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Narrative Review

Application of Virtual Reality in Pain Management

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Abstract

Introduction: Virtual Reality (VR) technology is developing rapidly in the last decade. The availability of affordable VR devices increases the use of VR in many sectors. VR is used as a platform for learning, entertainment, and medical profession. In the medical profession, VR is used in many aspects, ranging from medical education, training healthcare providers, medical intervention, and rehabilitation. This review aims to explore the potential application of VR in pain management.

Methods: Manuscripts were searched in PubMed, Cochrane Library, and PubMed Central. The search results underwent deduplication process. The remaining articles were screened based on the inclusion and exclusion criteria by reading titles and abstracts as the primary filter. The article that met the criteria underwent full read as a secondary filter.

Results: A total of 2401 articles were identified. Overall, six articles were included in this review. The application of VR is based on distracting patient's attention to reduce the perception of pain. Four articles showed advantage of VR in pain management. Two articles showed no difference between VR-based pain management and the control group.

Conclusion: The emergence of affordable VR devices boosts the utilization of VR-based technology in pain management. However, their use still requires larger data and verification.

Keywords: Medicine, Therapeutics, Disease Management, Complementary Therapies

Introduction

A virtual Reality (VR) system is a system composed of various output devices that provide sensory stimulation, input devices that detect user actions, and a computer that processes input and creates output.[1] VR provides a pseudo-three-dimensional environment that leads to an immersive experience through multi-sensory devices and has the ability to interact directly. The used devices can be simple, ranging from monitors, mice, and keyboards, to full immersion, such as glove data and head-mounted displays.[2,3]

Since the beginning of its development in 1990, VR has been applied in various fields.[2] Architects use VR to construct virtual buildings for pre-build analysis. In the industrial sector, VR is used in various stages. In the design section, VR is used to make product planning and prototyping. On the management side, VR is used for process planning, simulation, and staff training in production. In the production process, VR helps milling, assembly, and inspection processes.[2,3,5-7] Entertainment has experienced a rapid increase in the last decade. The production of affordable head-mounted displays, the gaming industry is estimated to earn $ 6.9 billion in profits by 2020 AND $ 11.6 billion in 2025.[4]

Furthermore, VR is used in the medical profession in many aspects, ranging from medical education to monitoring and treating patients. Anatomy is one of the basic sciences learned in early stages of medical education which is hard to understand and requires cadavers and models in the learning process. The 3D anatomy program that is displayed in VR can be a substitute to help students learn anatomy structures. In the same way, residents need to understand various anatomical deformities and surgery techniques. Combined with system inputs, the same program was developed to become a resident facility for surgery training. In addition to education, VR can be used in patient managements, such as reducing pain via distraction during the intervention and doing behavioral therapy remotely. This article aims to explore the potential application of VR in pain management.

Materials and Methods

The literature search strategy used PRISMA 2009 Flow Diagram[8] in December 2020 to find articles on

the use of VR in the health sector. Search was limited to articles published in 2016-2020. The used databases were PubMed, Cochrane Library, and Pubmed Central. The used keywords were "virtual reality" AND "application" AND "medicine". In Pubmed, the search was carried out using a clinical trial filter and a randomized controlled trial. In the Cochrane Library, the search was carried out by the trial filter. In Pubmed Central, we used all the fields filter for each keyword and the MEDLINE and Open access filters on the article attribute.

Every duplicate was excluded. Then, the title and abstract were read manually to filter out irrelevant articles as the main filter. The inclusion criteria included: use of fully-immersive VR and discussing the role of fully-immersive VR in pain management. The exclusion criteria included: non-English articles, pilot study or preliminary study, article content discussing augmented reality, mixed reality, or other technology partially using VR, articles funded by VR related company, and no full articles found. Articles included in the primary screening were read as a whole to be filtered based on the inclusion and exclusion criteria.

The data were extracted from the included articles and entered into the literature table using MS Excel 2007 worksheets. Articles were grouped based on the outcome of the study.

Results

The results of the literature search identified 2401 articles (Figure 1). After the deduplication, the titles and abstracts were screened. It was found that six articles met the inclusion and exclusion criteria.[9,10-4]

VR-based treatment is used in the management of chronic lower back pain. The patient uses VR glasses, then performs movements according to the instructions. The results showed that the patients had an improved quality of life, improved five out of eight subscale scores of SF-36 form significantly (P = 0.044) The same patients also experienced decreased pain, showing improvement in NRS pain score (P = 0.001).[9] The same treatment has also shown progress in chronic neck pain. The pain-related movement reduced after three months of therapy (P<0.05).[12]

VR-based distraction can also reduce pain during minor surgery. During the procedure, the patient uses VR glasses to play 360 videos in the form of scenery

