

Access this article online
Quick Response Code:

Website: <a href="http://www.jpdtm.com">www.jpdtm.com</a>
DOI: 10.4103/jpdtm.jpdtm_4_22

# The Effect of Virtual Reality Technology on Reducing Pain and Stress during Arterial Catheter Placement

Lida Fadaizadeh, Mohammad Sanaat, Seyed Mohammad Jafar Taheri, Marjan Sistani

## Abstract

**BACKGROUND:** Different pharmacological ways for pain and stress control exists, but still, there is space for alternative therapeutic methods and researchers are looking for novel ways to achieve this goal. The aim of this study was to evaluate the role of virtual reality (VR) in reducing pain and stress during minor interventions such as arterial line placement.

**METHODS:** In this study, patients who were candidates for arterial catheter placement before anesthesia induction were selected. Eligible patients were randomly divided into case and control groups. After obtaining consent from both groups and applying local anesthesia, the procedure was performed while displaying a film by VR camera for case group. After the procedure, pain, stress, and satisfaction levels were asked from patients. Pain score was measured by Visual Analog Scale score and during the procedure, vital signs were recorded to detect changes.

**RESULTS:** The results in case and control patients showed that 47.5% of patients in case group and 22.5% of patients in control group had pain ( $P$  value = 0.019). Considering stress, respectively, 32.5% and 45% of the patients in the control and case groups reported positive ( $P$  = 0.251). Intergroup comparison of vital signs showed no significant difference between the case and control groups.

**CONCLUSIONS:** According to the results, patients in case group experienced more pain and stress in comparison to the control group which shows that using the new technology was not quite acceptable. Therefore, we recommend the patients experience and be familiarized with the new device in normal condition before using it for procedures.

## Keywords:

Arterial catheter, pain management, telemedicine, virtual reality

## Background

The use of an arterial catheter is a common method for continuous monitoring of blood pressure and blood gas analysis in the operating room and intensive care unit (ICU).<sup>[1]</sup> Placement of an arterial catheter is a painful process and its insertion usually requires local anesthesia and sedation for the patients. Induction of sedation in patients is a drug-dependent process varying across a spectrum from

light to deep.<sup>[2]</sup> However, alternative means of mental distraction and sedation can also be used to calm the patients for performing minimally invasive procedures, especially when patients are considered high risk for anesthetic drug administration.

The virtual reality (VR) distraction technique is an adjunctive therapy, used since 2003, to induce sedation in patients and control pain and anxiety.<sup>[3,4]</sup> A pilot study utilized the oculus rift headset for orthopedic procedures and showed that using VR as an adjunctive nonpharmacological sedative is effective in reducing pain.<sup>[5]</sup>

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: [WKHLRPMedknow\\_reprints@wolterskluwer.com](mailto:WKHLRPMedknow_reprints@wolterskluwer.com)

**How to cite this article:** Fadaizadeh L, Sanaat M, Taheri SM, Sistani M. The effect of virtual reality technology on reducing pain and stress during arterial catheter placement. *J Prev Diagn Treat Strat Med* 2022;1:40-4.

Telemedicine Research Center, National Research Institute of Tuberculosis and Lung Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran

## Address for correspondence:

Dr. Lida Fadaizadeh, Telemedicine Research Center, National Research Institute of Tuberculosis and Lung Diseases, Shahid Beheshti University of Medical Sciences, Tehran, Iran.  
E-mail: [lfadaizadeh@yahoo.com](mailto:lfadaizadeh@yahoo.com)

Submitted: 16-Dec-2021  
Revised: 13-Jan-2022  
Accepted: 23-Feb-2022  
Published: 23-Mar-2022

This technology is provided by a special camera that makes the individual experience a virtual world with different visual, auditory, and other perceptions, and in fact, distracts the mind from the painful procedure and as a result reduces sedative drug requirements and eventually pain and stress in patients.<sup>[6]</sup>

The main aim of this study was to evaluate the effect of VR technique in reducing pain perception and analgesic drug requirement for performing minimally invasive procedures.

### Methods

In the present study, patients who were candidates for major surgery requiring arterial catheter placement were selected based on the inclusion (i.e., patients who were candidates for major surgery requiring arterial catheter placement, age above 20 years, and signing the informed consent form) and exclusion criteria (i.e., history of mental illness, history of drug addiction, alcohol addiction, lack of consciousness, any lesions in the head prohibit the use of a VR camera). The selected subjects were then assigned to the case and control groups sequentially.

