COMPARISON OF INTENSITY-MODULATED RADIOTHERAPY (IMRT) AND 3D TANGENTIAL BEAMS TECHNIQUE USED AT PATIENTS WITH BREAST CANCER

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Radiotherapy is one of the most effective treatments for breast cancer. Three-dimensional conformal radiotherapy (3D-CRT) and intensity-modulated radiotherapy (IMRT) are two recently developed radiotherapy techniques. IMRT is believed to be more effective than 3D-CRT in target coverage, dose homogeneity and reducing toxicity to healthy organs. However, these advantages have not been demonstrated in the treatment of breast cancer. This meta-analysis was performed to compare IMRT and 3D-CRT in the treatment of breast cancer in terms of dose-volume histograms and outcomes, including survival and toxicity.

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INTRODUCTION

Radiotherapy nowadays, together with chemotherapy and surgery, is a way to treat the patients who have different kinds of tumors. The radiotherapy aims to give the prescribed dose to the tumor and to protect as much as possible the organs and surrounding healthy tissue at risk. Intensity-modulated radiation therapy (IMRT) is an advanced technique of high-precision radiotherapy that uses a computer-controlled linear accelerator to deliver precise radiation doses to a malignant tumor or specific areas within the tumor.[1] IMRT allows for the radiation dose to conform more precisely to the three-dimensional (3-D) shape of the tumor by modulating or controlling the intensity of the radiation beam in multiple small volumes[2] and high radiation doses to be focused to regions within the tumor while minimizing the dose to surrounding normal critical structures.

The process of radiotherapy starts with scanning of the patients, delineating areas of interest, creating the treatment plans and sending all the data to the machine through a verification system, mosaiq. An essential part of this chain is the plan which is created in the treatment planning system. This system can create 3D CRT and IMRT plans.[3] Even the process of these two techniques is similar, and the design plan differs significantly. Conventional 3D CRT treatment planning is manually optimized. This means that the treatment planner chooses all beams parameters, such as the number of beams, beam directions, shapes, weights, etc., and the computer calculates the resulting dose distribution.[4] In the case of IMRT dose distribution is inversely determined, meaning that the treatment planner has to decide before the dose distribution he wants and the computer then calculates a group of beam intensities that will be produced, as nearly as possible, the desired dose distribution.[5] It is necessary to compare and to know the advantages and disadvantages of these two methods, and so to choose the right method for every single patient.

The purpose of this article is to compare the intensity-modulated radiotherapy (IMRT) with the 3D tangential beams technique in respect of dose distribution in target volume and critical organs they generate in patients with early-stage breast cancer who received breast-conserving therapy.

EXPERIMENTAL

In this study, five patients with breast tumors have been taken into account. The patients are scanned in the CT simulator. They are positioning with the help of immobilization devices such as breast step ELKETA. On the body, three orientated points in the crosses of lasers' room are put. These are some marks (cross). The slices' thickness is 3 mm and then the images are sent to the Monaco TPC. Monaco is the system where the doctors delineate the target volumes and the organs at risk. A treatment planning system that is in use Monte Carlo algorithm, which is a family of two and three-dimensional treatment plans systems.[6] It is composed of several modules; the most important module of patients' data, including patient demographics and anatomic data and the teletherapy planning module.[7]

The treatment planning system can create plans with both techniques three-dimensional conformal radiotherapy and intensity-modulated radiotherapy. The plans with the first technique treatment are done in two phases. In the first phase, the plan is a simple box technique with four beams. Each beam has the energy 6 MV. The beams are conformed with the help of MLC to the treatment planning volume PTV dose distribution.

