Cancer/Radiothérapie xxx (2017) xxx–xxx

Disponible en ligne sur
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Original article

Prospective medical analysis of radiation therapist image repositioning during image-guided radiotherapy

Analyse médicale prospective du repositionnement des images par les manipulateurs pendant une radiothérapie guidée par l'image

O. Lauche[a,*], F. Castan[b], H. de Forges[c], C. Guillaumon[a], S. Gourgou[b], P. Fenoglietto[a], N. Aillères[a], D. Azria[a], O. Riou[a]

[a] *Department of Radiation Oncology, institut régional du cancer de Montpellier (ICM), 208, avenue des Apothicaires, 34298 Montpellier, France*
[b] *Biometrics Unit, institut régional du cancer de Montpellier (ICM), 208, avenue des Apothicaires, 34298 Montpellier, France*
[c] *Clinical research unit, Institut régional du cancer de Montpellier (ICM), 208, avenue des Apothicaires, 34298 Montpellier, France*

ARTICLE INFO

Article history:
Received 31 March 2017
Received in revised form 16 June 2017
Accepted 17 July 2017

Keywords:
Image-guided radiotherapy
Repositioning
Prostate cancer
Breast cancer

ABSTRACT

Purpose. – Radiation oncologists are responsible for deciding which day-to-day variations are acceptable or not in the treatment setup. However, properly qualified and trained radiation therapists might be capable to perform image registration. We evaluated in our centre the capability and accuracy of radiation therapists to validate positioning images in a prospective study.
Methods and patients. – A total of 84 patients treated for prostate, head and neck, lung or breast cancer was prospectively and randomly included from July 2011 to July 2013 in radiotherapy unit of our institution. For each patient, three positioning images were randomly analysed. Two radiation oncologists analysed all positioning images and shifts decided by the radiation therapists in an independent and blinded way. The radiation oncologists had to decide whether to validate or not this shift and give a corresponding additional shift, if any. A theoretical disagreement rate less than 5% between radiation therapists and radiation oncologists was planned.
Results. – A total of 240 images were analysed (head and neck: 15.0%; prostate: 14.2%; breast: 55.0%; lung: 15.8%). The global disagreement between radiation oncologists and radiation therapists for all the images analysed was 2.5% 95% confidence interval (95% CI) [1.0–5.0], corresponding to six images out of 240. A 100% agreement was reached for prostate and lung images, a 97.2% agreement for head and neck images and a 96.2% agreement for breast images.
Conclusions. – The radiation therapist validation for repositioning images seemed accurate for image-guided radiotherapy in our institution. Periodic evaluation and in-house training are warranted when routine delegation of image registration to radiation therapists is considered.

Mots clés :
Radiothérapie guidée par l'image
Positionnement
Cancer prostate

RÉSUMÉ

Objectif de l'étude. – L'oncologue-radiothérapeute a la responsabilité de décider quelle variation quotidienne est acceptable ou non dans la planification du traitement. Cependant, des manipulateurs en électroradiologie correctement formés pourraient être capables de réaliser ce recalage quotidien. Nous avons évalué dans notre institution la capacité des manipulateurs en électroradiologie à valider les images de positionnement dans une étude prospective.

* Corresponding author.
E-mail address: olivier.lauche@icm.unicancer.fr (O. Lauche).

https://doi.org/10.1016/j.canrad.2017.07.048
1278-3218/

Matériel et méthodes. – Quatre-vingt-quatre patients pris en charge pour des cancers de la prostate, du sein, du poumon et de la tête et du cou ont été inclus dans notre étude prospective et randomisée entre juillet 2011 et juillet 2013. Pour chaque patient, trois images de positionnement ont été tirées au sort. Deux oncologues radiothérapeutes ont analysé les images de positionnement et les décalages réalisés par les manipulateurs en électroradiologie de manière indépendante et en aveugle. Les oncologues radiothérapeutes devaient valider ou non les décalages réalisés par les manipulateurs en électroradiologie. Un désaccord théorique de moins de 5 % entre les manipulateurs en électroradiologie et les oncologues radiothérapeutes a été planifié.
Résultats. – En tout, 240 images ont été analysées (tête et cou : 15 % ; prostate : 14,2% ; sein : 55 % ; poumon : 15,8 %). Le taux de désaccord global entre les onologues radiothérapeutes et les manipulateurs en électroradiologie pour toutes les images analysées était de 2,5 % (intervalle de confiance à 95 % : 1,0–5,0), correspondant à six images sur 240. L'accord était de 100 % pour les images de la prostate et du poumon, 97,2 % pour les images de la tête et du cou et 96,2 % pour les images du sein.
Conclusion. – La validation des images de positionnement par les manipulateurs en électroradiologie semble faisable dans notre institution. Une bonne formation des manipulateurs en électroradiologie est indispensable à la délégation en routine du positionnement des images.

