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A Dosimetric Comparison of IMRT Vsvmat Techniques in Single Vocal Cord Irradiation in The Treatment of T1an0 Glottic Cancer

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ABSTRACT

This dosimetric study compares intensity-modulated radiotherapy (IMRT) and volumetric-modulated arc therapy (VMAT) techniques in single vocal cord irradiation (SVCI) for patients with T1aN0 glottic cancer. Historically, early glottic carcinoma has been managed with large-field radiotherapy, often exposing surrounding healthy tissues to unnecessary radiation and increasing the risk of complications. In contrast, SVCI, inspired by the precision of surgical laser excision, targets only the affected vocal cord, minimizing radiation exposure to adjacent structures. Ten patients underwent CT simulation and treatment planning with both 7-field IMRT and single-arc VMAT. Dose-volume histogram analyses were performed to evaluate planning target volume (PTV) coverage, homogeneity index (HI), conformity index (CI), and dose exposure to organs at risk (OARs). Results demonstrated comparable PTV coverage between IMRT and VMAT, with VMAT showing statistically superior HI and CI. No significant differences were observed in radiation doses delivered to critical OARs including the contralateral vocal cord, pharyngeal constrictor muscles, thyroid gland, carotid arteries, and spinal cord. These findings affirm the feasibility of SVCI using either technique, with VMAT offering dosimetric advantages in homogeneity and conformity. This study supports the use of advanced radiotherapy techniques to achieve effective and safer treatment of early-stage glottic cancer.

Keywords: *Single Vocal Cord Irradiation, T1a Glottic Cancer, IMRT, VMAT, Dosimetric Comparison.*

1. INTRODUCTION

Most laryngeal cancers present in early stage and more than two thirds of it occur in the glottic region(T1-T2) (Ferlay et al., 2010)

Early glottic carcinoma is historically treated with conventional radiotherapy using large box fields (from lower border of hyoid to lower border of cricoid), using wedged parallel opposed photon beams (Rosenthal et al., 2010)

The contralateral vocal cord, arytenoids, thyroid cartilage, and all muscles responsible for opening and closing the vocal cords, the swallowing muscles, carotid arteries and thyroid gland are exposed to high radiation doses (fully or partially) which could lead to an increased probability of complications that negatively influence the quality of life of these patients. (Dornefeld et al., 2007; Rancati et al., 2010)

In contrast to the traditional radiotherapy principle to treat the whole larynx, surgical laser excision of T1a glottic cancer involves removal of gross tumor with minimal, often sub-millimeter, excisional margins with good oncological outcome and good quality of voice. (Rubenstein et al., 2010)

Similar to this surgical concept and with modern radiotherapy IMRT/VMAT technique, the approach of single vocal cord irradiation (SVCI) was introduced and a retrospective study reported excellent local control with low rates of side effects (Almamgani et al., 2015)

IMRT has been previously compared with VMAT in various types of cancer. Several studies have suggested that VMAT produces highly conformal dose distributions, achieves accurate dosimetric delivery and reduces treatment time. (Rawal et al 2024)

In the present study, we assessed the feasibility of vocal cord radiotherapy and we compared the dose coverage to the affected vocal cord and the dose delivered to the organs at risk using IMRT vs VMAT technique.

2. PATIENTS AND METHODS

10 patients with T1aN0 glottic cancer were included. All patients had CT simulation with slice thickness of 2 mm in a supine position and fixation with head and neck 4 points mask. cases.

Target and Organs at risk contouring:

The CTV included the affected vocal cord including ipsilateral arytenoid. A PTV margin of 5 mm was added in all directions except for 1 cm craniocaudally. The organs at risk included the contralateral vocal cord, arytenoids, swallowing constrictor muscles, carotid arteries, spinal cord and the thyroid gland. The prescription dose was 58.08Gy in 16 fractions.

Treatment Planning

Two plans were generated for each patient, one using the 7 field IMRT and other using one arc VMAT technique. The two techniques were compared using dose volume histogram (DVH) analysis of the PTV and different organs at risk.

Both treatment plans were performed using the Eclipse treatment planning

system (TPS) using 5 mm leaf width and 6 MV photon energy.

