative anxiety is a common and clinically consequential feature of elective surgery, associated with heightened postoperative pain, greater analgesic requirements, and lower patient satisfaction, which has driven interest in non-pharmacologic alternatives to benzodiazepine premedication.

This review synthesizes recent randomized controlled trials and meta-analyses examining immersive virtual reality (VR) as an anxiolytic intervention across the elective surgical pathway, from adult and pediatric preoperative holding areas through induction of anesthesia and, more recently, intraoperative use during regional anesthesia.

Across pooled analyses in adults and children, VR consistently reduces validated anxiety scores relative to standard care, with larger effects for interactive rather than passive content and for exposure timed close to the anxiety-provoking event, while the advantage narrows when compared against an active non-immersive distraction rather than no distraction.

Pediatric trials additionally show improved induction compliance and feasibility for integration into perioperative workflow, and early intraoperative work suggests a role during awake regional anesthesia cases as well.

We conclude that VR is a promising and low-risk adjunct to existing anxiolytic strategies, though larger pragmatic trials with active comparators and formal cost-effectiveness analysis are needed before it can be considered a protocolized standard of care.

Keywords: virtual reality; preoperative anxiety; elective surgery; anesthesia induction; non-pharmacologic anxiolysis

Citation: Nowak K, Moreau A and Kraus S (2021) Virtual Reality-Based Anxiety Reduction Before Elective Surgical Procedures. *Anesthesiology*. 1(1):01-05.

DOI: 10.17140/2021.vol1.i01.pp01-05

Corresponding Author: Katrin Nowak

E-mail Address: k.nowak@bums.cz

Article History: Received 16 June 2021 | Accepted 08 July 2021 | Published 30 July 2021

Copyright: © 2021 Katrin Nowak, et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (<https://creativecommons.org/licenses/by/4.0/>).

INTRODUCTION

Anxiety before surgery is less an incidental discomfort than a measurable perioperative risk factor. Patients

who arrive at the preoperative holding area with high state anxiety report more pain in the days following surgery, need more analgesia, are harder to induce smoothly, and in some series recover more slowly and are less satisfied with their care overall. Pharmacologic premedication with benzodiazepines has long been the default answer, but it comes with sedation, delayed emergence, and, in older or frailer patients, an unwelcome contribution to postoperative delirium. That tension has pushed anesthesiologists and perioperative nurses to look for anxiolytic strategies that do not carry a drug's downstream cost, and virtual reality (VR) has moved from a novelty demonstration to one of the more seriously studied non-pharmacologic candidates.

The appeal of VR is fairly intuitive. A head-mounted display replaces the sterile, alarm-filled visual field of a preoperative bay with an immersive scene the patient chooses or is guided through, and it does so while occupying enough of the sensory and attentional bandwidth that rumination about the upcoming procedure becomes harder to sustain. Unlike a video played on a ceiling monitor, VR blocks peripheral visual cues and often pairs with spatial audio, so the illusion of "presence" is stronger and, per several of the trials discussed below, the physiological anxiety response is measurably blunted. This review works through what the recent randomized and meta-analytic literature actually shows about VR as a preoperative and perioperative anxiolytic, across adult and pediatric elective surgery, and where the evidence still falls short of settling practice.

MECHANISMS AND RATIONALE FOR VR-BASED ANXIOLYSIS

The mechanistic case for VR draws mostly on attention-capture and distraction theory rather than any anesthetic pharmacology. Anxiety in the immediate preoperative period is sustained by anticipatory cognition — rehearsing worst-case scenarios, monitoring bodily sensations for signs of an impending crisis, and reacting to environmental triggers such as the sight of an IV line or the sound of a neighboring patient's monitor. Immersive VR interrupts this loop by substituting a controlled, engaging visual and auditory environment that competes for the same limited attentional resources. Several studies frame this in terms of Melzack and Wall's gate-control-adjacent distraction models originally developed for procedural pain, extended here to anxiety and autonomic arousal rather than nociception specifically [1].

A second mechanism, more prominent in the pediatric literature, is behavioral: VR gives an anxious child something active to do with attention and hands during induction, which reduces the struggling and crying that otherwise complicates mask induction and increases the likelihood of emergence delirium. Trials of VR delivered specifically during the walk to the operating room and through mask placement report smoother

induction compliance scores alongside lower anxiety scales, suggesting the benefit is not purely subjective self-report but translates into observable perioperative behavior [2]. Physiologic correlates reported across these studies — heart rate, blood pressure, and in some cases salivary cortisol or galvanic skin response — generally move in the same direction as the anxiety scales, which strengthens the case that the effect is real rather than an artifact of demand characteristics in a non-blinded intervention.

