A Virtual Reality App for Viewing Radiotherapy Treatment Delivery

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Background

We have built an application that will allow patients to view an educational virtual reality (VR) experience showing the delivery of their radiotherapy treatment plan. With this VR experience, a patient can get a virtual preview of their daily radiotherapy treatment in advance. The goal of this study was to build a tool to improve patients' understanding of how radiotherapy will be used to treat their cancer.

Methods

We designed and built a novel virtual reality app that runs on the Oculus Quest [1], a commercially available virtual reality headset. The patient's radiotherapy plan is exported from our clinical treatment planning system in standard DICOM-RT [2] format. All DICOM-RT patient structures (e.g., target volumes, normal organs) are converted into 3D geometry meshes and saved in a standard OBJ and MTL file formats, along with accompanying color and transparency information (Figure 1).

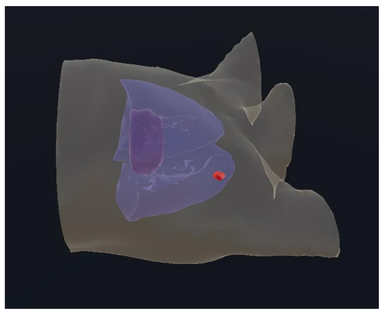


Figure 1: Example of anatomic structures taken from the radiotherapy treatment planning system, exported as DICOM, and converted into 3D geometry meshes as OBJ files for import into the virtual reality headset.

Radiotherapy beam information is extracted from the DICOM-RT file (jaw positions, MLC positions, gantry angle, collimator angle, table angle, monitor units) for all beam control points, and saved into an intermediate file format, YAML [3], and then imported to the Oculus Quest. Using Unity [4], we created a virtual environment of a treatment vault which contains a 3D model of a linear accelerator with a fully movable patient table and gantry head (gantry & collimator angles) w/ adjustable multi-leaf collimator (MLC) leaves. A full-scale 3D rendering of the relevant part of the patient's body is shown in position on the treatment table with a translucent body contour so that the target volume and internal normal organs can be seen.

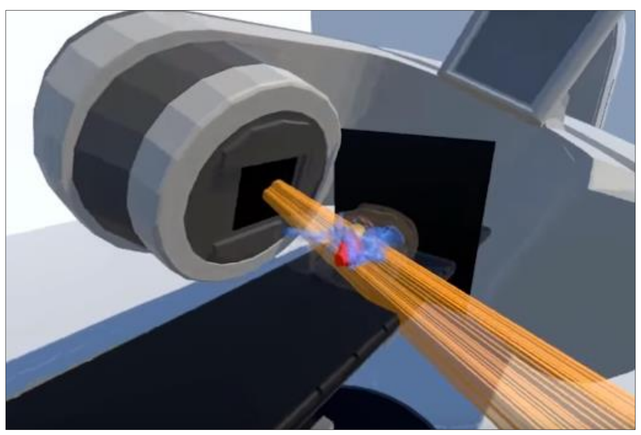


Figure 2: Virtual reality depiction of radiotherapy treatment delivery.

