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Clinical Impact of Patient's Head Position in Supraclavicular Irradiation of the Whole Breast Radiotherapy

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Patients with breast cancer can be positioned with their head turned to the contra lateral side or with their head straight during the radiation therapy treatment set-up. In our hospital, patients with locally advanced breast cancer who were receiving radiation therapy have experienced swallowing difficulty after 2 weeks of irradiation. In this pilot study, the impact of head position on reducing dysphagia occurrence was dosimetrically evaluated. Patients were divided into two groups viz., HT (head turned to the contra lateral side of the breast) and HS (head straight) with 10 members in each. Treatment planning was performed, and the dosimetric parameters such as Dmin, Dmax, Dmean, V_5, V_{10}, V_{20}, V_{30}, $V_{40,}$ and V_{50} of both groups were extracted from the dose volume histogram (DVH) of esophagus. The target coverage in the supraclavicular fossa (SCF) region was analyzed using D_{95} and D_{98}; moreover, the dose heterogeneity was assessed with D_2 from the DVHs. The average values of the dose volume parameters were 27.6%, 58.6%, 35.4%, 19%, 13.8%, 14.1%, 11.8%, 8.4%, and 8.1% higher in the HT group compared with those in the HS group. Furthermore, for the SCF, the mean values of D_{98}, D_{95}, and D_2 were 42.4, 47.5, and 54 Gy, respectively, in the HS group and 38.9, 45.35, and 55.5 Gy, respectively, in the HT group. This pilot study attempts to give a solution for the poor quality of life of patients after breast radiotherapy due to dysphagia. The findings confirm that the head position could play a significant role in alleviating esophageal toxicity without compromising tumor control.

Keywords: Head position, Breast radiotherapy, Supraclavicular fossa irradiation, Dose volume histogram, Esophageal dysphagia

Introduction

Dysphagia is a severe complication for patients undergoing breast irradiation [1]. Its onset usually occurs in the 2nd week of radiation therapy. Although its severity could be lessened with analgesic drugs, it is still detested by most patients. Symptom persists even after months of irradiation, which reduce the patient's quality of life.

Radiation-induced dysphagia happens due to the incidental dose to esophagus during breast radiotherapy. In analyzing the dose to normal structures while irradiating the whole breast with supraclavicular fossa (SCF), we usually take the following structures into account: the spinal cord and the lungs.

The patient's head is tilted to the contra lateral side of the breast to avoid the anterior midline normal structures. However, posterior organs, such as the esophagus, remain inside the radiation field. Specifically, the esophagus is

often missed out in dose volume histogram analysis. An evaluation of patient follow up data found that patients who kept their head turned had complaints of grade1/grade 2 esophageal dysphagia.

In this pilot study, a new technique was proposed in which the head is kept straight so that the esophageal anatomy remains the same compared with that when the head is tilted. The proposed approach is termed as the head straight (HS) technique, and the conventional head tilt is labeled as head turned (HT) position. Dose volume parameters in HT and HS were evaluated. Acute and late esophageal toxicity in lung and thoracic tumors has been well documented [2-6]; however, esophageal dosimetry for breast radiotherapy with respect to head position has not been investigated. This study compared dose volume parameters under the HS and HT head positions of breast radiotherapy. Although clinical follow up is needed to ascertain the clinical outcome with a large number of patients, our study could help oncologists and physicists learn about the impact of head position on reducing dysphagia in patients with breast cancer undergoing routine radiotherapy.

Materials and Methods

Twenty patients with locally advanced breast with high risk factors for supraclavicular irradiation were recruited. Four positive lymph nodes with or without extra capsular extension and incomplete axillary dissection were the main indications for supraclavicular irradiation, which were considered for this prospective study. The patients were divided into two categories of head positioning, namely, HS and HT, with 10 members in each group.

In the HS position, CT simulation was performed by keeping the patient's head straight with arms above. In the HT position, the head was turned to other side of the cancerous breast. Treatment plans were established in eclipse planning system (Varian Inc, Palo Alto, CA, USA) version 11.8.2. Breast CTV, lumpectomy GTV, and supraclavicular CTV were delineated in accordance with the consensus of RTOG2014 [7,8]. Esophagus was contoured as per Upper Abdominal Normal Organ Contouring Guidelines, RTOG Consensus Panel, 2013 [9-11]. The esophageal volume ranged from 3 cc to 17.3 cc (median volume: 7.55 cc) for the HS group and 7.4 cc to 17.8 cc (median volume: 14.05 cc) for HT group.

Two tangential portals for the whole breast and one anterior beam of gantry angle ±10° (350° for right breast/10° for left breast) for SCF with 6 MV was planned with mono isocenter technique. The total dose prescribed was 50 Gy in 25 fractions. Dose volume parameters such as Dmin, Dmax, Dmean, V_5, V_{10}, V_{20}, V_{30}, V_{40}, and V_{50} of esophageal volume; moreover, and D_{95}, D_{98}, and D_2 of SCF volume were extracted from the dose volume histograms of each plan [12]. The 10 patients in both groups were assessed for acute complication in a weekly interval by the oncologists.

Results and Discussion

Fig. 1 illustrates the comparison of 30 Gy dose color wash in coronal section between the HT and HS groups. The average values of Dmin, Dmax, Dmean, V_5, V_{10}, V_{20}, V_{30}, V_{40}, and V_{50} received by the esophagus were 0.94 Gy, 34.6 Gy, 4.8 Gy, 22%, 20.6%, 14.9%, 13%, 11.9%, and 1.8%, respectively, for the HS group. Furthermore, the average values of Dmin, Dmax, Dmean, V_5, V_{10}, V_{20}, V_{30}, V_{40}, and V_{50} received by the esophagus were 1.2 Gy, 54.9 Gy, 6.5 Gy, 41%, 34.4% 29%, 24.8%, 20.3%, and 9.9%, respectively, for the HT group.

