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Image-Guided Radiotherapy in Paediatrics: A Survey of International Patterns of Practice

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ABSTRACT

Background and purpose: Image-guided radiation therapy (IGRT) is widely used in the treatment of various tumour types in both adult and paediatric patients. However, there are no international guidelines on its optimal use in paediatric radiotherapy. This study proposes to evaluate the current patterns of practice regarding IGRT policy in paediatric patients compared with adult patients through an international survey.

Materials and methods: A five-item questionnaire was created to address IGRT protocols for paediatrics and adults. International Paediatric Radiation Oncology Society members were eligible to partake and were contacted via email (number = 119).

Results: Forty-three members have responded to the survey. Most (65%) centres did not have separate written IGRT protocols for paediatric and adult patients. The imaging frequency used was the same for adults and paediatrics in up to 74% of the centres responded, and scanning parameters used were different in adults and paediatrics in 47% of the centres for central nervous system treatment. Different measures to decrease exposure dose from IGRT in paediatrics have also been explored.

Conclusion: Despite the extensive use of IGRT internationally, most centres use a series of site-specific protocols that fail to consider patient age or size. Given the desire to reduce radiation exposure in the paediatric patient cohort, further research is warranted to develop consensus guidelines on optimal IGRT use.

RÉSUMÉ

Contexte et but : La radiothérapie guidée par l'image (RTGI) est largement utilisée dans le traitement de différents types de tumeurs

chez les patients adultes et pédiatriques. Cependant, il n'existe pas de directives internationales sur son utilisation optimale en radiothérapie pédiatrique. Les auteurs proposent d'évaluer les modèles de pratique actuels concernant la politique de RTGI chez les patients pédiatriques en comparaison des patients adultes par une étude internationale.

Matériel et méthodologie : Un questionnaire de cinq questions a été créé afin de traiter les protocoles de RTGI chez les adultes et les enfants. Les membres de la Société internationale de radio-oncologie pédiatrique pouvaient participer et ont été contactés par courriel (n = 119).

Résultats : Quarante-trois membres ont répondu au sondage. La majorité des centres n'ont pas de protocoles de RTGI écrits séparés pour les patients pédiatriques et adultes. La fréquence d'imagerie utilisée était la même pour les patients pédiatriques et adultes dans 74% des centres ayant répondu et les paramètres de scanning utilisés étaient différents pour les patients pédiatriques et adultes dans 47% des centres pour les traitements du SNC. Des mesures différentes pour diminuer la dose d'exposition en RTGI pour les patients pédiatriques ont aussi été explorées.

Conclusion : Malgré l'utilisation intensive de la RTGI à l'échelle internationale, la majorité des centres utilisent une série de protocoles qui leurs sont propres et qui ne tiennent pas compte de l'âge ou de la taille du patient. Compte tenu de désir de diminuer l'exposition aux rayonnements dans la cohorte de patients pédiatriques, des recherches plus poussées s'imposent pour développer des lignes directrices faisant consensus sur l'utilisation optimale de la RTGI.

Introduction

Image-guided radiation therapy (IGRT) is widely used in the treatment of various tumour types in both adult and paediatric patients and is designed to improve patient setup [1]. Although there is no internationally recognised definition, it commonly refers to regular, serial imaging before

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radiotherapy treatment delivery in the treatment room, allowing for improved localisation of the target and surrounding tissues [2]. It allows for setup uncertainties and organ motion to be more readily identified during treatment, increasing the accuracy, precision, and quality of treatment delivered [3]. This allows for the use of dose escalation techniques and a reduction in planning target volumes (PTV) [1], leading to reduced toxicity and improved local control [4].

IGRT can include planar (2D) and volumetric (3D) imaging, in addition to tracking of internal or surface markers (4D) [1]. Volumetric imaging (such as kV cone beam computed tomography [kV CBCT]) offers the ability to identify the target volume through adequate soft tissue and bony visualisation. However, there is an additional dose (ranging from 0.3 to 3 cGy), longer treatment time and greater cost associated with CBCT when compared with planar imaging [5].

