International Journal of Research in Medical Sciences
Kunheri B et al. Int J Res Med Sci. 2017 Feb;5(2):469-472
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20170134

Original Research Article

Brachial plexopathy in breast cancer: is it radiation related? An analysis technique and dose volume parameters to brachial plexus in breast cancer radiotherapy

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Received: 29 December 2016
Accepted: 17 January 2017

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ABSTRACT

Background: Brachial plexus dysfunction is a rare but well-recognized complication of breast cancer surgery and radiotherapy. Most of the time it presents as paraesthesia of the arm. In an earlier publication Dan Lundstedt et al from Sweden, quantitatively assessed the radiation related brachial plexopathy (mainly paraesthesia) with the help of dose volume histograms and its co relation between patient reported paraesthesia. Paraesthesia was reported by 25% after radiation therapy to the supraclavicular fossa, with a V40 Gy 13.5 cm^3 and maximum dose to brachial plexus (Dmax) was not found to correlate with paraesthesia. In order to predict the risk brachial plexopathy in our patients we decided to analyze the dose volume parameters for brachial plexus in carcinoma breast patients treated at our institution with modern radiotherapy techniques.
Methods: Twenty five consecutive patients who received post mastectomy radiation during the period September 2015 to January 2016 with a dose of 50Gy in 25 fractions were included for this analysis. Brachial plexus contoured using RTOG guidelines, and dose volume parameters for brachial plexus were documented from the existing treatment plans.
Results: The maximum dose to the brachial plexus ranged from 5045cGy to 5679cGy with a mean value of 5312.8cGy. The mean dose received by the brachial plexus ranged from 3093cGy to 4714cGy and the mean value was 4137.28cGy. Volume receiving 40Gy, that is V40, ranged from 2.0078cc to 11.56cc with a mean value of 7.57cc.
Conclusions: Maximum dose and V40 Gy values were well below the tolerance limit of plexus, and hence post mastectomy irradiation with modern techniques is unlikely to produce significant brachial plexus neuropathy.

Keywords: Brachial plexus, Breast cancer, Paraesthesia, Radiotherapy

INTRODUCTION

Brachial plexus dysfunction is a rare but well-recognized disabling complication of cancer that are caused by trauma to the plexus during surgery or anesthesia, metastatic spread of tumor, radiation injury , or radiation-induced plexus tumors.[1-7] Tumour related brachial plexus symptoms are common with superior sulcus tumours and tumors producing large supraclavicular or axillary nodal metastasis. Breast cancer being the most common cancer among females, treatment or disease related paraesthesia is a frequent complaint among breast cancer patients. Radiation-induced brachial plexopathy (RIBP) is a delayed complication of radiation treatment for tumors involving the neck and chest area. Irradiation to the brachial plexus leads to progressive fibrosis, nerve entrapment, ischemic demyelination, and conduction block. Although the incidence of brachial plexopathy is

relatively low with modern conformal planning and standard fractionation schemas (46-50 Gy in 1.8-2-Gy fractions), studies evaluating older techniques have shown that the doses to the brachial plexus can be as high as 130% of the prescribed dose, therefore significantly increasing the risk of brachial plexus injury.[7] To minimize the risk of radiation induced brachial plexopathy, it is important to reduce significant hotspots in the supraclavicular field, avoid usage of large dose per fraction, and place the match line for the supraclavicular, chest wall fields below the level of the brachial plexus whenever possible.[7]

In an earlier publication Lundstedt D et al from Sweden, quantitatively assessed the radiation related brachial plexopathy (mainly paraesthesia) with the help of dose volume histograms and its co relation between patient reported paraesthesia. After treatment with axillary dissection followed by radiation therapy to the supraclavicular region, 20% of the women reported paraesthesia, compared to 13% of those with axillary dissection without radiation therapy, resulting in a relative risk (RR) of 1.47 (95% confidence interval [CI] 1.02-2.11). Paraesthesia was reported by 25% after radiation therapy to the SCLNs with a V40 Gy 13.5 cm^3 and maximum dose to brachial plexus (Dmax) was not found to correlate with paraesthesia.[8] With this background we decided to analyze the dose volume parameters for brachial plexus in carcinoma breast patients treated at our institution with modern radiotherapy techniques.

