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Original article

Investigation of electron boost radiotherapy in patients with breast cancer: Is a direct electron field optimal?

Enquête sur le boost*par électrons chez les patients atteints de cancer du sein : un faisceau direct est-il optimal ?*

M. Aghili [a], M. Barzegartahamtan [b,*], A. Alikhassi [c], R. Mohammadpour [d]

[a] *Radiation Oncology Research Centre, Tehran University of Medical Sciences, Tehran, Iran*
[b] *Radiation Biology Research Center, Iran University of Medical Sciences, Tehran, Iran*
[c] *Department of Radiology, Imam Hospital, Tehran University of Medical Sciences, Tehran,Iran*
[d] *Department of Biostatistics, Health Sciences Research Centre, Mazandaran University of Medical Sciences, Sari, Iran*

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ABSTRACT

Purpose. – Historically, electron boost dose mainly was delivered by a direct field in adjuvant radiotherapy of breast cancer. In this prospective study, we investigated direct electron field, in terms of optimal coverage of tumour bed volume following localization using ultrasound and surgical clips.
Material and methods. – First, for all 24 patients, a breast sonographer drew perimeter of tumour bed on the breast skin. Then an electron boost field was outlined on the demarcated territory, and a lead wire marker compatible with CT scan was placed on the field borders by a 2 cm margin. After CT scan simulation, all patients underwent adjuvant whole breast irradiation with 3D-conformal radiotherapy to 50 Gy in 25 fractions. Then for boost radiotherapy, lead wire in CT images was countoured as electron boost field. Also, the tumour bed was contoured based on surgical clips (true clinical target volume and true planning target volume). Electron treatment planning was done for electron boost field. Finally isodose coverages for true planning target volume investigated.
Results. – On average, 16.68% of clips planning target volume (true planning target volume; range: 0.00 to 95%) received 90% oor more of the prescribed dose when the electron treatment plan was made. Isodose curves does not provide adequate coverage on the tumour bed (clips planning target volume) when electron boost treatment planning was generated for electron boost field (en face electron field). In fact, a part of target (planning target volume-c) is missed and more doses is absorbed in normal tissue.
Conclusions. – Electron boost treatment planning (an en face electron field) following tumour bed localization using ultrasonography does not provide an optimized coverage of tumour bed volume.

Mots clés :
Cancer du sein
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RÉSUMÉ

Objectif de l'étude. – Historiquement, le *boost* d'électrons a été principalement délivré par un faisceau direct lors de la radiothérapie adjuvante chez les patientes atteintes de cancer du sein. Dans cette étude prospective, nous avons étudié le faisceau d'électrons direct, en termes de couverture optimale du volume du lit de la tumeur après la localisation du lit de la tumeur en utilisant des ultrasons et des clips chirurgicaux.
Méthodes. – En premier lieu, pour les 24 patientes, le périmètre du lit de la tumeur a été dessiné sur la peau du sein d'après une échographie. Ensuite, un faisceau d'électrons a été mis en place sur le territoire délimité, et un fil de plomb compatible avec la tomodensitométrie a été placé sur ses bords avec une

* Corresponding author. Department of Radiation Oncology, Firoozgar Hospital, Iran University of Medical Sciences, Tehran, Iran. Tel: 912-084-3162.
E-mail address: mbtahamtan@gmail.com (M. Barzegartahamtan).

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marge de 2 cm. Après la tomodensitométrie de simulation, toutes les patientes ont reçu une irradiation conformationnelle tridimensionnelle de 50 Gy en 25 fractions. Ensuite, pour le *boost*, le fil de plomb délinéé sur les images tomodensitométriques a été considéré comme *boost* d'électrons. En outre, le lit de la tumeur a été délinéé à partir de clips chirurgicaux (vrais volumes cibles anatomoclinique et prévisionnel). Le traitement a été planifié pour le boost d'électrons, puis les couvertures d'isodose pour le vrai volume cible prévisionnel ont été étudiées.

Résultats. – En moyenne, 16,68 % du vrai volume cible prévisionnel recevait 90 % ou plus de la dose prescrite (plage : 0,00 %–95 %) lorsque le plan de traitement d'électrons a été réalisé. Les courbes d'isodose ne fournissaient pas une couverture adéquate du volume cible prévisionnel avec le faisceau direct d'électrons. En effet, une partie n'était pas irradiée aux dépens des tissus sains.

