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The “one-isocenter-quarter-beam” technique as a radiotherapy of breast cancer patients

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	<p>Summary</p>
<p>Aim</p>	<p>To describe the “one-isocentre-quarter-beam” technique, used in the Department of Radiotherapy, Maria Skłodowska-Curie Memorial Cancer Center, and in the Institute of Oncology, Gliwice Branch.</p>
<p>Materials/Methods</p>	<p>Sixty eight patients were treated using the “one-isocentre-quarter-beam” technique in our department. On the basis of this experience, we show the methods for treatment planning and irradiation and the methodology for marking the isocentre and fields. The workloads and times necessary for treatment planning and everyday irradiation were described along with the methodology for the collimation of the side of the lung and for the best alignment of tangential breast and supraclavicular fields. Other methods for irradiation were also compared and described.</p>
<p>Results</p>	<p>This technique, with some modifications, is useful in several clinical situations, such as postoperative irradiation of patients after radical mastectomy or breast conserving therapy.</p>
<p>Conclusions</p>	<p>The application of the described technique, together with the use of the IMRT technique, promises new possibilities.</p> <p>The “one-isocentre-quarter-beam” technique permits the avoidance of hot spots. Planning is more time-consuming though an overall time benefit is seen during everyday irradiation. Reproducibility of positioning is simple and precise.</p>
<p>Key words</p>	<p>breast cancer • irradiation • new technique</p>
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BACKGROUND

In the 1970's and 1980's there was general agreement that adjuvant radiotherapy in breast cancer patients allowed for improvements in the loco-regional control of the disease, especially in patients in more advanced stages, but that it did not improve overall survival. In consequence, the development of radiation techniques used in breast cancer was slower than in cancers of other origins. Also, in the 1970's, breast conserving therapy was introduced. The method comprised breast conserving surgery and postoperative irradiation of the remaining breast tissue. In the two decades following, the method became a widely accepted treatment modality for patients in the early stages of breast cancer.

In 1997, two articles were published in the "New England Journal of Medicine", which were considered milestones in the development of modern radiotherapy in breast cancer. The authors of these studies revealed that postoperative radiotherapy not only improves locoregional control but also improves overall survival. This observation, together with the development of new radiotherapy devices, led to a new wave of interest in the use of radiotherapy in breast cancer [1,2].

There are two main groups of breast cancer patients who undergo postoperative radiotherapy: women with advanced breast cancer - after radical mastectomy, and women with early breast cancer - after breast conserving therapy (BCT). In both groups of patients the following separate and independent volumes are irradiated, CTV1 (Clinical Target Volume 1) - comprising the axillary, supraclavicular and infraclavicular lymph node areas (irradiated more frequently in women who underwent mastectomy than in women who underwent BCT) and CTV2 - the chest wall or breast (in patients after mastectomy and BCT). In CTV2, the tumour bed could be especially defined as CTV2b.

Most studies have been concerned with radiotherapy in BCT patients [3,4]. The authors of studies into the technical aspects of radiotherapy after mastectomy focused on the inhomogeneity of dosing in clinical target volumes [5]. An analysis of the results of these studies led to the conclusion that in the majority of patients, the best results were to be achieved when CTV1 is irradiated using two field (AP and PA) techniques. The AP field is composed of the whole nodal area while the PA field is composed of the

armpit area [6]. To ensure the homogeneity of radiation doses, in patients irradiated after mastectomy, new modalities including IMRT were introduced [7].

AIM

To describe the "one-isocentre-quarter-beam" technique, used in the Department of Radiotherapy, Maria Skłodowska-Curie Memorial Cancer Centre, and in the Institute of Oncology, Gliwice Branch.

MATERIALS AND METHODS

In 2004, sixty eight patients were treated using the "one-isocentre-quarter-beam" technique in our department. The method was considered as an alternative to traditional techniques. In all cases, 3D planning, CT, X-ray simulation, and immobilization by means of an Orfit mask, were used.

