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Teaching Case

Use of Audiovisual Assisted Therapeutic Ambience in Radiotherapy (AVATAR) for Anesthesia Avoidance in a Pediatric Patient With Down Syndrome

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Introduction

Radiation therapy is important in the treatment for many pediatric cancers; however, its delivery may be challenging in children. During lengthy set-up and treatment times, which can range from 30 to 45 minutes, patients must be separated from their parents while remaining immobilized, often with masks attached to the treatment table or other positioning devices. Because of understandable anxiety, fear, and agitation that can arise from these factors, sedation may be required for radiation treatment in children, as they must remain motionless to ensure precise targeting for optimal treatment delivery.

Patients with Down syndrome (DS) have special needs when undergoing cancer treatment. Variable cognitive impairment in patients with DS[1] may interfere with their understanding of the necessary steps in cancer treatment, which may exacerbate anxiety, agitation, and noncompliance. Thus, patients with DS frequently require anesthesia for procedures such as imaging, chemotherapy, and/or radiation therapy. Anesthesia presents an enhanced risk in patients with DS, as 40% to 60% present with congenital cardiac, esophageal, gastrointestinal, and/or urinary tract anomalies.[2] These factors increase the risk for cardiac instability, airway obstruction, gastrointestinal reflux, and aspiration during anesthesia.[2,3] In addition, individuals with DS are susceptible to atlantoaxial instability, which presents increased danger for spinal cord injury during anesthesia intubation.[2]

The audiovisual-assisted therapeutic ambience in radiotherapy (AVATAR) system, previously described,[4] is an audiovisual system that enables patients to watch streaming video during radiation treatment without interfering with radiation dose or delivery (Fig. 1). This has eliminated the need for anesthesia in select pediatric patients. Herein, we report our experience using the AVATAR system, as well as supplemental techniques, for successful treatment of a patient with DS.

Case Presentation

A 9-year-old girl with a history of trisomy 21 and developmental delay, chronic kidney disease, celiac disease, and chronic otorrhea, presented with polyuria and polydipsia and was diagnosed with diabetes insipidus.

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Magnetic resonance imaging of the brain revealed an enhanced, thickened pituitary infundibulum with a lack of pituitary bright spot. Further work-up was unremarkable, and pathology from transnasal biopsy indicated a reactive process with perivascular lymphocytic inflammation. Surveillance magnetic resonance imaging 1 year later revealed a 3-mm growth of the suprasellar mass. Cerebrospinal fluid revealed normal α-fetoprotein and β-human chorionic gonadotropin, and no cytologic evidence of malignancy. She underwent repeat transnasal biopsy; pathology demonstrated pure germinoma.

She began treatment as per the Children's Oncology Group ACNS1123 study[5] with carboplatin and etoposide, but exhibited low frustration tolerance and poor impulse control, causing agitation and combativeness throughout the courses of chemotherapy. This resulted in the necessity for pediatric intensive unit care with a dexmedetomidine sedation drip to allow her to continue chemotherapy. During her chemotherapy course, she suffered complications of febrile neutropenia, *Clostridioides difficile* infection,[6] bacterial tracheitis and epiglottitis, and stroke. After careful consideration, the chemotherapy was discontinued after 3 of 4 planned cycles.

External beam radiation was recommended to complete therapy, with treatment planned according to ACNS1123, with the desire for the slightly reduced radiation dose on the protocol to minimize potential acute and late effects, including the patient's risk of developing Moya-Moya syndrome, a cerebrovascular disease associated with patients with DS and radiation treatment.[7] Owing to concern the child might have difficulty wearing the mesh immobilization mask, 2 masks were created during simulation so that she could become familiarized with the mask and practice positioning at home. The patient was introduced to and set up with the AVATAR system in a practice session and allowed to select her preference video; with the additional assistance of a child life specialist, she tolerated supine immobilization well and without difficulty. Treatment set-up time and radiation delivery was approximately 20 minutes, on average. During and after daily radiation delivery, she displayed no agitation at all and was compliant with the AVATAR system. She completed the full course of radiation of 18 Gy to the ventricular system, with a 12 Gy boost to the tumor bed, over a total of 20 fractions, all without the need for daily anesthesia. She appeared to enjoy the daily experience of treatment and quickly became a department favorite, to the point that the staff planned a party for her on her last day of treatment. The patient is now 18 months out from completion of treatment with no evidence of disease.

Discussion

We present our experience of successfully eliminating the need for anesthesia with use of the AVATAR system during radiation treatment for a young girl with DS who had had significant difficulty cooperating with treatment during chemotherapy.