No incidence of 60 Gy volume was observed in the HS group. Meanwhile, 3 out of 10 patients had minimal 60 Gy dose volume in the HT group. Fig. 2 shows the deviation in esophageal dose when the head position was changed from straight to turned. The mean target coverage in SCF region was assessed with D_{98}% and D_{95}% in both groups. The dose received by 95% of volume was 47.5 Gy in the HS group and 45.35 Gy in the HT group. Similarly, the dose received by

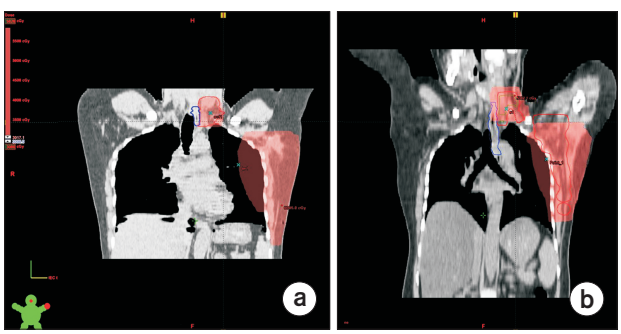

Fig. 1. Dose comparison of 30 Gy in coronal CT sections of HS (a) and HT (b). CT, computed tomography; HS, head straight; HT, head turned.

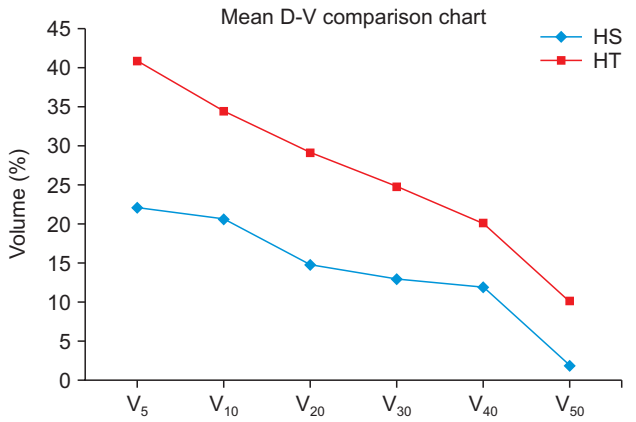

Fig. 2. Comparison chart of mean dose volume. HS, head straight; HT, head turned.

98% of volume was 42.4 Gy in the HT group, i.e., the mean D_{98} was 3.5 Gy more than that in the HT group. High dose regions were analyzed with D_2% parameter. Thus, the mean D_2% was 111% (55.5 Gy) in the HT group and 108% (54 Gy) in the HS group.

Esophageal dysphagia is an acute radiation-induced complication when the SCF is treated simultaneously with the breast. The HT position is often suggested to move any midline normal structures from the radiation field.

The HT position helps simply mark the treatment field on skin and pull the midline structures away from radiation beam portals. Posterior structures, such as the esophagus, remain inside the field when the head is turned to one direction. This phenomenon may be due to the posterior position of the internal organs that causes them to move toward the opposite direction when the head is turned.

This pilot study investigated esophageal dosimetry for breast plus SCF radiotherapy in HS and HT positions in a small cohort of patients. Further investigations are needed to substantiate in large group of patients with strong statistical ranking and correlations. In our hospital, radiation oncologists come across breast radiotherapy patients complaining of esophageal dysphagia. Therefore, we aimed to conduct this research in our clinical setting to analyze the dosimetric advantage of using the HS position.

Results inicate that the volume of cervical esophagus receiving 30 Gy dose for a prescription of 50 Gy total dose in 25 fraction was 11.8% higher in the HT group than in the HS group. The small incidence of high dose volume of 50 Gy (1.8%) found in the HS group was 8.1% less than that in the HT group. A small incidence of 60 Gy dose was found in 30% of the HT group but not in the HS group. The highest comparable dose was V_5, which was 19% higher in the HT group than in the HS group. The mean esophageal dose was 35.4% higher in the HT group than in the HS group. On the basis of the results of dose volume comparison, the esophagus could be spared in the HS position. No change in tumor control was observed when the head position was changed from HT to HS due to the similar mean dose to target volume (SCF). The low values of D2% indicated that dose heterogeneity can also be avoided with the HS position.

Weekly follow up results indicated the prevalence of grade1/grade2 esophageal dysphagia in the HT group. The HS group did not have a complaint of swallowing difficulty. Thus, the HS position seems to be more advantageous compared to the HT position when SCF is treated simultaneously with the whole breast. Thus, esophageal dysphagia could be avoided when the head is kept straight. Eventually it could improve the quality of life during and after breast radiotherapy.

Conclusions

This study recommends for clinicians to evaluate head position in the breast radiotherapy of patients for whom SCF treatment is indicated. Findings from this investigation could possibly improve the patient's quality of life.

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Conflicts of Interest

The authors have nothing to disclose.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Author Contributions

Conceptualization: Surega Anbumani. Data Curation: Priyadarshini V and Sasikala P. Formal Analysis: Lohith G. Reddy. Investigation: Lohith G. Reddy. Methodology: Lohith G. Reddy. Project Administration: Lohith G. Reddy. Resources: Ramesh S. Bilimagga. Supervision: Ramesh S. Bilimagga. Writing-original draft: Surega Anbumani. Writing-review and editing: Surega Anbumani.

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