Methodology

Marking of the isocentre was the first step of planning. During this procedure we preliminarily outlined the parameters of the fields to be irradiated, especially the angles of tangential fields. The following steps were followed:

With patients lying in the therapeutic position on the X-ray simulator table, the upper and lower borders of the areas to be treated were marked. The upper border of the treatment area was positioned at the upper border of the supraclavicular field and the lower border of the treatment area was positioned one centimeter below the submammary fold.

The axis of the beam and the isocentre were marked, using X-ray simulation, at the second anterior intercostal space. The horizontal line crossing this point formed the border between the supraclavicular and tangential fields. A length of 0 cm for side Y_1 was introduced in order to achieve an asymmetric field (longitudinal axis), covering the area of the tangential fields only. The target point - the isocentre point - is therefore located on the upper cranial border of the field. During imaging of the tangential external fields, the external lower quarter of the field served as a guide (dimension X_1). After matching suitable gantry angles, the gantry was returned to the 0° position in order to establish the SSD (source skin distance) =95-97 cm (SSD depends on the isocentre point position, the choice of which de-



Figure 1. The patient immobilized with orfit mask; The fields and the isocentre are marked (lateral view).



Figure 2. The patient immobilized with orfit mask; The fields and the isocentre are marked (cranial side view).

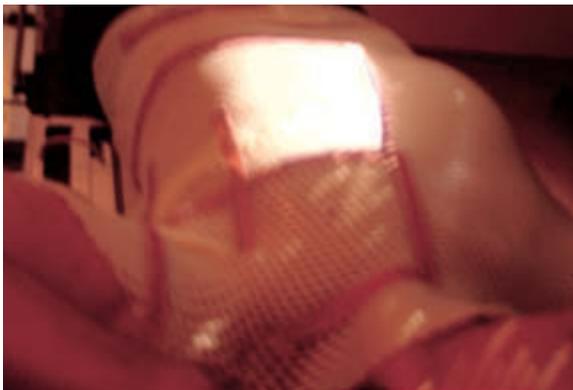


Figure 3. The same patient immobilized with orfit mask; The internal tangential fields is simulated.

depends on the thickness of the chest wall and/or irradiated breast). The isocentre was marked (Figures 1–3).

After the end of simulation of tangential fields, dimension Y was changed (Y2 should be equal to 0 cm). Then supraclavicular field was outlined.

CT scans were performed with a density of 8 mm. Then, CTVs and risk organs were outlined. After that step, treatment planning is conducted, on the basis of the parameters defined during the preliminary simulation. PTV was defined as a CTV plus an External Margin. The volumes of PTVs ranged from 246,8 to 486,5, and the mean value was 311,3 cm³.

In our group of patients, the preliminary parameters (isocentre, fields sizes, gantry positions) remained unchanged, after CT scans and subsequent treatment planning procedures, in over 90% of cases. The described method allowed us to reduce the time required for planning. All the patients were irradiated using high energy 6 and 20 MV photons generated by an “Clinac 600” or “Clinac 2300”. The choice of energy depended on the PTV volume. In most cases only photons of 6 MV energy were used. In a few cases (primarily patients after BCT) because of the large volume of irradiated tissue, mixed beams (6 and 20 MV photons) were used to improve dose distribution. Weights of 20 MV to 6 MV photon beams were less than 0,3 to 0,7. 20 MV photon beams were often used to irradiate the axillary area from the back (PA field). In all cases, a multileaf collimator was used. For patients after mastectomy, doses of 50 Gy in 25 fractions, over 5 weeks, were delivered to nodal areas while doses of 50–60 Gy in 25–30 fractions, over 5–6 weeks, were delivered to the chest wall area. For patients after BTC, the radiation dose delivered to nodal areas was the same as for patients after mastectomy. The dose for the breast was 50 Gy delivered in 25 fractions, over 5 weeks; additionally, a boost to the tumour bed was delivered using electron beams: 10 Gy in 5 fractions, over 1 week. In many cases, the boost was delivered intraoperatively or using brachytherapy.

In all patients radically irradiated in our Department, *in vivo* dosimetry was used. The accepted differences between planned and measured dose data were less than 3% for open fields and less than 5% for wedged fields.