Daily anesthesia for radiation treatment in children poses risks for complications[8] and neurocognitive impairment,[9] which are elevated for those with DS.[2] Use of anesthesia places an additional burden on both the patient and family as it requires pretreatment fasting and additional time for administration and prolongs overall treatment time. Fasting may be particularly problematic for patients with the comorbidity of diabetes insipidus and polydipsia, as it causes extreme discomfort and presents an increased risk of hypernatremia,[10] thus options to avoid anesthesia should be carefully considered in such patients. Furthermore, administration of anesthesia demands additional resources and personnel, and carries a significant additional monetary cost per session of radiation.[11] The AVATAR system complements treatment delivery, enhances patient treatment experience, and avoids potential anesthesia-associated complications.

The AVATAR system was first described in 2017; 92% (23/25) of pediatric patients completed a course of radiation therapy without anesthesia.[4] In this study, physician discretion was used to select patients who could benefit from AVATAR during treatment, excluding patients who were either: (1) felt to not need anesthesia at all and (2) patients deemed to require anesthesia regardless of AVATAR intervention. No patients with developmental delay were treated in this study using AVATAR. A recent analysis comparing anesthesia use among pediatric patients over a 6-year period before and after the introduction of AVATAR confirmed a greater proportion of children were able to avoid anesthesia after AVATAR was implemented than age-matched children before AVATAR use ($P = .03$).[12] All pediatric patients between the ages of 3 to 12 were included in this analysis, with all patients qualifying as candidates for AVATAR use after the system's implementation in the clinic, unless the physician felt that the patient required anesthesia regardless of video intervention. Patients were documented as using child life services if they were involved during any point in the treatment process, and child life services were used significantly more frequently in the cohort of patients treated after AVATAR introduction.

Previously reported methods to reduce anesthesia use in radiation therapy include hypnosis,[13] increased utilization of certified child life specialists and support staff,[14] psychoeducational intervention,[15] and multifaceted approaches involving educating families using pictorial representations and positive-reinforcement for the patient.[16] Use of audiovisual aids has also been described[16,17]; however, the AVATAR system is unique, as it is flexible, can be manually adjusted, and can be placed in the path of the radiation beam without beam attenuation.[4,12] Additionally, use of the AVATAR system does not require additional health care personnel or

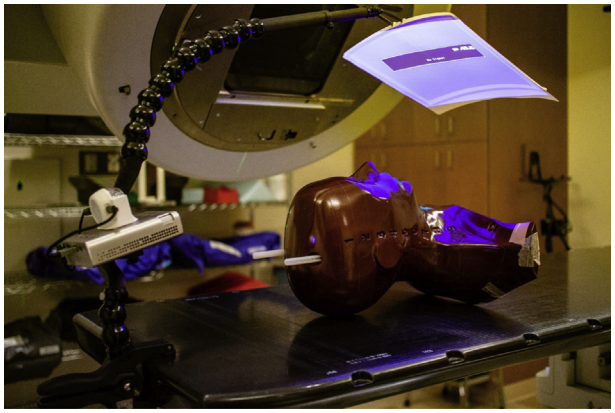

Figure 1 Audiovisual-assisted therapeutic ambience in radiation therapy (AVATAR) system.

increase the cost of treatment per patient, making it a practical and suitable intervention.

Our report describes a unique experience demonstrating avoidance of anesthesia for a patient with DS known to have significant difficulty tolerating cancer treatment. At our institution, patients are assessed on a case-by-case basis to determine whether they might benefit from involvement of child life specialists or measures such as additional masks to practice with at home. Incorporation of these additional tools was judged to provide important supplementation to this patient's care in addition to the AVATAR system, given her difficulty during chemotherapy treatment. These methods to increase patient comfort accompanied by distraction with use of the AVATAR system were successful in helping to reduce the patient's fear and anxiety as well as avoid unnecessary costs and complications from anesthesia. This report illustrates the potential for AVATAR to fit the needs of those with special needs during radiation treatment and provides a unique approach to enhancing patient care. Children with special needs may require additional measures to improve ease and quality of cancer treatment; thus, the present case serves to outline successful techniques in caring for difficult pediatric patients while avoiding anesthesia. Patients may be selected at physician discretion based on the projected benefit of AVATAR use and anesthesia avoidance, with the goal of maximizing patient experience without compromising safety. In our experience, children who particularly enjoy watching videos and using tablets (such as those patients noted to be using tablets during initial consultation) are especially good candidates for AVATAR-based distraction during radiation therapy. Currently, the use and feasibility of the AVATAR system across institutions is being assessed in a multicenter study, and patient/treatment factors associated with successful use of AVATAR are being studied (ClinicalTrials.gov Identifier: NCT03991156).

Conclusions

The AVATAR system was effective in eliminating the need for anesthesia during radiation therapy in a pediatric patient with DS. This demonstrates the adaptability and feasibility of the AVATAR audiovisual system, which can be used to facilitate compliance throughout radiation treatment for pediatric patients.

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