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Intact Functioning of Intrathecal Pain Pump Receiving Radiation Therapy

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Abstract

Programmable Intrathecal (IT) drug delivery systems are being increasingly used with radiation therapy for cancer treatment and palliation. Ionizing radiation is assumed to cause dysfunction of the programmable IT device. However, the dose limit and safety of the IT drug delivery device used concurrently with radiotherapy have not been extensively documented. Here we report a patient who underwent the implantation of an IT pump during radiotherapy. This device was subsequently directly exposed to radiation. Estimated cumulative doses to the pump were in the range of 1.28 to 9.98 Gy. The IT pump exposed to this high-dose radiation did not pose any risk to the patient or the environment. The device was queried during and after the completion of treatment and found to be functioning without fault. This is the first case description about the successful function of an IT drug delivery device directly exposed to ionizing radiation.

Keywords: Intrathecal pump; Spinal analgesics; Pain; Pediatrics; PACS number: 87.53.Jw

Introduction

Programmable Intrathecal (IT) drug delivery systems can be highly effective in controlling intractable cancer pain. This technology is being increasingly used with radiation therapy for cancer treatment. However, the dose limit and safety of the IT drug delivery devices used concurrently with radiotherapy have not extensively been reported. In this brief report, we present a patient who underwent the implantation of an IT pump during the course of radiotherapy.

Materials and Methods

This is a case description of a 15-year-old girl who had Wilms' tumor at age 3 and received radiation therapy as part of her treatment subsequently developed a radiation-induced rhabdoid tumor of the back. In spite of induction chemotherapy, her tumor continued to progress causing significant pain. Urgent radiation therapy was begun, with the goal of improving her pain. A 7 field Intensity Modulated Radiation Therapy (IMRT) plan was used to minimize dose to nearby normal structures including kidney and bowel. However, her pain continued to be poorly controlled and after 27 Gy, she underwent placement of a Medtronic (Minneapolis, MN) SynchroMed® II pump with the tip of the intrathecal catheter at T11. The pump was used to infuse baclofen intrathecally. The patient received an additional 6 fractions (10.8 Gy) with the IT pump placed within some of the treatment fields due to the large size of the tumor. The IT pump was completely encompassed within one field (Figure 1) and partially within 4 fields, and out of the remaining 2 fields. She continued to decline and further radiation therapy was discontinued. Once during radiation therapy and once after completion of treatment, the IT pump was queried and was found to be functioning without error or faults.

Description of the IT Pump

The Medtronic SynchroMed® II pump is a programmable device that stores and infuses medication into the intrathecal space. The pump is typically implanted into the lower abdomen, with a catheter inserted into the intrathecal space. The implanted pump contains an electronic module, battery, peristaltic pump and drug reservoir.

Potential radiation-induced effects on IT pump

Medtronic specifies that malfunctions of the pump could cause medication over-dosing or under-dosing. In patients receiving baclofen, under-dosing could result in decreased pain control, and potentially withdrawal symptoms of muscle spasticity and rigidity, and rhabdomyolysis with progression to multiple organ failure. An overdose of baclofen could induce vomiting, muscular hypotonia, drowsiness, accommodation disorders, coma, respiratory depression, seizures, or death.

The manufacturer's recommendations regarding pump exposure to ionizing radiation are: 1) to avoid direct irradiation, and 2) if direct radiation is unavoidable, to use lead shielding of the device (http://professional.medtronic.com/pt/neuro/idd/prod/synchromed-ii/manuals-technical-resources/index.htm). Ionizing radiation could potentially damage the circuitry or battery, which would cause operational changes. Improper functioning would require pump replacement and could result in under-dosing or over-dosing.

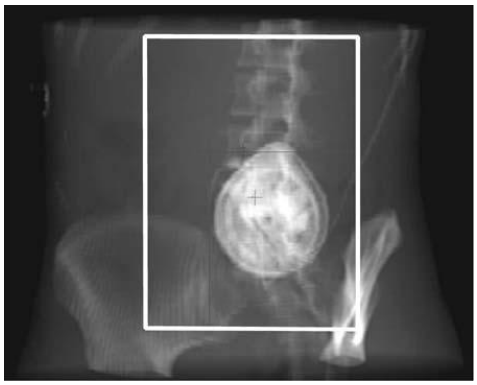

Figure 1: IMRT field that completely encompasses IT pump.

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Results

The CT-based radiation dosimetry of the intrathecal pump was reviewed. The patient underwent a total of 6 treatments (10.8 Gy) during which time the IT pump was implanted and within the radiation field. The mean dose to the IT pump was 3.45 Gy, with maximum point dose of 9.98 Gy and minimum dose of 1.28 Gy.

Discussion

Intrathecal drug delivery in the management of cancer pain is an effective addition to conventional pain management strategies [1]. Radiotherapy also has an established role in the palliation of pain [2]. In our patient, the IT pump was implanted in a location that overlapped with the radiation treatment field. The manufacturer recommends against radiating the device and does not make a specific dose limit. The pump contains battery powered electronics that control a peristaltic pump. The manufacturer notes that radiation therapy can damage the electronics that could result in either under-dosing, which could result in reduced pain relief or withdrawal symptoms, or overdosing, which could potentially be fatal.

There is little literature on the radiation tolerance of IT pumps, with one case report of failure of a radiated IT pump. In that patient, the IT pump received between 28.5 and 36 Gy over 20 fractions. After completion of radiation treatment, the pump was found to have damage to an electronic circuit and the battery was drained [3].

The effect of therapeutic radiation on other implantable devices has been extensively documented. The American Association of Physicists in Medicine (AAPM) Task Group 45 published guidelines for the management of patients with implanted pacemakers in 1994 [4]. Currently, the AAPM Task Group 203 is working on updating those recommendations. Direct radiation to some pacemakers can cause transient malfunction. Significant functional changes have been observed between 1 and 10 Gy, and total and abrupt failure of pacemakers has been documented at cumulative doses between 10 and 30 Gy. It is recommended that radiation oncology facilities establish protocols which specify cardiac monitoring and pacemaker query requirements based upon the estimated absorbed dose of the device. However, a survey of facilities in the US and Canada found that 12% of facilities had no policy in place [5].

Specific guidelines regarding the use of ionizing radiation and IT pumps have not yet been established. Based on the experience with pacemaker function and ionizing radiation, it is reasonable to limit dose to the IT device to a total absorbed dose of 2 Gy. Some caution should be used when estimating the absorbed dose to the IT device using treatment planning systems when the device is in the buildup region, as dose errors can be as large as 25% [6,7]. Dose to the device should be verified with thermoluminescent dosimetry. Should the IT pump receive an estimated cumulative dose of greater than 2 Gy, we would suggest daily query of the IT device to allow rapid detection of pump malfunction.

With increasing frequency, both IT pumps and radiation therapy are being used in the same patients. Radiation oncology departments should consider development of policies to address these situations. We suggest that close collaboration between the surgeon implanting the IT pump and radiation oncologist is helpful in choosing the optimal location for the IT pump. If an IT pump must be within the radiation field, the IT pump should be queried during and after treatment. Additional studies on the radiation tolerances for IT pumps are needed.

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