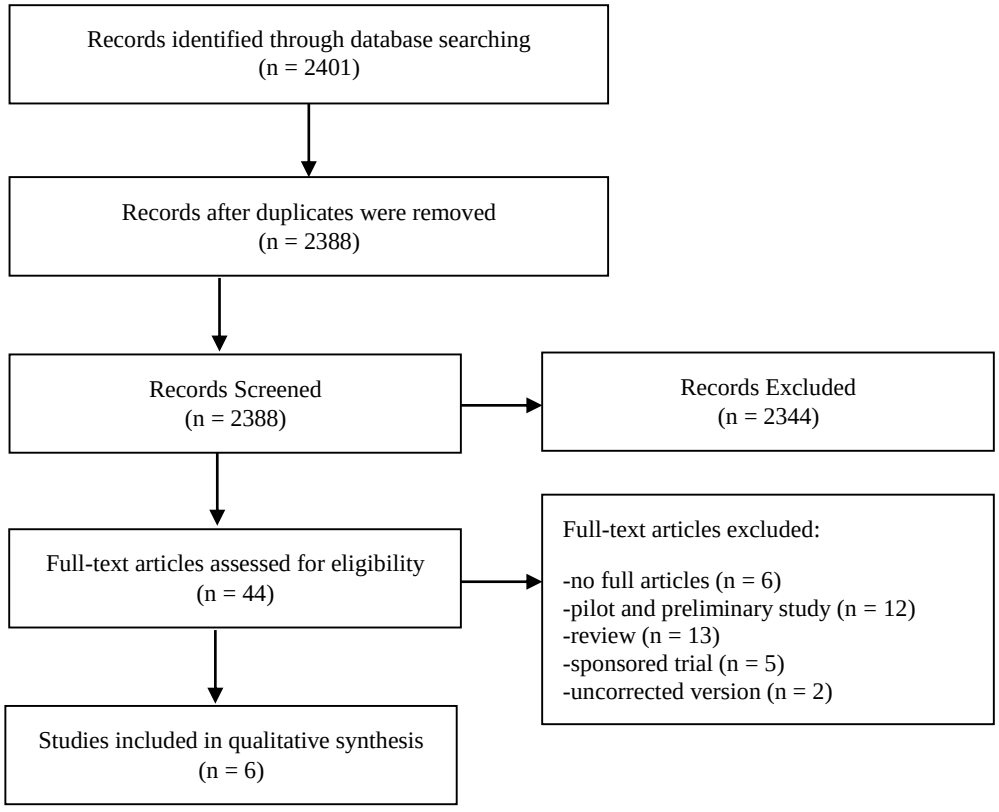

Figure 1. Flow Diagram of the Study

Table 1. Application of VR in Pain Management

Author,(year)	Number of samples	Study type	Description	Outcome
Alemano et al. (2019)[9]	N=20	Clinical trial	VR as non-pharmacology analgesia to reduce chronic back pain	Positive
Esumi et al. (2020)[10]	N=1	Case report	VR as non-pharmacologic analgesia for an infected wound in compartment syndrome patients	Positive
Pandya et al. (2017)[11]	N=14	Retrospective study	VR used to decrease sedation dose and pain during the preoperative procedure	Positive
Tejera et al. (2020)[12]	N=44	Randomized controlled trial	VR compared to exercise as pain management of chronic neck pain	Neutral
Brennan et al. (2019)[13]	N=120	Randomized controlled trial	VR used to reduce pain in the regular intervention compared to the control group	Positive
Sшren et al. (2019)[14]	N=64	Randomized controlled trial	VR used to reduce pain in venous cannulation compared to the control group in pediatric patients	Neutral

and relaxation music. Patients undergoing perineural catheter insertion hardly needed intravenous sedation. Only one out of seven patients required it, and the pain resulting from the procedure is reduced for the time of the procedure ($P = 0.029$).[11]

VR-based distraction is also beneficial in patients with acute compartment syndrome undergoing open fasciotomy. This procedure is used in patients already intolerant to IV PCA fentanyl due to nausea and respiratory depression. Low-cost VR devices can be paired with smartphones to provide distraction.[10]

In regular intervention, VR-based distraction reduce pain in adult population. Post-intervention pain score is significantly reduced in the VR group compared to the control group ($P = 0.048$).[13] In pediatric population, VR-based distraction did not show significant differences compared to the control group ($P = 0.23$), but higher in satisfaction.[14]

Discussion

The results show that VR is beneficial in reducing pain during the action. Pain management revolves around distraction methods to shift the patient's focus during the procedure.[9,10-4]

The obtained results are in line with previous studies. According to the hypothesis, with the multi-sensory distraction method patient's attention will be diverted from the pain that arises.[15-6] VR-based distraction help reducing patients' pain for the same amount of analgesia or reduced analgesia use for the same pain reduction.[10,13,16] The availability of low-cost devices and reusability makes VR an inexpensive resource. The fact that VR is able to reduce the amount of used drugs can reduce the cost of health services.[12]

The limitations of this study lie in the small number of populations, and the differences in the population between studies. The obtained results also cannot explain the mechanism of VR-based pain relief. Studies in larger populations are needed to confirm the results of these studies.

Conclusion

VR is still an ever-developing technology. The emergence of affordable VR devices boosts the utilization of VR-based technology in many fields. The use of VR in pain management varies from substituting to supplementing existing therapy. The low-cost system and reusability of VR devices can lower healthcare costs. However, their use still requires more data and verification.

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Conflict of Interest

The authors declare that they have no conflicts interest.

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