This project was approved and registered by the National Research Institute of Tuberculosis and Lung Disease ethical committee (IR.SBMU.NRITLD.REC.1396.424).

Local anesthesia at puncture site was induced using 1 mL of 2% lidocaine in both groups. No intravenous drug was used for performing the procedure. In the case group, in addition to this, arterial catheter placement was performed while using the VR headset (Samsung Gear VR powered by Oculus). The patients were asked to choose the type of relaxation videos among seaside, jungle and underwater videos and the VR headset was placed on their face 15 min before performing the procedure. For the control group, only local anesthesia was used and the procedure was performed after 5 min of injection.

Arterial line placement was performed using a 20 gauge cannula. At the end of the catheter placement, the patients were asked to score the level of pain they experienced based on Visual Analog Scale (VAS). An anxiety self-report scale was also used to determine the level of anxiety patients had during the procedure. The heart rate and blood pressure of the subjects were recorded every 5 min during the catheter placement.

All data analysis was performed by SPSS 26.0 (IBM Corporation, Armonk, New York, USA). Demographic data (age, gender), parameters including patient satisfaction, procedure duration, pain, and stress were analyzed using Chi-square test. For analyzing vital sign

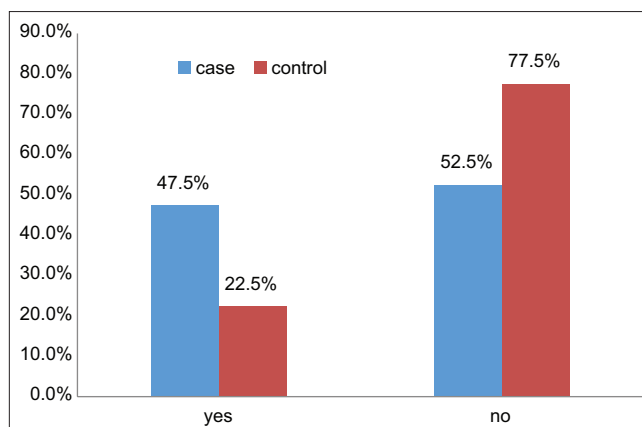
variation and first-last difference *t*-test, Mann–Whitney, paired *t*-test, and Wilcoxon-test were performed.

### Results

After an 8-month intervention, the results showed that a total of 80 patients participated in the study through the case and control groups, 40 subjects in each. The mean age of the study subjects was  $48.16 \pm 14.26$  years; 60% were male. Regarding the statistical analysis of data, 47.5% and 22.5% of the patients in the case and control groups, respectively, reported the feeling of pain, showing a significant difference between the two groups ( $P = 0.019$ ) [Graph 1]. In addition, 32.5% and 45% of the patients in the control and case groups, respectively, reported experiencing stress, indicating no significant difference between the two groups ( $P = 0.251$ ) [Graph 2]. The results showed that the placement of an arterial catheter in 30% of the subjects in the case group was performed within 1–5 min, while it took more than 5 min in 45% of the subjects in the control group ( $P = 0.024$ ) [Graph 3].

Intergroup comparison of vital signs showed no significant difference between the case and control groups. Within-group comparisons also showed no significant differences between the first and last vital signs, except for the diastolic pressure in the control group which a significant difference was observed ( $P = 0.005$ ) [Table 1].

Statistical analysis of data showed no significant relationship between the level of satisfaction and the mean age of the subjects ( $P = 0.779$ ) [Graph 4]. In addition, no significant relationship was found between the mean age of the subjects and their reported level of pain ( $P = 0.691$ ). There was also no significant relationship between gender and the level of pain reported by patients ( $P = 0.924$ ).

