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Using virtual reality to manage pain and anxiety during dental treatments in patients with stroke: A case series

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Abstract

Dental anxiety is common post-stroke, with many patients unable to receive standard anesthetics. Virtual reality has been increasingly used to manage pain and anxiety in dentistry, though its use in individuals with stroke is largely unexplored. A case series of two patients with a history of stroke and dental anxiety was conducted at a specialized dental clinic. Patients watched 360°-virtual reality videos in a dental chair using a head-mounted display. Outcomes (patient: dental anxiety and pain, reactions to virtual reality; dental team: system usability, impact on workflow) were assessed using a standard observation tool, questionnaires, and interviews. Both patients wore virtual reality throughout the procedure and reported that the device was comfortable, provided a distraction, and had potential to reduce anxiety/pain. The dentist reported a positive impact on patient anxiety and time to complete procedures, and intends to continue using virtual reality with other stroke patients and clinical populations.

Keywords

Virtual reality, stroke, anxiety, pain, dentistry, dental care, digital health, case report

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Introduction

Maintaining oral health post-stroke is challenging for patients and care providers alike. For example, stroke is associated with loss of mobility and hemiparesis, potentially impacting the patient's ability to brush their teeth.[1] Anxiety disorders are a common psychological outcome of stroke.[2,3] For stroke survivors in particular, dental anxiety is a concern as it can affect dental appointment attendance and is associated with an increased risk of poor oral health.[4] Moreover, analgesics that are routinely prescribed during dental appointments, such as ibuprofen, frequently cannot be provided post-stroke due to an increased risk of adverse effects.[5] Accordingly, it is imperative to develop non-pharmacological interventions to manage dental pain and anxiety in stroke survivors.

A number of studies have shown that virtual reality (VR) administered through a head-mounted display (HMD) is an effective tool to manage acute pain and associated anxiety[6] though distracting the user with an immersive and multisensory experience and occluding the user's view of the real-world environment.[6] Its utility, however, may vary by population and clinical indication.[6] In dentistry, this application of VR is an emerging area of research, with studies suggesting its potential to manage dental phobia,[7] pain, and/or anxiety in both adults[8] and children.[9,10] To date, research on VR's use in dentistry has focused on pediatric populations where it has been found to reduce subjective pain scores[9] and physiological markers of anxiety, such as heart rate,[10] when compared to the current standard of care.

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For individuals with stroke, VR is being rapidly adopted as a rehabilitation tool.[11] VR has shown to be safe in individuals with stroke, with no serious adverse events occurring across multiple studies, and overall mild side effects[11] (e.g., dizziness, headaches). In summary, VR may be an unexplored tool for managing dental pain and anxiety in stroke patients.

A case series, in accordance with CARE (CAse REports) guidelines[12] (see Supplemental Materials 1), was conducted to explore the feasibility of using immersive VR to manage pain and anxiety in patients with stroke and dental anxiety, in a clinical context. Objectives included assessing the acceptability of the VR system (hardware and software), the impact of the invention on patient pain and anxiety, and the impact on dental team workflow.

Case

The researchers first observed three dental appointments at a specialized clinic in Toronto, Canada, that provides care for patients with stroke, dementia, and acquired brain injury. Potential environmental challenges were identified, and two patients with a history of stroke and dental anxiety were selected to participate, with the clinical team's input. The intervention was administered by the research team, who assisted with fitting a sanitized HMD on the patient. Patients selected from a YouTube playlist of 360° VR videos (prescreened by the research team to exclude first-person motion) to watch during the procedure. Post-procedure, the HMD was sanitized with medical-grade disinfectant and CleanBox™ UV-C light technology.[13]

Case 1 was a 68-year-old male, 1.5 years post-stroke, with a history of multiple ischemic strokes and left hemiparesis, who underwent a simple tooth extraction with local anesthetic (polocaine 3%). Case 2 was a 58-year-old male, 1 year post-stroke, with stroke syndrome, small vessel disease/lacunar infarction, previous subcortical infarcts/stroke, who underwent a recall exam cleaning and scale polish. Both patients were seated in a reclined position during their procedure. No caregivers were present and neither patient had previous VR experience. Outcomes were assessed using mixed methods including qualitative observations, semi-structured interviews, and validated scales (see Supplemental Materials 2). Written informed consent was provided by the patients and dental team to take part in the case report and for publication of photographs.

Both patients wore the VR headset (Case 1 wore an Oculus Go[14] HMD (see Figure 1) and Case 2 wore a Oculus Quest 2[15] HMD) for the duration of the procedure (approximately 25 min). Tables 1 and 2 provide a summary of results from patient self-report measures and researcher observations. During post-intervention interviews, the dentist reported that the VR device was simple to operate (System Usability Scale score = 75),[16] did not impede workflow, and did not impact the time to complete the procedure, aside from additional setup and pre-intervention questions. The dentist reported that the patients required less reassurance due to the distraction provided by VR. The dentist mentioned patients were "much more" relaxed during their respective appointments and less talkative, which was "useful" to the

Figure 1. Patient wearing an Oculus Go virtual reality head-mounted display during dental procedure.

Table 1. Quantitative results—patient self-report.

Item	Case 1	Case 2
Pre-Intervention Visual Analog Scale (VAS)[17]		
Self-reported anxiety[a]	6	6–7
Post-Intervention VAS[17]		
How much pain did you feel during the session?[b]	5	1
How much time did you spend thinking about your pain during this most recent session?[b]	5	3
How unpleasant was the most recent session?[b]	3	0
How much did your teeth/gums bother or cause you discomfort during the most recent session?[b]	2	1
How anxious did you feel during this session?[b]	6	2
To what extent (if at all) did you feel nausea as a result of experiencing the virtual world?[b]	0	0
To what extent did you feel like you went inside the virtual world?[b]	1	5
How real did the virtual world seem to you?[b]	2	7
How did you find the headset in terms of comfort?[c]	7	9

[a]Scale of 0–10 where 0 = "totally relaxed," 10 = "highest anxiety you have ever felt."
[b]Scale of 0–10 with 0 being the least amount and 10 being the greatest amount; see Supplemental Materials 1: Part B: Appendix C.
[c]Scale of 0–10 where 0 = "very uncomfortable," 10 = "very comfortable."