Ionising radiation has been acknowledged as a carcinogen by the World Health Organisation, potentially giving rise to second malignancies in patients previously treated with radiotherapy [6]. Eric Hall identified the three major factors that contribute to an increased risk of second malignancies in paediatrics—the age at exposure, genetic susceptibility, and stray radiation—all of which are more detrimental to a child when compared with an adult [7]. The dose of radiation to any patient is affected by the size of the patient at that site, equipment factors (eg, mAs, kV), technique, and image quality required [8]. Despite the extensive use of IGRT in a clinical setting, there are no consensus guidelines on its optimal use in the treatment of paediatric patients. This study aimed to evaluate the international patterns of practice of IGRT in paediatric vs. adult patients.

Materials and Methods

Ethical Considerations

Ethical approval for this study was sought and obtained from the School of Medicine Research Ethics Committee, Trinity College Dublin in August 2015.

Participation Population

A total of 119 international Paediatric Radiation Oncology Society members were eligible and contacted to participate in this research study evaluating the patterns of IGRT and PTV margin practice in the treatment of paediatric patients. Eligibility was granted to departments that treat both paediatric and adult patients, and use IGRT. Ineligibility was ruled on the basis of invalid email address, no longer working within the affiliated institution and the lack of IGRT in a department.

Survey

Each participant was provided with a five-item survey comprised of closed- and open-ended questions (see [Appendix A](#)). It addressed IGRT under the following

headings: having separate protocol for IGRT in paediatrics, frequency of IGRT, scanning parameters by treatment site, as well as any measure undertaken to reduce radiation exposure from IGRT in paediatric patients. Participation was voluntary and without remuneration. Participants returned completed surveys on the SurveyMonkey website. The survey was open from September 1 to October 31, 2015. Descriptive analysis was performed on all open-ended questions.

Results

Do You Have a Separate Written Protocol for Your IGRT Policy in Paediatrics and Adults?

Forty-three centres responded to the survey. Most of the responders did not have a separate protocol for different treatment sites with 35%—only 15 out of 43 (35%) have a separate protocol for central nervous system (CNS) as shown in [Table 1](#). In the comment section, 16 commented further. Nineteen percent (3/16) stated that IGRT is individualised based on a number of factors, including dose, margins, organs at risk (OARs), tumour location, treatment intent, and treatment machine. Thirteen percent (2/16) indicated the use of daily IGRT for both patient groups, whereas another 13% (2/16) stated the use of guidelines from other studies ([Table 1](#)).

Imaging Frequency

Most participants (74% [32/43]) stated that the same imaging frequency is used for both paediatrics and adults for CNS treatment and it ranged from 71% to 83% in different subsites, 71% for torso and 83% for other treatment regions.

Those who use the same imaging frequency have been asked to comment on its adequacy, and 16 commented half (50% [8/16]) of these stated that daily imaging is used for both patient groups. And 19% (3/16) of respondents stated the use of an individualised approach. One indicated the use of increased imaging frequency in the reduction of PTV margins from 1 cm to 3 mm.

Those who use different imaging frequencies have been asked in question 3 regarding the frequency used in both adult and paediatric patients in different treatment sites. As an example, in CNS, 55% (11/20) use a daily imaging protocol for adults compared with 68% (13/19) for paediatrics and 30% (6/20) of centres use an extended no action level

Table 1
Answers to Question 1 (Do You Have a Separate Written Protocol for Your IGRT Policy in Paediatrics and Adults?)

Site	Number Replied Yes	Number Replied No	Total Number
Central nervous system	15 (35%)	28 (65%)	43
Head and Neck	14 (34%)	27 (66%)	41
Pelvis	12 (29%)	30 (71%)	42
Torso	14 (33%)	28 (67%)	42
Others	8 (25%)	24 (75%)	32

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