Portal images (PI) were made in all patients when a new course of treatment was begun and in any case where miscalculation was thought likely. We accepted differences between simulator and PIs of 5 mm. Mean differences were 2,96 mm (axis OX) and 3,02 (axis OY). When differences were not acceptable, patient and field positions were checked on the simulator. Differences greater than 5 mm were observed in less than 4.8% of cases.

Table 1. Measured times at ten random choice cases both methods.

No of following measures	Time of planning (min.)		Time of one therapeutic session (min.)	
	Classic technique	One isocentre technique	Classic technique	One isocentre technique
1	59	76	15	7
2	60	71	16	9
3	59	78	20	8
4	62	75	15	8
5	58	69	18	8
6	63	74	17	7
7	55	78	15	10
8	61	75	19	9
9	58	74	18	10
10	62	77	15	7
Mean	59.7	74.7	16.8	8.3

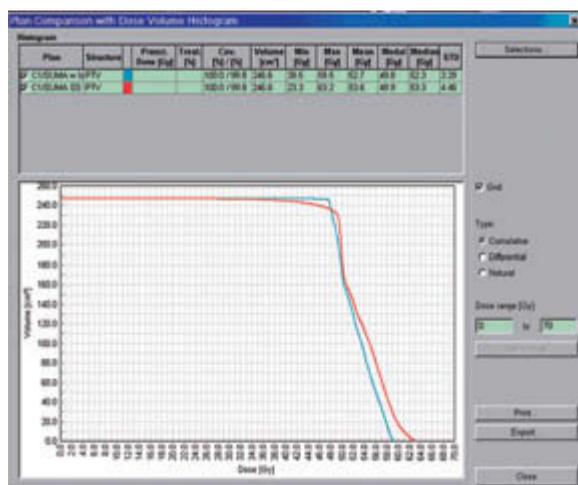


Figure 4. Examples of DVH (dose volume histogrames) for both methods at the same patient.

The work load and time necessary for treatment planning and every day irradiation was calculated. The expenditure of work and time for planning in the “one-isocentre-quarter-beam” technique was greater than in the planning of standard techniques. However, everyday therapeutic sessions were less time-consuming and labour intensive. Measured times in ten randomly selected cases, using both methods and performed by the same radiation oncologist and radiotherapist, are shown in Table 1. The mean time for treatment planning using the standard method was 59,7 minutes while for the newly described method it was 74,7 minutes. The mean duration

of daily therapeutic sessions using the standard method was 16,8 minutes and using the newly described method it was 8,3 minutes.

Examples of DVH (dose volume histograms) are shown in Figure 4.

RESULTS

This technique, with some modifications, was useful in several clinical situations, such as in post-operative irradiation patients after radical mastectomy, breast conserving therapy, and for the irradiation of inoperable patients treated radically. Sometimes it was also useful in palliative treatment. The use of described technique together with IMRT increased radiotherapy possibilities.

DISCUSSION

Postoperative irradiation delivered to the chest-wall is usually performed with the use of two tangential fields or a single anterior electron field of energy dependent on the chest wall thickness, measured during CT scan, by X-ray simulator or by use of ultrasonography [8]. Tangential fields could be used as asymmetric ones. In this way the collimation on the lung side is greatly improved (Figures 5,6). The dose distribution is optimal when the borders of the fields on this side are positioned at the axes of these fields (x_1 for one tangential field and x_2 for the other are both 0). Such fields are sometimes known as “half-beam”.

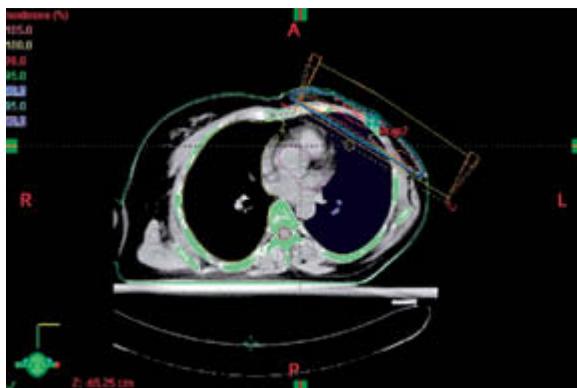


Figure 5. The collimation on lung's side, using "half-beam" fields.

