Volume 14, No 3 | International Journal of Radiation Research, July 2016

Evaluation of regional nodes irradiation during breast cancer radiotherapy

M.H. Larizadeh[1*], A. Neamati[2], V. Moazed[2], F. Bahremand[3]

[1]*Radiation Oncology Department, Research Center for Health Services Management, Kerman, Iran*
[2]*Hematology-Oncology, Bahonar Hospital, Kerman, Iran*
[3]*Department of Medical Physics, Shafa Hospital, Kerman, Iran*

▶ ***Technical note***

***Corresponding author:**
Dr. Mohammad Hasan Larizadeh,
***Fax:** +98 343 2115803*
***E-mail:** larizad_mh@yahoo.com*

Revised: July 2015
Accepted: Aug. 2015

Int. J. Radiat. Res., July 2016; 14(3): 257-261

DOI: 10.18869/acadpub.ijrr.14.3.257

ABSTRACT

Background: The purpose of this study was to evaluate nodal irradiation with conventional three-field's technique. ***Materials and Methods:*** Fifty patients with breast cancer were enrolled in this study. Computed tomography scans in the supine treatment position were imported into a treatment planning system. Levels I-III axillary and supraclavicular nodes were identified and their depths to the anterior skin surface were measured. Two tangential fields and one anterior- posterior supraclavicular field were developed to treat all of the patients. Dose –volum histogram was evaluated for quality measurement. ***Results:*** The mean depths of the level I, II and III axillary and supraclavicular nodes varied widely (4.6, 5.7, 6.1 and 5.9 cm, respectively). Complete coverage of level II was not achieved by tangential fields. In some patients the optimal dose was not prescribed. The median dose administered to level I, II and III was 42.6 Gy (10 to 53 Gy), 41.9 Gy (8.3 to 54 Gy) and 41.3 Gy (5 to 52 Gy), respectively. The median dose to supraclavicular nodes was 46.9 Gy (from 38 to 51 Gy).The mean regional nodal volumes included in the 95% isodose were 47, 48, 45.7, and 65.1 percent for level I-III and supraclavicular, respectively. ***Conclusion:*** As the depth of regional nodes varies widely, thus using a fixed calculation depth for dose prescription is not optimal. Careful depth measurement for each patient is necessary. Moreover, the use of conventional three- field technique is not optimal for all patients. At least in some patients, adding posterior axillary boost field is necessary, to optimize axillary coverage.

Keywords: *Axillary nodes, breast cancer, radiotherapy, supraclavicular nodes, tangential fields.*

INTRODUCTION

It has been shown that regional nodal irradiation has a significant role in breast cancer outcome. Post mastectomy radiotherapy has improved about 10% in 10-year overall survival. Adjuvant radiotherapy is necessary after conservative surgery to reduce loco regional recurrence [1, 2, 3]. Although the current standard for patients with a positive sentinel node is to undergo axillary dissection, the necessity of this has been remained controversial. During conservative surgery, regional radiotherapy can be considered in sentinel node positive patients instead of nodal dissection [4-9]. As the extent of axillary surgery decreases, the radiation dose and quality within the axilla becomes increasingly important [10]. An important factor affecting radiation quality is the radiation technique [7]. Different techniques have been used so far, varying from 2 to 3 field techniques, with or without posterior boost field [2]. It has been shown that the maximum depth of the regional nodes varies widely and is related to the anterior-posterior interfaces of the patient, patient positioning, delineation method of lymphatic areas, and inter-observer variability [11-14]. Careful target delineation and correct depth measurement have a significant role in technique selection and quality assessment [7, 13]. In one study the depth of the axillary nodes ranged from 1.4 cm to 8cm and the depths of supraclavicular nodes ranged from 2.4 cm to 9.5 cm [11]. In another study the mean and median depth for the supraclavicular nodes were 3.9 cm and 3.7 cm (from 2.1 to 7 cm). The mean and median level III node depths were 3.6 cm and 3.2 cm (from 1.9 to 7.4 cm). The mean and median level II node depths were 5.2 cm and 5.1 cm (from 2.5 to 11.6 cm). The mean and median level I node depths were 4.6 cm and 4.9 cm (from 1to 12 cm) [14]. A few studies have been conducted to investigate regional nodal coverage in tangential fields and quality of nodal irradiation in breast cancer patients [15]. The purpose of this study was to assess the quality of so called three-portal technique in treatment of regional nodes. An attempt also was made to measure the median depth of nodal regions. In addition, the relationship between tangential fields and axillary nodes was studied.