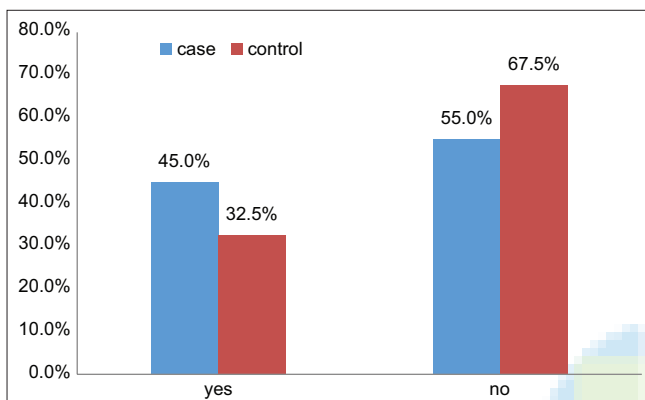


Graph 1: Patient pain reported during the procedure

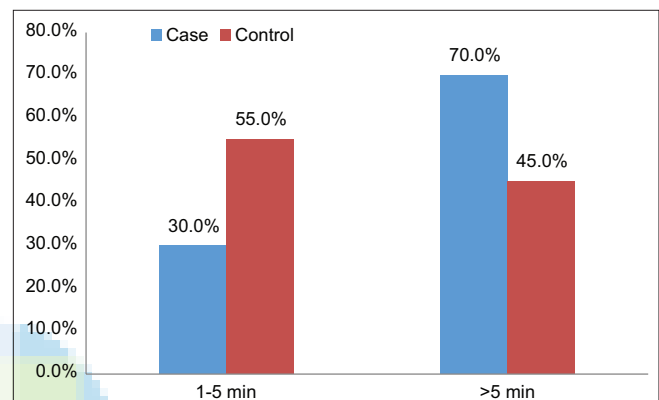
**Table 1: Mean measures of vital signs and mean difference between first and last measures of vital signs in case and control groups**

	Group (mean)		P	
	Case	Control		
HRM	88.31±16.24	83.31±12.38		0.125
HR1 - HR.Last	-0.17500±6.47	-0.02500±6.63	Case: 0.865	Control: 0.981
BPSM	131.74±19.75	132.97±18.22		0.772
BPS1 - BPS.Last	-1.62500±16.85	0.65000±15.31	Case: 0.545	Control: 0.790
BPDM	83.42±11.57	83.05±13.55		0.894
BPD1 - BPD.Last	1.57500±9.55	4.55000±9.76	Case: 0.304	Control: 0.005
Maximum O <sub>2</sub> SAT	96.05±3.18	96.35±2.39		0.831*
O <sub>2</sub> SAT1 - O <sub>2</sub> SAT.Last	-0.12500±2.13	-0.27500±2.18	Case: 0.682**	Control: 0.710**

\*Mann–Whitney test, \*\*Wilcoxon test. Green cells are means of paired differences between first and last measurement. HRM: Heart rate monitor, BPSM: Blood pressure self-measurement, BPDM: Blood pressure daily monitoring, O<sub>2</sub>SAT: O<sub>2</sub> saturation



**Graph 2:** Patient stress reported during the procedure



**Graph 3:** Procedure duration

The level of pain was assessed using the VAS score, and no significant differences were observed between the mean scores of the two groups. The Mann–Whitney test was employed to evaluate the relationship between VAS score and patients’ satisfaction, and the results showed weakly significant relationship ( $P = 0.067$ ).

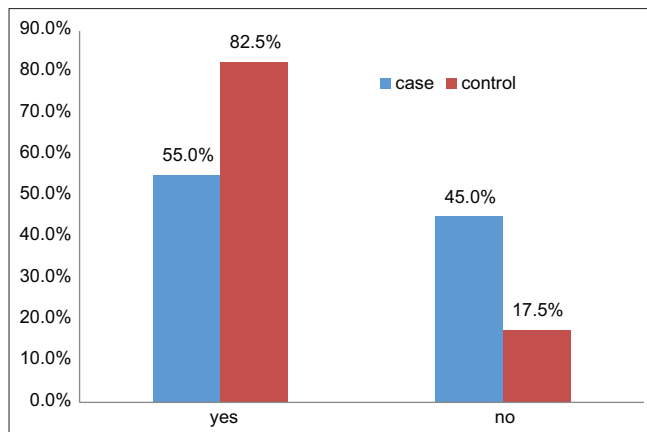
## Discussion

Arterial catheter placement is one of the painful procedures for patients, whether in the operating room or ICU. The use of appropriate methods to reduce anxiety and pain with minimal side effects has always been considered important. Induction of anesthesia and sedation, which is the routine method for management of painful procedures in the operating room or ICU, is a drug-dependent procedure performed by opioids and hypnotics. The use of such agents alone or in combination causes different degrees of sedation.<sup>[7]</sup> Considering the side effects of sedation and anesthesia, especially in unstable patients, alternative methods should be introduced to deliver lower doses of drugs to patients.<sup>[8]</sup>