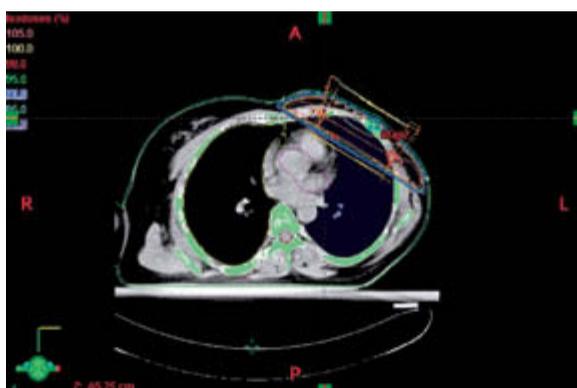


Figure 6. The collimation on lung's side, using standard fields.

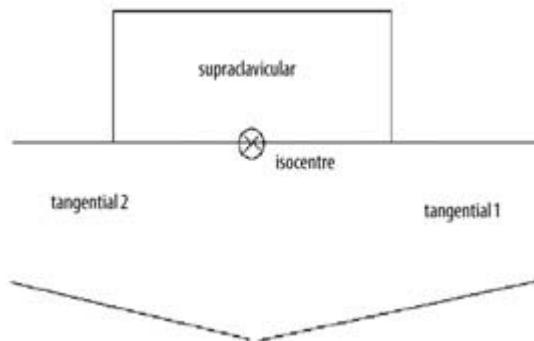


Figure 7. The alignment of tangential breast and supraclavicular fields using one isocentre.

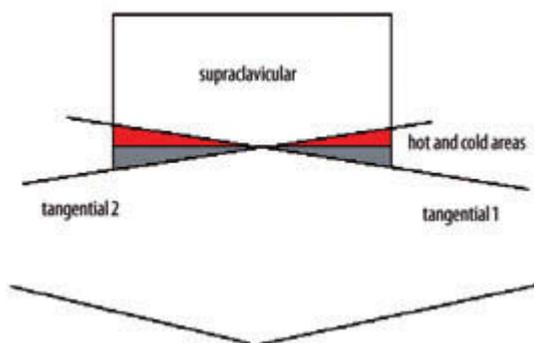


Figure 8. The alignment of tangential breast and supraclavicular fields using standard technique.

The best alignment for tangential breast and supraclavicular fields is achieved by use of a single isocentre and asymmetric fields [8,9]. As a result, the elimination of cold and hot spots at border regions between the tangential and supraclavicular fields is also achieved (Figures 7,8).

Both of the above advantages may be achieved by the use of the technique we propose. The sizes x and y for one side (tangential fields) are 0, so our fields could be called quarter-beam.

Realization of everyday irradiation is the next issue. Use of different isocentres for tangential and supraclavicular fields, especially using SSD positioning, implies the necessity of placing each patient in several different positions. The one-isocentre quarter-beams technique makes it possible to position the patient only once.

It is necessary to use an Orfit mask with patients. The mask not only immobilizes patients, but also serves as a kind of bolus. It is also possible to join an additional bolus to the mask, though by use of

cobalt beams or 4–6 MV photon beams, the use of the mask alone is sufficient for most patients.

A similar technique also exists, known as the mono isocentric irradiation technique, its use has been described in breast cancer patients after BCT [4]. Experiences at the Maria Skłodowska-Curie Memorial Cancer Centre, and at the Institute of Oncology, Warsaw Branch have led to very good results. There is a time benefit during everyday irradiation and there are no local recurrences or complications associated with radiation therapy. Although those observations are not the aim of our study and though only eighteen cases were described by authors from Warsaw, we can agree with their results. Asymmetric collimation in breast cancer irradiation has also been proposed for more than twenty years by other authors [10,11].

CONCLUSIONS

The "one-isocentre-quarter-beam" technique allows the avoidance of hot spots. Treatment plan-

ning is more time-consuming than in existing techniques though this is outweighed by time benefits during everyday irradiation. Reproducibility of positioning is precise and simple.

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