MATERIALS AND METHODS

Fifty patients with breast cancer undergoing conservative surgery (20 patients) or modified radical mastectomy (30 patients) were enrolled in this study. The mean age of the patients was 48 year (28 to 72 year). Tumor location was in left breast in 24 patients (48%) and in right breast in 26 patients (52%). 38 patients have T1 or T2 lesions (76%) and 12 patients have T3 or T4 lesions (24%). Nodal involvement was seen in 35 patients (70%). Excluding criteria included no need for comprehensive nodal treatment, necessity of internal mammary radiation, using a technique deferred from study protocol, inability to treat the patient in designed position and the presence of anatomical anomaly. 3-dimentional Computed tomography scans with 5 mm slices in the supine treatment position, with the arm abducted 90 degrees or greater (in a manner the patient be relaxed in CT gantry aperture) were performed. These scans were imported into a treatment planning system (TPS) (Isogray, version: 4.1.3.182). Collapsed cone algorithm was used for dose calculation two-tangential fields with one isolated anterior-posterior supraclavicular field were designed for all of the patients. Treated volumes (levels I, II and III axillary and supraclavicular nodes, breast or chest wall) were delineated according to Radiation Therapy Oncology Group (RTOG) guideline [16]. Single isocenter and half beam technique was used to align tangential fields with supraclavicular field. The upper margin of tangential field was placed at the head of clavicle and the medial margin was placed at midline. The lateral margin was defined in mid axillary line and inferior margin was drawn 2 to 3 cm below the ipsilateral or contralatral inframammary fold. The inferior border of the supraclavicular field was matched to the tangential field. The medial border was in medial border of sternocleidomastoid muscle and superior border was at the level of thyrocricoid groove and the lateral border was medial to humeral head (figures 1 and 2). Photon beam with 6 MV energy was used and 50 Gy with 2Gy daily dose during 5 weeks was prescribed (25 fractions). The tumor dose was specified so that the entire target volume should be included within the 95% isodose line. In the patients with conservative surgery a boost dose of 20 Gy was

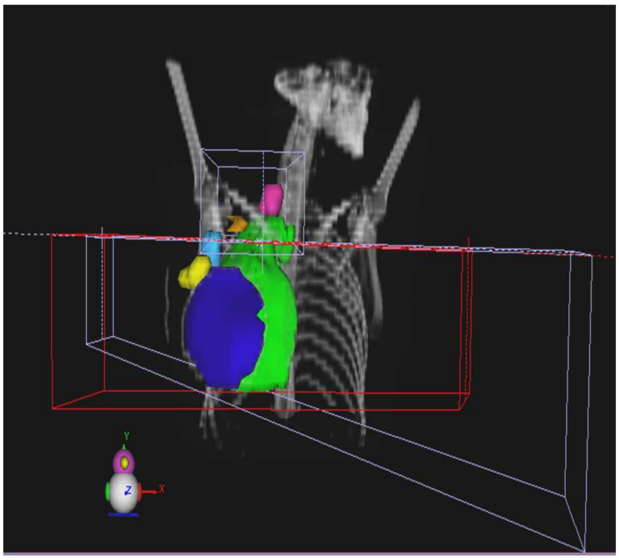

Figure 1. 3- Field design for intact breast irradiation. Regional nodes were delineated (Thin yellow: level I, Thin blue: level II, Yellow: level III, Red: supraclavicular).

given with electron beam. The maximum depth of each nodal region was measured from anterior skin surface. For this purpose the slices with the deepest located node were chosen. The body diameter was measured at these slices. The midplan was defined at middle depth of anterior -posterior separation of the patients. The cumulative dose volume histogram was used to evaluate the plan. SPSS software, version 13, was used for statistical purpose.

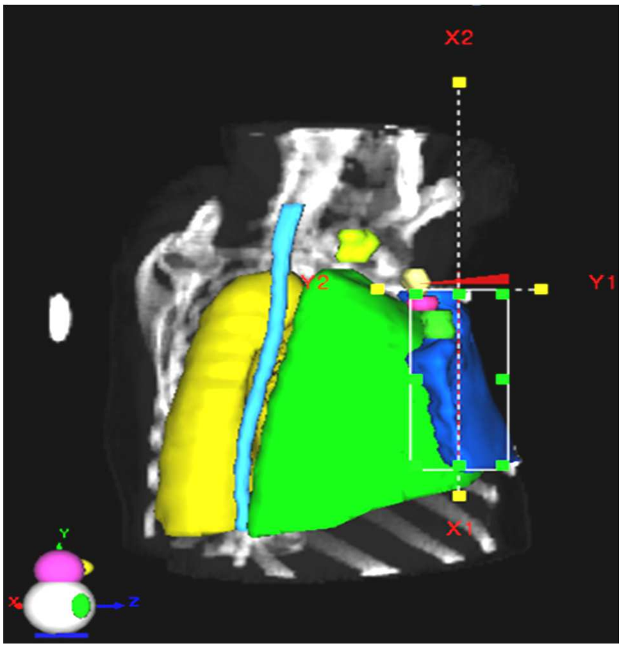

Figure 2. Beam eye view of lateral tangential field. Level I (green) and II (red) were included in this field completely.

RESULTS

The mean values for the maximum depth of various nodal levels were shown in table 1. As it was seen, the deepest part of various nodal regions varied widely (From 2 to 9.6 cm). To estimate the relation between the midplane of the patients and nodal location, the mean anterior-posterior separation at various nodal regions was measured (table 1). The mean values for midplain were 10.5, 7.4, 7.8 and 6.7 cm in level I, II, III and supraclavicular region, respectively. These measurements showed that nodal levels were located anterior to midline. Level I was completely included in tangential fields in 100 % of cases, where in 50 % (25 patients) of cases the volume of level II was entirely included in tangential fields. The median nodal doses and the mean nodal volume received 95% of prescribed dose have been shown in table 2. As it was seen that the median received dose was fewer than 95% prescribed dose (fewer than 47.5 Gy).