METHODS

Twenty five Consecutive patients with breast cancer who underwent post mastectomy radiation treatment during the period September 2015 to January 2016 with a dose of 50Gy in 25 fractions were included for this analysis.

All patients underwent CT simulation for a 3D-CRT based radiation treatment planning. Patients were simulated in breast board in supine position with ipsilateral arm abducted and externally rotated. RTOG contouring guidelines for post mastectomy were followed for target contouring. Brachial plexus contouring was not routinely done for breast planning. Brachial plexus were contoured in the existing CT plan study sets. Plexus contouring was done according to RTOG guidelines.[9]

To contour the brachial plexus a 5-mm-diameter paint tool was used. The contouring started at the neural foramina from C5 to T1, and the delineation extended from the lateral border of the spinal canal to the space between the anterior and middle scalene muscles. If the neural foramen was lacking on the CT slice, the space between the anterior and middle scalene muscles was delineated. Further contouring went between the first rib and the clavicle, behind the minor pectoral muscle (following the subclavian artery when possible), below the coracoid process, and in front of the subscapularis muscle. Treatment planning was done in Xio planning system. Treatment fields delivered were antero-posterior supraclavicular fossa (AP SCF), postero-anterior (PA) axillary 6 MV photons, and chest wall electron with a dose prescription of 50 Gy in 25 fractions. Dose contribution was 40-42Gy from APSCF and the remaining from PA axilla field. Chest wall was treated using electrons of appropriate energy. Using Dose Volume Histograms (DVH) brachial plexus contoured volume, dose minimum, maximum, mean and V40 were analyzed.

RESULTS

Twenty five consecutive patients' treatment plans were retrieved and brachial plexus dose volume parameters were obtained. Individual patients dose volume details were as shown in Table 1.

Table 1: Dose volume data for brachial plexus.

Max. dose (cGy)	Mean dose (cGy)	V40	Plan global Max.
5428	4444	2.0078	5618
5628	4533	11.59	5761.5
5171	3923	10.88	5496.5
5314	3903	5.82	5676.5
5228	3772	5.4	5567.5
5116	3543	7.29	5515
5045	3093	4.64	5513
5606	4251	6.39	5943
5211	4411	8.31	5710.5
5301	3950	6.3	5506
5250	3207	6.24	5542.5
5287	4125	7.35	5533
5317	4386	8.7	5542
5135	4044	7.9	5494.5
5679	4442	7.87	5990.5
5128	4333	9.54	5683
5556	4067	7.84	5916.5
5405	4714	8.62	5642.5
5135	4448	9.84	5669
5453	4460	8.5	5868.5
5400	3996	8.51	5647.5
5390	4183	7.85	5504.5
5154	4456	8.54	5519
5129	4349	6.46	5564.5
5354	4399	7.15	5986.5

Total volume of brachial plexus, ranged from 7.67cc to 15.29cc and the mean volume was 10.4676cc. The minimum dose received by the brachial plexus ranges from 3cGy to 1634cCy and the mean value of the minimum dose is 349.56cGy. The maximum dose to the brachial plexus ranged from 5045cGy to 5679cGy with a mean value of 5312.8cGy. The mean dose received by the brachial plexus ranged from 3093cGy to 4714cGy and the mean value was 4137.28cGy. Volume receiving

40Gy, that is V40, ranged from 2.0078cc to 11.56cc with a mean value of 7.57cc.

DISCUSSION

We analysed the brachial plexus dosimetric details of twenty five patients who underwent post mastectomy irradiation with a dose of 50 Gy in 25 fractions during the period September 2015 to January 2016.