Table 2. Qualitative results—Researcher observations and patient self-report.

Item	Case 1	Case 2
Feasibility and acceptability		
Usability: software	Headset removed once because video stopped playing for unknown reason.	Initial technical issue where researcher had to reset the boundary. Patient would have liked to have used the controller to switch between videos.
Usability: hardware	Disliked the "nose gap" that was caused by using the head-mounted display (HMD) in a reclined position; commented that being able to see the room impacted sense of presence.	Found the "nose gap" preferable to see what the dentist was doing and to remain "grounded"/avoid becoming "lost" in virtual reality (VR). Described weight of the HMD as "reassuring."
VR content: quality	Described the videos as blurry and out of focus. Note: patient was not wearing glasses during the intervention.	Described the quality of the videos as "amazing." Described disliking only being able to see the "sky" in the videos (Figure 2).
VR content: preferences	Nature/outdoors. Disliked close focal point (animals close-up).	Liked Northern Lights, stars/night time videos, would want to see waterfalls, orchestras. "I wanted something more interactive, but I think it might disrupt the patient-doctor interaction if I am too engaged with the video and moving around."
Impact of intervention		
Pain and anxiety	Reported that pain and anxiety during this appointment were comparable to other experiences. Anxiety remained constant throughout the appointment (6/10).	During procedure, reported less breath-holding. Reported that anxiety started at a 6/10 and dropped to a 2/10 throughout the appointment. Post-procedure, described anxiety and pain as comparable to other appointments, but that VR was a helpful distraction from anxiety pain and the overall experience was different: "It felt like only 15 minutes! The time really goes fast [. . .] no offense to doctors or assistants, but it was just better with the VR."
Willingness to use VR Again	Would use VR again or recommend it to a friend if the quality of the videos was higher. "It was good, but if it's not in focus, it's a waste of time."	Would want to use VR again in future appointments. Would recommend VR for patients who are already familiar with their dentist and dentist's workstyle.

dentist. The dentist also reported that VR was a better tool than sedation, which causes initial sleepiness, followed by patients "waking up fighting" during the procedure.

Discussion

Overall, VR was well-tolerated by both patients. Both patients and the dentist reported that the VR headset was helpful in providing distraction during procedures and were interested in using VR during future dental appointments. Patient 2 reported that their procedure felt like it took half the time, and noted breathing more normally instead of holding their breath as was their habit, telling researchers, "No offense to doctors or assistants, but it was just better with the VR." The dentist also reported that VR was a better tool than standard-of-care strategies (e.g., calm voice, sedation), and did not intervene with patient communication, which is an important consideration when treating those with stroke[18] (e.g., due to aphasia).

While It is important to note that the limited sample size of two participants in this case report introduces a potential for bias, as individual variations may not be fully representative of a broader population, our findings are in line with a recent systematic review that found that VR has been used successfully during dental procedures.[19] Some additional suggestions were identified, for example, since patients need to limit their head movements during procedures, calming videos without much action (e.g., flashing bright lights) or first-person motion were better suited for this context. Another challenge when reclined is that the patient's view is of the upper quadrants of the 360°-video, limiting the video selection to those with stimulating sky views (see Figure 2). For reclined patients, regular or 180° videos displayed in "movie theatre" mode may be more appropriate as they can be adjusted to the patient's eye level. Another challenge was that a gap forms at the nose bridge when patients are in a reclined position, letting in environmental light. This was noticed by both patients, though one reported it as a flaw while the other said it was helpful (giving them visibility and thus comfort with their surroundings).

Finally, it should be noted that in both cases, it was the researcher who administered the VR. In order to determine scalability, a next step would be for the dental team to administer the intervention. A companion application accessed

Figure 2. Differences in view based on dental chair position and type of video: screenshots taken from an Oculus Quest 2 virtual reality head-mounted display. (a) 360-degree video, upright view. (b) 360-degree video, reclined view (note that the view is predominantly of the sky). (c) Standard two-dimensional YouTube video, upright view. (d) Standard two-dimensional YouTube video, adjusted for reclined view.

through a computer or smart device would be ideal for controlling the VR headset in this setting.[20] The companion application should have mirroring capabilities (i.e., show what the person is seeing in the headset) to help the dental team ensure the program is functioning properly and should assist with resolving the issue of limited reclined view.

Conclusion

To our knowledge, this case series is the first to explore the use of VR with stroke patients undergoing dental treatments. The results demonstrate that VR did not cause any adverse effects and was effective in providing a distraction for anxiety and pain in two stroke patients. The dental team reported that VR did not impact their workflow and at the same time was helpful in reducing the amount of reassurance that patients needed. Both the patients and the dental team are interested in using VR again during future appointments, demonstrating the acceptability of this intervention. These findings support the use of VR as a non-invasive and person-centered tool to provide dental care that meets the unique needs of stroke survivors. Given the promising feedback, future research should evaluate the effectiveness of VR in managing pain and anxiety with a larger sample.

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Author contributions

L.A., E.M.T., I.P.G., S.L., and R.S. conceived of the study and collected the data. L.A., E.M.T., I.P.G., S.L., and D.C. wrote the first

draft of the manuscript. All authors reviewed, edited, and approved the final version of the manuscript.

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Ethics approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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Supplemental material

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