The use of new technologies for relaxing and mentally distracting patients is a raising topic; VR is one of the main. The use and application of this technology in various medical disciplines are growing. VR technology

is an adjunctive therapy for anxiety disorders such as illness-induced anxiety and claustrophobia.<sup>[8-10]</sup> Today, it is increasingly used in neurology for stroke rehabilitation, in speech therapy, and to induce sedation during endoscopy, dentistry, etc.<sup>[11-13]</sup> A review study by Malloy and Milling on venous catheters placement reported that the employment of VR technology could be effective in reducing pain and anxiety during the procedure.<sup>[14]</sup> In a study conducted in 2019 on war veterans with chronic pain, VR technology and a specially developed application were used to make a virtual environment for patients, and their effects on helping to overcome the fear of mobility were examined. Ease of use and self-management were reported as the advantages of the introduced method and generally matched to the patients’ needs.<sup>[15]</sup>

A study, in addition to placebo, used a VR camera to examine the gait ability in patients with Parkinson’s disease, and the results showed that the technology failed to improve patients’ gait but reduced the stride interval.<sup>[16]</sup> In a study by Walker *et al.* (2014), a VR camera was used to control and reduce pain and anxiety in patients during cystoscopy, and the results showed no significant differences between the case and control groups.<sup>[17]</sup> Furthermore, in a study by De Miguel-Rubio (2020) on patients with spinal cord



Graph 4: Patient satisfaction during the procedure

injury, rehabilitation was done for low activity and no significant differences were observed between the controls and patients who used VR cameras.<sup>[18]</sup>

There was no significant difference in terms of age between the control and case groups in the present study. On the other hand, the satisfaction of patients in the control group was higher than that of the ones in the case group; hence, age and therefore familiarity with new technologies have no effect on patient's satisfaction. Furthermore, the level of stress in the case group subjects was higher than that of controls, which may indicate that the VR cameras played a role in increasing stress in patients. This finding highlights the importance of knowledge and awareness; the effectiveness of VR in reducing anxiety and stress is achieved when patients are first trained and fully acquainted before using the technology.

Although the results of various studies confirmed the efficacy of using VR technology,<sup>[14,19-22]</sup> as previously mentioned, in some studies, the results were not satisfactory or decisive and surprisingly, the findings of our study were in contradiction with those of most previous studies. The provision of a suitable bed for patients to obtain the proper effect of VR technology seems essential. Familiarizing patients with VR cameras, the experience of using the camera before undergoing the procedure, and training in working with the camera can reduce the fear of the first encounter. In addition, the results of other studies also confirm that people with higher education, those familiar with computer use, and patients in youth age are more positively affected by VR technology compared to the elderly.<sup>[23,24]</sup>

## Conclusions

As a conclusion, if VR is intended to be used as an alternative to usual anesthesia and analgesic methods for pain reduction, we recommend meticulous patient

selection and individualization of the method according to the patient's level of education and interests. Moreover, the patients should experience and be familiarized with the new device in normal condition before using it for procedures. This method of pain and stress reduction may be a promising alternative for usual analgesic techniques, but it must be tailored to the needs of each patient and must be experienced in advance to achieve best results. Acute pain control is an essential part of strategic planning for better delivery of health care now a day. Therefore, finding the best and most efficacious method on the one hand and the least invasive means of pain control on the other hand is a major goal. With the advent of new information and visual technologies, such as VR, pain can be controlled easily using visual distraction, but as a rule, new inventions require adequate training and familiarizing to be acceptable. We propose that strategic planning for utilizing these new technologies be taken into consideration by health-care policymakers to make the best use of these new noninvasive methods in modern medicine.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## References