1. Introduction

The recent advances in radiation techniques (3-dimensional conformal radiotherapy, intensity-modulated radiotherapy, stereotactic body radiation therapy) now allow a more precise irradiation. However, with these new techniques, dose gradients are high, and in case of poor patient repositioning in the treatment setup, the risks of excessive irradiation of healthy tissue and insufficient irradiation of target volumes are encountered. To reduce these risks, linear accelerators with on-board imaging systems were developed and image-guided radiotherapy was implemented in many centres. Many image guidance systems have been developed, either bi or tri-dimensional. The system the most commonly used is performing kilovoltage images with the linear accelerators onboard imagers and megavoltage images with the linear accelerator itself. In these cases, control images are compared and matched to their corresponding digitally-reconstructed radiography generated from the computerized tomography used for treatment planning. The isocentre is shifted if there is a misalignment between the digitally-reconstructed radiography and control image. Image-guided radiotherapy has thus been shown to improve outcomes for tumours of many localisations compared to non-image-guided techniques [1–4]. However image-guided radiotherapy with daily control images increases the workload for radiotherapy professionals and especially for radiation oncologists [5,6].

There is no clear international recommendation or consensus concerning which professional should perform daily guidance, but it is recommended that it should be performed under the radiation oncologist supervision. In France, real-time control image must be validated by the radiation oncologist on the first day of treatment [7,8] but there is no legislation regarding the validation of control images during the course of the treatment.

Some retrospective studies suggest that qualified and trained radiation therapists may be capable of performing image guidance [6–9,17].

The present work aimed at validating that hypothesis in a prospective study.

2. Patients and methods

2.1. Study design

The study was monocentric and prospective. Patients included in this study were randomly chosen from the list of patients listed to be treated with radiotherapy for prostate, lung, head and neck or breast cancer in our radiotherapy unit. Between July 2011 and July 2013, two random draws were performed, as to include a total of 80 patients: 40 patients in July 2011 and 43 patients in November 2012. Due to missing images for some patients, 16 supplemental patients were randomly included during a third random draw. For each patient, three images out of all images taken during the course of treatment were randomly chosen for analysis. The study was conducted according to the Helsinki Declaration following the Good Clinical Practices. It was approved by the local board.

2.2. Image control protocol

Radiotherapy for prostate and head and neck cancers was performed using volumetric modulated arc therapy (VMAT) with a Clinac IX (Varian™) equipped with a kilovolt (kV) orthogonal on-board imaging system (OBI™ kV-kV). For these patients, isocentre placement was verified by two daily kilovolt control images (0 and 270°) and one weekly cone beam computed tomography (CT). Radiotherapy for breast and lung cancers was performed using 3DCRT with a Clinac IX or a Clinac 21-EX (Varian™). For patients treated with the Clinac 21EX, isocenter placement was verified by an electronic portal image (megaVolt [mV] images). For these patients, kilovolt or megavolt control images were performed the first three days of treatment and then once a week.

Kilovolt or megavolt control images were compared and matched to their corresponding digitally-reconstructed radiography. Bony landmarks (and breast shapes for breast cancer) of digitally-reconstructed radiography were translated and aligned on the bony landmarks of the kilovolt or MV images. Resulting misalignments were reported along vertical, latero-lateral and antero-posterior directions and then registered on an offline review system (Varian medical system®).

A radiation oncologist performed the first on-line verification of the treatment. This first control image was excluded from the study to minimize the risk of bias. He further verified one control image a week on the offline review system. The radiation therapists performed image guidance for the rest of the sessions. In case of an isocentre shift greater than 0.5 cm, the patient was repositioned and re-imaged for verification. If the shift was still superior to 0.5 cm after the second image, radiation therapists called the radiation oncologist to decide on the shifting of the isocentre or not.

For each patient, three positioning images were randomly analysed out of all kilovolt or megavolt images undertaken during

Please cite this article in press as: Lauche O, et al. Prospective medical analysis of radiation therapist image repositioning during image-guided radiotherapy. Cancer Radiother (2017), https://doi.org/10.1016/j.canrad.2017.07.048