Table 1. Disease Sites

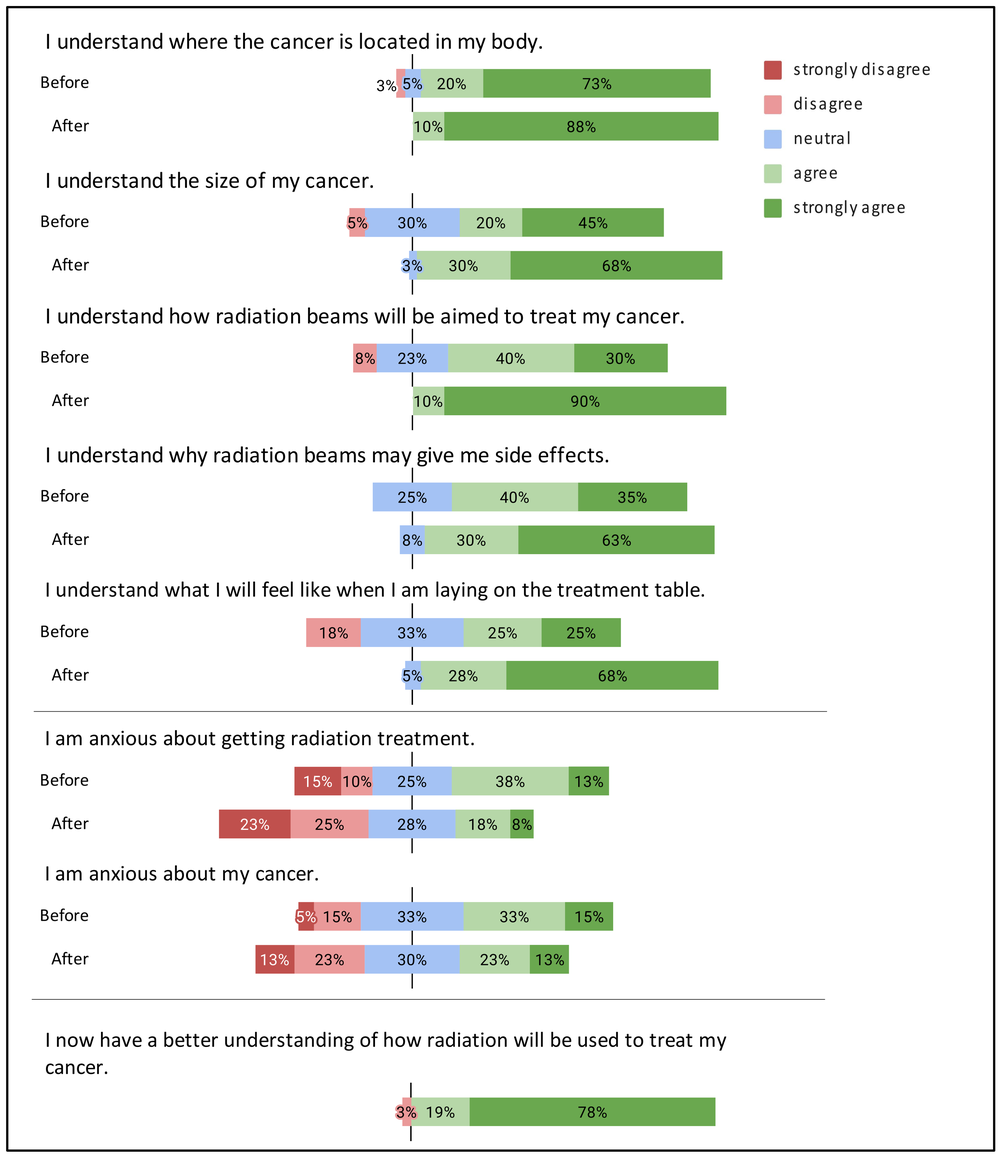
	n	%
breast	18	(45)
prostate	11	(28)
lung	4	(10)
esophagus	3	(8)
rectal	2	(5)
endometrial	2	(5)
	40	(100)

The patient's radiotherapy treatment plan can then be played in real time on the virtual linear accelerator. Each beam in the treatment plan is played in sequence in real-time based on the MU/min for each beam. Gantry movement is modeled as smoothed arcs for dynamic conformal arcs or volumetric modulated arc-based therapy. The radiation beams are shown as yellow beams of light for better visibility. MLC leaf motion is modeled for each control point, which dynamically changes the shape of the visible yellow radiation beams. The beam can be seen entering the translucent patient body and conforming to the target volume of interest while avoiding adjacent normal structures in their body. Because this device is untethered and uses room scale VR, the user can walk around and view the radiation beam delivery from any perspective in the room.

We are conducting a clinical trial to determine if showing patients a VR rendition of their RT treatment plan can improve the patient's understanding of their treatment, improve physician-patient communication, or decrease their anxiety level about radiotherapy. A pre- and post-session questionnaire was administered to each participant to ascertain the impact of this intervention.

Results

To date we have enrolled a total of 40 patients who were preparing to receive radiotherapy. Of those surveyed, 31 (78%) indicate that they "strongly agree" that the VR session gave them a better understanding of how radiotherapy will be used to treat their cancer. Of the 20 patients who expressed any anxiety about radiotherapy beforehand, 12 (60%) said the VR session helped decrease their anxiety about undergoing radiotherapy.



Conclusions

We created a novel app that can emulate the delivery of a patient's radiotherapy treatment plan on a wireless virtual reality headset. We are studying the use of this app in a prospective clinical trial to determine if this VR tool can improve patient understanding and/or reduce anxiety about their radiotherapy treatment. Our prospective clinical patient trial demonstrates that this VR experience gives patients a better understanding of how radiotherapy will be used to treat their cancer, and it decreases their anxiety about undergoing radiotherapy treatment.

References

[1] https://www.oculus.com/quest/
[2] Law, RadioGraphics, 2009:29(3), DICOM-RT and Its Utilization in Radiation Therapy, https://doi.org/10.1148/rg.293075172
[3] https://yaml.org/
[4] https://unity.com/

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- This study was approved by the Salem Hospital Institutional Review Board.