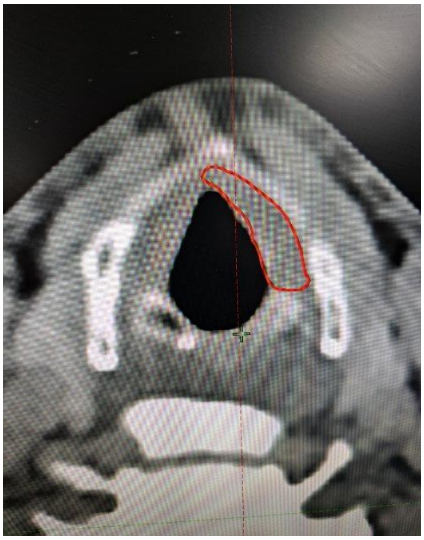

Figure (1) CTV contouring

3. RESULTS

The PTV coverage was comparable in both study arms, with no difference in D2, D98, D95 in both arms. Doses to different organs at risk were analysed and compared.

Table 1: Summary of dosimetry analysis

	Arm		
	IMRT	**VMAT**	
	Median (range)	**Median (range)**	**p value**
PTV D2(%)	104.3 (102-107)	105 (101-108)	0.318
PTV D98(%)	96.5 (93-99.5)	97 (94-98.5)	0.455
PTV D95(%)	98.5 (95-100)	98 (96-99)	0.147
Spinal cord Dmax (Gy)	25 Gy	23 Gy	0.659
Ipsilateral Carotid Dmax	32 Gy	34 Gy	0.430

(Gy)			
Ipsilateral Carotid Dmean (Gy)	10 Gy	12 Gy	0.782
Contralateral Carotid Dmax (Gy)	21 Gy	18 Gy	0.57
Contralateral Carotid Dmean (Gy)	6 Gy	9 Gy	0.35
Pharyngeal Constrictors Dmean (Gy)	34 Gy	31 Gy	0.826
Thyroid Dmean (Gy)	8 Gy	10 Gy	0.76
Esophagus Dmean (Gy)	2.5 Gy	2.2 Gy	0.686
Contra lateral vocal cord Dmean (Gy)	38Gy	36Gy	0.85
Conformity index	1.07	1.04	0.03
Homogeneity index	1.02	0.0985	0.023

The results showed the feasibility of Single vocal cord irradiation using both techniques with no statistically significant difference in dose distribution to the PTV or to organs at risk.

VMAT is an advanced radiation treatment modality for cancers which has potential to prompt treatment plans for different anatomical sites which are comparable with corresponding IMRT plans. In present study IMRT plans were compared with VMAT in terms of various dose volume parameters to assess PTV coverage, homogeneity index, conformity index and OAR sparing

PTV coverage:

No difference was noted in PTV coverage between IMRT and VMAT plans. D2,D98 and D95 were comparable in the 2 techniques

However, the VMAT plans gave more statistically significant better homogeneity index and conformality index.

Doses to organs at risk:

No statistically significant difference was noted to different organs at risk in the 2 techniques. The mean doses to contralateral vocal cord, pharyngeal constrictors muscles, spinal cord, thyroid gland and carotid arteries were comparable in the 2 techniques.

4. DISCUSSION

This dosimetric study assessed the feasibility of single vocal cord irradiation using IMRT and VMAT techniques and compared the radiation dose distribution between the 2 techniques regarding PTV coverage, Conformality index, Homogeneity index and organs at risk doses.

Our findings are consistent with previous dosimetric studies. For example, Osman et al. (2012) reported significant reductions in dose to OARs, including the contralateral vocal cord and carotid arteries, with SVCI.

Our results showed no difference in organs at risk sparing between IMRT and VMAT techniques and this is in accordance with previous study. (Osman et al 2012)

Similarly, Chera et al. (2010) demonstrated that IMRT-based SVCI could achieve excellent sparing of OARs while maintaining target coverage. Our study builds on these findings by providing a comprehensive comparison of dose distributions to multiple OARs, including the pharyngeal constrictor muscles and thyroid gland, which are often overlooked

in other studies.