Conclusion. – La planification du traitement par un faisceau direct d'électrons suite à la localisation d'un lit de tumeur à l'aide d'une échographie ne fournit pas une couverture optimisée du volume de la tumeur.

1. Introduction

Breast cancer is the most common cancer among women globally [1]. It is also the primary cause of death from cancer in women in less developed regions [1]. Randomized trials have established that adjuvant radiotherapy improves local control and survival in patients with breast cancer [2]. There is a linear dose–response relationship in breast cancer [3]. Most cases of local recurrence occurs in the tumour bed. It is logical that higher doses (boost dose) to be given in this area [4].

Several studies have shown the additional boost dose (10 to 20 Gy) would decrease local recurrence by almost half (especially in younger patients) in comparison with standard-treatment group (50 Gy) ($P < 0.001$) [4–8]. On the other hand, several studies also confirmed the impact of local control on survival [9–12]. For these reasons, the ongoing clinical trial are investigating the benefits of higher doses on further reduction of local recurrence (26 Gy) [3,13].

If a boost is indicated, a variety of techniques may be used for target definition including clinical and paraclinical parameters (scar, location of mass based on patient recall or preoperation imaging, radiography, ultrasound, CT scan, and surgical clips), radiation treatment planning (bidimensional radiotherapy, three-dimensional conformal radiotherapy, etc.) and dose delivery (electron, photon, etc.).

Overall, there seems to be no standard technique has been established. But historically, the boost dose mainly was delivered by electron [11,12]. In this study, we investigated direct electron field for boost treatment, in adjuvant radiotherapy of breast cancer patients following tumour bed localization using ultrasound and surgical clips.

2. Material and methods

2.1. Time and place of study

This study as a doctoral thesis at Imam Khomeini Hospital of Tehran was conducted on patients with breast cancer from 2013 to 2014.

2.2. Inclusion criteria

Women suffering from breast cancer and who had breast conserving surgery, at least twenty days interval from the surgery were included. At least, five Titan surgical clips had been placed around the tumour bed by the surgeon (upper, lower, medial, lateral, and floor [posterior]).

2.3. Exclusion criteria

Patients who did not have five clips were excluded, or any patient who decided to come out at any time in the course of the project.

3. Method

Before the CT Scan simulation was made for receiving adjuvant whole breast radiation therapy, all patients had a breast sonography for tumour bed localization. The sonographer drew the perimeter of tumour bed on the breast skin with a marker and also reported depth. After, an electron boost field was outlined with a 2 cm margin perimeter of the demarcated territory on the breast skin as the tumour bed. Then a lead wire marker compatible with CT scan was placed on the borders.

In the next step, the patient was taken under the CT scan simulation in the radiation treatment position on a breast board (CT Scan model: Siemens, SOMATOM Sensation 16). The patient position was supine and her ipsilateral arm was on her head. All CT images were obtained with a cut of 5 mm, from the angle of mandible to 2.5 cm under the breast. Then, the CT scan images were imported in the PCRT3D Activation SOFTWARE treatment planning software named (manufacturer: tecnologo radiacion, version 6).

After importing CT images, treatment planning was performed using two tangential photon field and all patients underwent adjuvant whole breast irradiation with 3D-Conformal radiotherapy to 50 Gy in 25 fractions. Then for boost radiotherapy, radiopaque markers (lead wire on breast skin) in CT images was contoured as electron boost field (borders of an en face electron field).

On the other hand, clips clinical target volume (CTV-c) was contoured by adding 1 cm around the tumour bed (based on surgical clips). The clips planning target volume (PTV-c) was obtained by adding 1 cm around the CTV-c.

Electron treatment planning based on wire contouring, considering the depth obtained by sonography, and for covering this depth by isodose 90%, was done with a direct electron field. Then, isodose coverages for PTV-c (true planning target volume) were investigated and treatment planning data including fieldsize, energy, D100%, D95%, D90%, V95%, V90%, V50%, PTV-c, were recorded.

3.1. Statistical method

The sample volume was determined for 24 patients based on former studies and formula for calculating the sample size. The obtained results were analysed using the software (Spss, Vr20.0) and the hypothesis was tested using t test.

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