DISCUSSION

In this study the depth of supraclavicular nodes ranged from 2.5 cm to 7 cm and the depth of the axillary nodes ranged from 2 cm to 9. 6

Table 1. Mean value of the maximum depth and patients diameters in various nodal levels.

Lymphatic region	Mean value of the maximum depth (range,SD*)	Mean value of patients diameters (range,SD*)
Level I	4.6cm(2-8,±2)	21cm(10-11,±5)
Level II	5.7cm(3.2-9.1,±1.7)	14.8 cm(11-21,±3)
Level III	6.1cm(3-9.6,±1.5)	15.7 cm(13-20,±2)
Supraclavicular	5.9cm(2.5-7,±6)	13.4 cm(10-20,±5)

*: Standard deviation

Table 2. The median nodal doses and the mean nodal volume received 95% prescribed dose.

Lymphatic region	The median dose (range,SD*)	Mean Volume in 95% isodose (%)
Level I	42.6 Gy(10-53,±10.7)	47(5-100)
Level II	41.9 Gy(8.3-4,±10.3)	48(1-100)
Level III	41.3 Gy(5-52,±10.9)	45.7(2-100)
Supraclavicular	46.9 Gy(38-51,±2.8)	65.1(19.7-95.6)

*: Standard deviation

[DOI: 10.18869/acadpub.ijrr.14.3.257]

cm. It is consistent with results of the other studies that showed wide variety in depth of regional nodes [11, 14]. According to these findings a fixed depth (for example 3cm depth or midplain depth) should not be used for dose specification. Only a few studies have been conducted to evaluate the axillary nodal coverage in tangential fields. In one study adequate coverage of level I and II in tangential fields was seen in 29% of the patients [17]. In another study only 23.4% of the patients had adequate axillary coverage with tangential fields [18]. Goodman et.al concluded that axillary nodes were adequately covered in tangential fields. In this study level I nodes were present in all patients within the tangential fields [14]. Aristel *et al.* concluded that standard tangential fields do not adequately cover levels I and II axillary nodes [15]. They showed that complete coverage of level I and II in the tangential fields were fewer than 67% and 55%, respectively. One contributing factor for this variability is cephalic position of field and arm position is another factor [12, 13]. In our study arm was adducted more than 90 degrees in some patients due to small CT gantry aperture. For better coverage of axillary region, modified tangential techniques have been studied. For example, superior border of tangential field has been moved toward cranial direction to include all of axillary nodes in tangential fields [12]. We showed that complete coverage of level I and II is achievable with standard tangential fields. In 50% of cases, level II was not entirely included in tangential fields. So, using modified tangential fields may be necessary to optimize axillary coverage in some patients. Lymphatic mapping and sentinel node biopsy is recently established to determine the node status. The question arises whether radiotherapy can safely serve as an alternative to surgical dissection in the sentinel node positive patients. As the extent of axillary surgery decreases, the radiation dose and quality within the axilla becomes increasingly important [10]. Acceptable radiotherapy doses and techniques provide a very low incidence of axillary failure. However a low dose of radiotherapy (less than 44-45 Gy) apparently increases the risk of failure [19, 20]. Posterior axillary boost field has been used widely to bring axillary dose to optimal value [2]. Our evaluation showed that nodal levels were located anterior to midline. The same result was seen in other studies [11, 14]. Therefore some authors suggested that the so–called posterior axillary boost field might not be necessary in all patients [11]. According to this hypothesis we designed our study without using posterior axillary field. The median doses administered to regional nodes were more than 40 Gy (more than 80% of prescribed dose). But the ranges of these median doses were wide (from 5 to 54 GY). In a study conducted by Aristei *et al.*, they showed that with the standard tangential fields the mean dose delivered to level I, II, III was 66%, 44%, 31% of the prescribed dose, respectively. The coverage increased when the modified tangential fields were used [15]. In our study the mean regional nodal volumes included in the 95% isodose ranged from 45.7% to 65.1% for various nodal regions. This result is in agreement with the results of other series that demonstrated that the range of nodal volume within the standard tangential fields is wide. For example in one study, the mean axillary nodal volume included in the 95% isodose was 55% (range, 23-87%) [15]. In conclusion, there is considerable variation in the depth of regional nodes in patients with breast cancer. Careful delineation of regional nodes on CT scan is necessary. Although using three standard fields may achieve adequate nodal coverage in most patients, however this technique is not appropriate for all patients and adding a posterior axillary field or modifying the tangential fields may be necessary to optimize the administered dose.

ACKNOWLEDGMENT

The authors acknowledged Jamileh Mahdavy for proof reading of this manuscript.

Conflict of interest: *Declared None*

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[DOI: 10.18869/acadpub.ijrr.14.3.257]