1. Miller AG, Bardin AJ. Review of ultrasound-guided radial artery catheter placement. *Respir Care* 2016;61:383-8.
2. Kelly JS. Sedation by non-anesthesia personnel provokes safety concerns: anesthesiologists must balance JCAHO standards, politics, safety. *APSF Newslett* 2001;16:3.
3. Hoffman HG, Patterson DR, Carrougher GJ, Sharar SR. Effectiveness of virtual reality-based pain control with multiple treatments. *Clin J Pain* 2001;17:229-35.
4. Deo N, Khan KS, Mak J, Allotey J, Gonzalez Carreras FJ, Fusari G, et al. Virtual reality for acute pain in outpatient hysteroscopy: A randomised controlled trial. *BJOG* 2021;128:87-95.
5. Chan PY, Scharf S. Virtual reality as an adjunctive nonpharmacological sedative during orthopedic surgery under regional anesthesia: A pilot and feasibility study. *Anesth Analg* 2017;125:1200-2.
6. Mahrer NE, Gold JI. The use of virtual reality for pain control: A review. *Curr Pain Headache Rep* 2009;13:100-9.
7. Clark JO, Clark TP. Analgesia. *Vet Clin North Am Equine Pract* 1999;15:705-23.
8. Oprüş D, Pinteş S, García-Palacios A, Botella C, Szamosközi Ş, David D. Virtual reality exposure therapy in anxiety disorders: A quantitative meta-analysis. *Depress Anxiety* 2012;29:85-93.
9. Meyerbröker K, Emmelkamp PM. Virtual reality exposure therapy in anxiety disorders: A systematic review of process-and-outcome studies. *Depress Anxiety* 2010;27:933-44.
10. Garcia-Palacios A, Hoffman HG, Richards TR, Seibel EJ, Sharar SR. Use of virtual reality distraction to reduce claustrophobia symptoms during a mock magnetic resonance imaging brain scan: A case report. *Cyberpsychol Behav* 2007;10:485-8.
11. Marque P, Gasq D, Castel-Lacanal E, De Boissezon X, Loubinoux I. Post-stroke hemiplegia rehabilitation: Evolution of the concepts.

- Ann Phys Rehabil Med 2014;57:520-9.
12. Harpham-Lockyer L, Laskaratos FM, Berlingieri P, Epstein O. Role of virtual reality simulation in endoscopy training. *World J Gastrointest Endosc* 2015;7:1287-94.
  13. Alshatrat SM, Alotaibi R, Sirois M, Malkawi Z. The use of immersive virtual reality for pain control during periodontal scaling and root planing procedures in dental hygiene clinic. *Int J Dent Hyg* 2019;17:71-6.
  14. Malloy KM, Milling LS. The effectiveness of virtual reality distraction for pain reduction: A systematic review. *Clin Psychol Rev* 2010;30:1011-8.
  15. Fowler CA, Ballistrea LM, Mazzone KE, Martin AM, Kaplan H, Kip KE, *et al.* A virtual reality intervention for fear of movement for veterans with chronic pain: Protocol for a feasibility study. *Pilot Feasibility Stud* 2019;5:146.
  16. Griffin HJ, Greenlaw R, Limousin P, Bhatia K, Quinn NP, Jahanshahi M. The effect of real and virtual visual cues on walking in Parkinson's disease. *J Neurol* 2011;258:991-1000.
  17. Walker MR, Kallingal GJ, Musser JE, Folen R, Stetz MC, Clark JY. Treatment efficacy of virtual reality distraction in the reduction of pain and anxiety during cystoscopy. *Mil Med* 2014;179:891-6.
  18. De Miguel-Rubio A, Rubio MD, Salazar A, Camacho R, Lucena-Anton D. Effectiveness of virtual reality on functional performance after spinal cord injury: A systematic review and meta-analysis of randomized controlled trials. *J Clin Med* 2020;9:2065.
  19. Guo C, Deng H, Yang J. Effect of virtual reality distraction on pain among patients with hand injury undergoing dressing change. *J Clin Nurs* 2015;24:115-20.
  20. Basak T, Duman S, Demirtas A. Distraction-based relief of pain associated with peripheral intravenous catheterisation in adults: A randomised controlled trial. *J Clin Nurs* 2020;29:770-7.
  21. Dunn J, Yeo E, Moghaddampour P, Chau B, Humbert S. Virtual and augmented reality in the treatment of phantom limb pain: A literature review. *NeuroRehabilitation* 2017;40:595-601.
  22. Gutiérrez-Maldonado J, Gutiérrez-Martínez O, Loreto-Quijada D, Nieto-Luna R. The use of virtual reality for coping with pain with healthy participants. *Psicothema* 2012;24:516-22.
  23. Oliveira CR, Lopes Filho BJ, Esteves CS, Rossi T, Nunes DS, Lima MM, *et al.* Neuropsychological assessment of older adults with virtual reality: Association of age, schooling, and general cognitive status. *Front Psychol* 2018;9:1085.
  24. Plechatá A, Sahula V, Fayette D, Fajnerová I. Age-related differences with immersive and non-immersive virtual reality in memory assessment. *Front Psychol* 2019;10:1330.