Brachial plexopathy is a potential late toxicity associated with radiation therapy for breast cancer. The pathogenesis of radiation induced brachial plexopathy is uncertain but believed to be secondary to the development of fibrosis and the entrapment of nerve fibers.[2,3] The natural course of radiation injury to the brachial plexus is uncertain and has been reported to range widely. The development of the radiation –induced nerve injury is believed to be a slow process, with a latency period of 1-4 years. It is speculated that brachial plexus roots, trunks, divisions, cords and branches may have difference in radiation tolerance.[5,6]

Currently, consensus recommendations by Emami et al have suggested that the dose tolerances for a 5% risk of developing radiation-induced brachial plexopathy at 5 years is 62, 61, and 60 Gy, and for a 50% risk at 5 years dose tolerances are 77, 76, and 75 Gy for one-third, two-thirds, and the whole organ, respectively.

Dan Lundstedt et al in their review of 192 patients who received radiation therapy to the breast area 5 days per week over 5 weeks, at 2.0 Gy per fraction, to a total target dose of 50 Gy, they investigated the following volumes and doses as predictor of paraesthesia. V40Gy: This is divided into three categories that is less than 11.3cm^3 which includes 65 patients, between 11.4 and 13.4cm^3 which includes 65 patients and greater than 13.5 which includes 61 patients.[7,8] The maximum dose within the delineated volume, which is also divided into three category that is greater than 55Gy which include 12 patients and between 50 to 55 which include 97 patients and less than 50 Gy which includes 82 patients. V40 less than 13.5cc showed no significant relation to paraesthesia and among the women withV40 greater than or equal to 13.5cc, 25% reported paraesthesia. Maximum dose was not found to significantly correlate with paraesthesia.[8]

In the present analysis we reviewed twenty five brachial plexus dose, who had undergone PMRT with 50Gy in 25 fractions during the period September 2015 to January 2016. Total volume of the brachial plexus irradiated ranges from 7.67cc to15.29cc with a mean value of 10.467cc. V40 that is volume of receiving 40 Gy ranges from 2.007cc to 11.56cc with a mean volume of 7.57cc.[9]

None of present patients V40 exceeded 13.5 cc. The minimum dose received by the brachial plexus ranges from 3cGy to 1634cGy with a mean value of 349.56cGy. The maximum dose received by the brachial plexus ranges from 5045cGy to 5679cGy with a mean of 5312.8cGy. The mean dose of brachial plexus ranges from 3093 cGy to 4714cGy and the mean value is 4137.28cGy.[10]

Emami et al have suggested that the dose tolerances for a 5% risk of developing radiation-induced brachial plexopathy at 5 years is 62, 61, and 60 Gy, and for a 50% risk at 5 years dose tolerances are 77, 76, and 75 Gy for one-third, two-thirds, and the whole organ, respectively. In our study, the mean dose to the brachial plexus was 5312.8cGy and maximum dose was 5679cGy, and the V40 was 7.57cc. Dan Lundstedt et al in their review of 192 patients reported that V40 less than 13.5 cc showed no significant relation to paraesthesia and among the women withV40 greater than or equal to 13.5cc, 25% reported paraesthesia. In present study the mean V40 value was only 7.57cc. In present series dose to the brachial plexus is well below the emami tolerance limit and dose volme parameters were also significantly less, and hence post mastectomy irradiation with modern techniques is unlikely to produce significant brachial plexus neuropathy.

CONCLUSION

Brachial plexus maximum dose and V40 Gy values were well below the tolerance limit of plexus, and hence post mastectomy irradiation with modern techniques is unlikely to produce significant brachial plexus neuropathy.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Kunheri B, Radhakrishnan A, Stephan T, Mon R, Menon A. Brachial plexopathy in breast cancer: is it radiation related? An analysis technique and dose volume parameters to brachial plexus in breast cancer radiotherapy. Int J Res Med Sci 2017;5:469-72.