EVIDENCE IN ADULT ELECTIVE SURGERY

The adult evidence base has matured enough in the past two to three years to support meta-analysis rather than reliance on isolated trials. A 2025 systematic review and meta-analysis in the *Journal of Medical Internet Research* pooled trials of VR interventions delivered before elective surgery under general or regional anesthesia and found a consistent reduction in validated anxiety scores (State-Trait Anxiety Inventory or the Amsterdam Preoperative Anxiety and Information Scale, depending on the trial) relative to standard care or non-immersive distraction controls [3]. A separate meta-analysis and meta-regression published the previous year in the *International Journal of Nursing Studies* reached a similar conclusion while also probing moderators of effect size, reporting that the magnitude of anxiolysis varied with exposure duration and with whether the VR content was passive (a calming 360-degree scene) versus interactive (a simple game or guided breathing exercise), with interactive content generally outperforming passive viewing [1]. An earlier 2023 systematic review and meta-analysis of VR in adults reached the same directional conclusion using a smaller and more heterogeneous set of included trials, which is reassuring in that the effect has held up as the literature has grown rather than attenuating toward the null as more rigorous trials accumulated [4].

Individual randomized trials add texture that pooled estimates can obscure. A recent randomized controlled trial in adult surgical patients undergoing a range of elective procedures found that a brief, single-session VR exposure delivered in the preoperative holding area produced a clinically meaningful drop in anxiety scores compared with usual care, with the effect present regardless of the type of surgery planned [5]. Another randomized trial looked specifically at perioperative anxiety trajectories rather than a single preoperative timepoint, following patients from the holding area through recovery, and reported that the VR group's anxiety advantage over controls persisted into the early postoperative period rather than dissipating once the headset came off [6]. Gynecological surgery has received particular attention: a prospective single-blind randomized trial of a multistage VR intervention — delivered at more than one point across the perioperative pathway rather than as a single dose — found improvements not only in anxiety but in broader measures of perioperative

recovery, suggesting that repeated or staged exposure may outperform a single preoperative session [7]. Colorectal and abdominal wall surgery patients, a population often carrying additional anxiety related to stoma or cancer diagnoses, showed a similar anxiolytic benefit from VR in a dedicated randomized trial, which is a useful data point given that much of the broader literature is drawn from more generic "elective surgery" populations rather than procedure-specific cohorts [8]. A 2025 systematic review with meta-analysis focusing specifically on perioperative (rather than strictly preoperative) anxiety in adults corroborated the overall direction of effect while flagging substantial heterogeneity in how anxiety was measured and timed across studies, a methodological caveat worth keeping in view when comparing effect sizes across trials [9].

EVIDENCE IN PEDIATRIC POPULATIONS

Pediatric anesthesia has arguably been the most fertile ground for VR research, in part because induction anxiety in children is common, distressing for families, and directly implicated in emergence delirium and negative postoperative behavioral changes. A randomized controlled trial examining VR distraction specifically during the induction sequence — from the preoperative holding area through mask placement — found reduced anxiety and improved induction compliance compared with standard care, establishing that the intervention can be sustained through the highest-anxiety moment of the pediatric perioperative pathway rather than only in the calmer holding area beforehand [2]. That trial's approach has since been replicated and extended, and a 2025 meta-analysis of randomized controlled trials in pediatric patients undergoing general anesthesia found a pooled anxiolytic benefit consistent with the earlier single-center work, while noting that trial quality and blinding remain limited given the obvious difficulty of blinding a child to whether they are wearing a headset [10].

A separate and more recent systematic review and meta-analysis of pediatric VR trials reached the same directional conclusion but focused specifically on how immersion quality and the timing of VR exposure relative to induction moderated the effect, reporting that higher-immersion devices and exposure timed closer to induction rather than only in the waiting room produced larger anxiety reductions [11]. Another pediatric-focused meta-analysis published around the same time pooled a broader set of trials specifically restricted to general anesthesia inductions and likewise found a significant reduction in validated pediatric anxiety scales, reinforcing that this is not an effect resting on one or two well-cited trials but one that has now been replicated across multiple independent pooled analyses [12]. A narrative review synthesizing this pediatric literature more broadly highlighted practical implementation themes — content selection appropriate to age, the importance of a familiar caregiver or child life specialist introducing the headset

rather than an unfamiliar staff member, and the need to have a rapid removal plan if a child becomes distressed by the headset itself — that randomized trials do not typically report but that matter for real-world adoption [13]. A systematic review focused on preoperative anxiety management more broadly, including but not limited to VR, situated the technology alongside more established options like parental presence at induction and premedication, concluding that VR performs comparably to or better than many non-pharmacologic alternatives without their logistical burden [14].