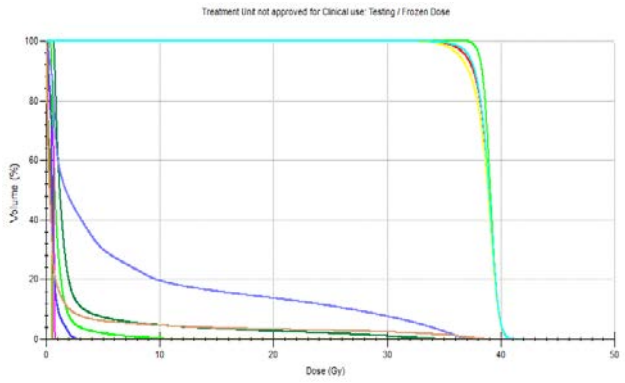

Figure 1. A case of IMRT treatment plan DVH.

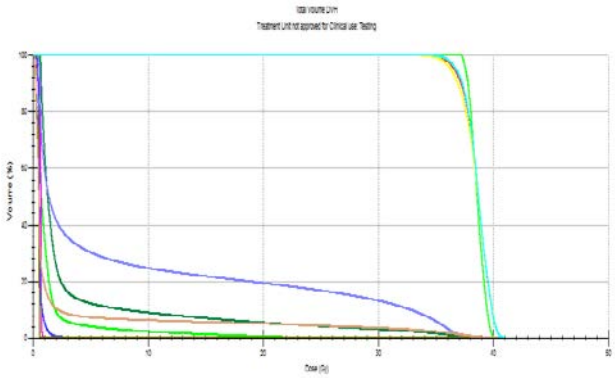

Figure 2. A case of 3D CRT.

The second technique (IMRT) is done with one phase. The number of beams is fixed. There are six beams, with energy 6 MV, in different angles, which are used to create the plan. All the beams are created by more small beams to modulate the intensity in such a way to have the desire. When the plans are finished, they are compared for both methods, first according to the dose-volume histogram and then according to time-consuming for quality control procedures. The checks for the position of the patients, so the giving of the right dose to the right part of the body, for 3D CRT and IMRT are done in the machine according to the set-up beams with the help of IGRT. The time which is needed to treat the patients with the first technique is much shorter than the second technique.

RESULTS AND DISCUSSIONS

These plans were done with both techniques, three-dimensional conformal radiotherapy and intensity-modulated radiotherapy for five patients with breast tumors. Their comparison is done first according to dose-volume histograms and then according to time-consuming for QC checks. For all organs at risk, the comparison is made for the mean doses. It is observed that the average doses, for all patients, are a little lower in the IMRT technique then in 3D (Figures 1 and 2). Table 1 gives a picture of such results. The mean doses are in Gy.

Table 1. Means radiation doses at various organs.

	Mean dose			Heterogeneity index CTV (vol. 95 %)
	Heart	Lung	cont. breast	
IMRT	2.486	6.737	1.092	1.08
3D	3.579	8.146	1.418	1.10

From the obtain histograms (Figures1 and 2), it is seen that the conformity to planning target volume does not differ very much. Anyway, a bit better conformity it is observed with the IMRT technique. Regarding the doses to the organs at risk, it is not a big difference between doses taken by organs at risk in the IMRT and 3D CRT technique. So according to the histograms we can say that the IMRT technique is better for protection of the organs at risk and irradiating with the best coverage the treatment planning volume, because in the 3D CRT due to the dose limits for the organs at risk it should be irradiate first the planning target volume as the doctors delineate and then a smaller planning target volume. So in the IMRT technique, it is irradiated the appropriate planning target volume with the maximum protection of the organs at risk and not only a part of it.

CONCLUSIONS

The work done in this investigation stresses the advantages and disadvantages of two treatment methods for breast tumors. To choose between two techniques, it is necessary to see the patients' characteristics case by case. It is important to determine the total dose, which has to be given to the planning target volume. It is preferable to use the 3D CRT technique while planning treatment with a volume of dose within the safe limits for the organs at risk because it is less time consuming for QC and more comfortable for the patient which in this case has to spend less time in the machine during the treatment. For the cases where the doses which have to be given for the procedure will not be significant, say around 40 Gy, it will be preferable to use the IMRT technique for keeping the doses within the permitted level for the organs at risk.

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