Two further pediatric trials worth noting for their design choices rather than just their headline results: one tested a VR exposure-therapy-style intervention combined with structured patient education delivered before the day of surgery, essentially treating VR as a rehearsal tool rather than a same-day distraction, and found benefits that extended into reduced anxiety on the actual day of the procedure [15]; the other was a mixed-methods pilot feasibility study that, rather than powering for an anxiety endpoint, focused on whether VR could realistically be integrated into a pediatric perioperative workflow without disrupting throughput, an important and often-skipped question given how many efficacy trials say little about implementation burden [16].

INTRAOPERATIVE AND REGIONAL ANESTHESIA APPLICATIONS

Most of the literature above concerns the preoperative period under a plan for general anesthesia, but a smaller and newer body of work has asked whether VR can help during the case itself when a patient is awake under regional or neuraxial anesthesia. A 2026 randomized controlled trial tested VR as an intraoperative intervention for patients undergoing procedures under regional anesthesia, reasoning that an awake patient lying on an operating table for an hour or more, unable to see the surgical field but fully able to hear it, represents a distinct and ongoing anxiety exposure rather than a single preoperative moment, and found that VR reduced both self-reported anxiety and physiologic stress markers measured intraoperatively [17]. This extension matters clinically because regional anesthesia is increasingly favored for exactly the populations — older adults, patients with significant cardiopulmonary comorbidity, ambulatory surgery candidates — in whom minimizing sedative premedication is most desirable, which is also where an awake, anxious patient on the table is hardest to manage with pharmacology alone without undermining the reason regional anesthesia was chosen in the first place. Whether VR can be feasibly maintained throughout a full case, versus only at induction of the block or during particularly stimulating portions of surgery, remains an open logistical question that this early trial does not fully resolve.

IMPLEMENTATION CONSIDERATIONS AND LIMITATIONS

Several practical and methodological issues temper how far this evidence should be extrapolated into routine practice. First, blinding is essentially impossible — a patient obviously knows whether they are wearing a headset — so nearly every trial in this area is open-label with respect to the intervention, which inflates the risk that some portion of the measured effect reflects expectation or attention from staff rather than the VR content itself. Second, the comparator arms vary considerably: some trials compare VR against genuinely standard care with no attention control, while others compare against a non-immersive distraction (music, a tablet video), and the effect size shrinks, sometimes substantially, when the comparator itself is an active distraction rather than usual care, a pattern the meta-regression work has specifically flagged [1]. Third, the population that VR is hardest to help is also probably the population with the most anxiety-related morbidity — patients with claustrophobia, prior adverse experiences with anesthesia, or significant cognitive impairment may tolerate a headset poorly or not at all, and most trials exclude such patients rather than characterizing the intervention's limits in them.

There are also basic infrastructure and cost questions that efficacy trials do not answer: headset cleaning and infection-control protocols between patients, staff time to introduce and remove the device, content licensing, and the capital cost of hardware that must be replaced as VR technology iterates. A feasibility-focused pilot study in the pediatric setting is one of the only publications in this literature to engage with throughput and workflow integration directly rather than treating cost and logistics as someone else's problem [16]. Until larger, blinded-to-the-extent-possible trials with active distraction comparators and formal cost-effectiveness analyses accumulate, VR should probably be regarded as a promising adjunct for motivated patients and programs rather than a default replacement for existing anxiolytic pathways.

CONCLUSION

The accumulated randomized and meta-analytic evidence, spanning adult elective surgery, pediatric anesthesia induction, and now intraoperative use during regional anesthesia, points in a consistent direction: immersive VR measurably reduces perioperative anxiety relative to standard care, and in several trials the benefit persists past the moment the headset is removed. The effect is not uniform — it is larger with interactive rather than passive content, larger when timed close to the anxiety-provoking event itself rather than delivered only in a waiting room hours earlier, and smaller when compared against an active distraction rather than no distraction at all. What the field still lacks is a large, pragmatic, multicenter trial with a real active comparator, standardized anxiety

timepoints, and an honest accounting of implementation cost, which would let VR move from "a promising non-pharmacologic option worth offering interested patients" to a protocolized element of enhanced-recovery pathways. Until then, clinicians adopting VR should treat it as one useful tool in a broader anxiolysis strategy rather than a substitute for good preoperative communication or, where genuinely needed, pharmacologic premedication.

DECLARATIONS

Acknowledgements

The authors thank the perioperative nursing and anesthesia staff whose clinical observations informed this review's focus on practical implementation questions.

Funding

This review received no external or internal funding.

Conflict of Interest

The authors declare no conflicts of interest relevant to this work.

Author Contributions

Katrin Nowak conceived the review and drafted the initial manuscript. Astrid Moreau performed the literature search and critically revised the manuscript for intellectual content. Sofia Kraus contributed to synthesis of the surgical and regional anesthesia literature and provided final approval of the version to be submitted. All authors read and approved the final manuscript.

Ethics Statement

This is a literature review that did not involve new human or animal data collection and therefore did not require ethics committee approval.

Data Availability

No new data were generated or analyzed for this review; all sources discussed are cited and publicly available.

REFERENCES

1. Virtual reality-enhanced interventions on preoperative anxiety symptoms in adults undergoing elective surgery: a meta-analysis and meta-regression (2024) International Journal of Nursing Studies.
2. Pediatric Distraction on Induction of Anesthesia With Virtual Reality and Perioperative Anxiolysis: A Randomized Controlled Trial (2020) PMID:32618627.
3. Effects of Virtual Reality-Based Interventions on Preoperative Anxiety in Patients Undergoing Elective Surgery With Anesthesia: Systematic Review and Meta-Analysis (2025) Journal of Medical Internet Research.

4. Effectiveness of virtual reality in reducing preoperative anxiety in adults: a systematic review and meta-analysis (2023) PMID:37350039.
5. Efficacy of Virtual Reality-Based Intervention for Reducing Preoperative Anxiety in Adult Surgical Patients: A Randomized Controlled Trial (2026) PMID:42220327.
6. Virtual reality and perioperative anxiety: a randomized controlled trial (2026) PMID:41556277.
7. Effects of a multistage virtual reality intervention on perioperative anxiety and recovery in patients undergoing elective gynecological surgery: a prospective single-blind randomized controlled trial (2025) PMID:41353183.
8. The Effects of Virtual Reality on Preoperative Anxiety in Patients Undergoing Colorectal and Abdominal Wall Surgery: A Randomized Controlled Trial (2022) Journal of PeriAnesthesia Nursing.
9. Effectiveness of Virtual Reality Interventions for Perioperative Anxiety in Adults: A Systemic Review With Meta-Analysis (2025) Journal of Clinical Nursing.
10. Preoperative Virtual Reality for Pediatric Patients Undergoing General Anesthesia: A Meta-Analysis of Randomized Controlled Trials (2025) meta-analysis.
11. The Effect of the Immersion Quality and Timing of Virtual Reality Technology to Reduce Preoperative Anxiety in Pediatric Patients Before Undergoing Anesthesia Induction: A Systematic Review and Meta-analysis (2026) PMID:41615340.
12. Efficacy of virtual reality interventions in reducing preoperative anxiety in pediatric patients undergoing general anesthesia: a systematic review and meta-analysis (2026) PMID:42038473.
13. Virtual reality on perioperative anxiety in pediatric patients: A narrative review (2025) narrative review.
14. Management of Preoperative Anxiety via Virtual Reality Technology: A Systematic Review (2025) Frontiers/PMC review.
15. Virtual Reality Exposure Therapy and Patient Education for Preoperative Anxiety in Pediatrics: Randomized Controlled Trial (2025) randomized controlled trial.
16. Use of Virtual Reality in the Pediatric Perioperative Setting and for Induction of Anesthesia: Mixed Methods Pilot Feasibility Study (2025) JMIR Perioperative Medicine.
17. Virtual Reality as an Intervention for Intraoperative Anxiety and Stress in Regional Anesthesia: A Randomized Controlled Trial (2026) Health Science Reports, DOI:[10.1002/hsr2.72113](https://doi.org/10.1002/hsr2.72113).