However, our results are not in accordance with other studies that showed better sparing of organs at risk with VMAT technique in the treatment of head and neck cancer. This can be explained that other studies included other head and neck primaris with complex anatomy which is different from T1N0 glottic cancer (Lu et al 2012) (Nagarajan et al 2020)

5. LIMITATIONS OF THE STUDY

The accuracy of dose calculation algorithms at tissue-air interfaces, such as the vocal cords, remains a challenge. This issue has been highlighted by Chera et al. (2010), who noted that under- or overdosage at these interfaces could compromise treatment outcomes. Finally, the use of IMRT and VMAT techniques for SVCI requires advanced treatment planning and quality assurance protocols, which may not be available in all radiotherapy centers.

6. CONCLUSION

In conclusion, this dosimetric study demonstrates that SVCI using IMRT or VMAT techniques is feasible and it offers significant advantages in terms of reducing radiation exposure to critical organs at risk including the carotid arteries, contralateral vocal cord, pharyngeal constrictor muscles, and thyroid gland. These findings suggest that SVCI could improve the safety profile of radiotherapy for early-stage glottic cancer, particularly for patients at risk of long-term complications. Both IMRT and VMAT techniques resulted in similar dosimetric parameters with no statistically significant difference regarding doses to different organs at risk. However, VMAT plans result in better conformality index and homogeneity index.

REFERENCES

[1] Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM. Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. Int J Cancer. 2010;127(12):2893-2917. doi:10.1002/ijc.25516.

[2] Rosenthal DI, Fuller CD, Barker JL Jr, et al. Simple carotid-sparing intensity-modulated radiotherapy technique and preliminary experience for T1-2 glottic cancer. Int J Radiat Oncol Biol Phys. 2010;77(2):455-461. doi: 10.1016/j.ijrobp.2009.04.061.

[3] Dornefeld A, Fuller CD, Wang SJ, et al. Randomized trial of accelerated hyperfractionated radiation therapy with or without concurrent chemotherapy for stage III and IV head and neck cancer. Int J Radiat Oncol Biol Phys. 2007;69(3): S32-S33. doi: 10.1016/j.ijrobp.2007.07.081.

[4] Rawal, T., Sharma, N., Gajraj, V. K., Meena, R., Thanvi, S., Singh, G., Jakhar, S. L., & Kumar, H. S. (2024). Comparative dosimetric analysis of IMRT and VMAT in head and neck cancers. Asian Pacific Journal of Cancer Care, 9(1), 77–80. https://doi.org/10.31557/apjcc.2024.9.1.77-80.

[5] Rancati T, Schwarz M, Allen AM, et al. Radiation dose-volume effects in the larynx and pharynx. Int J Radiat Oncol Biol Phys. 2010;76(3 Suppl): S64-S69. doi: 10.1016/j.ijrobp.2009.03.079.

[6] Rubenstein JH, Surawicz CM, Weinstein WM. Clinical Gastroenterology and Hepatology. 2nd ed. Philadelphia, PA: Elsevier Saunders; 2010.

[7] Almamgani A, van den Broek GB, Tans L, et al. Single vocal cord irradiation for early-stage glottic cancer: excellent local control and low toxicity. Radiother Oncol. 2015;116(2):240-244. doi: 10.1016/j.radonc.2015.07.018.

[8] Dorresteijn LD, Kappelle AC, Boogerd W, et al. Increased risk of ischemic stroke after radiotherapy on the neck in patients younger than 60 years. J Clin Oncol. 2010;28(1):144-150. doi:10.1200/JCO.2009.24.5357.

[9] Chera BS, Amdur RJ, Morris CG, et al. Intensity-modulated radiotherapy for early-stage glottic cancer: a dosimetric comparison with conventional radiotherapy. Int J Radiat Oncol Biol Phys. 2010;76(3): S64-S65. doi: 10.1016/j.ijrobp.2009.03.080.

[10] Osman SO, Astreinidou E, de Boer HC, Keskin-Cambay F, Breedveld S, Voet P, et al. IMRT for image-guided single vocal cord irradiation. Int J Radiat Oncol Biol Phys. (2012) 82:989–97. 10.1016/j.ijrobp.2010.12.022

[11] Lu S, Cheng JC, Kuo S, Lee JJ, Chen L, Wu J, Chen Y, etal. Volumetric modulated arc therapy for nasopharyngeal carcinoma: a dosimetric comparison with TomoTherapy and step-and-shoot IMRT. Radiotherapy and Oncology: Journal of the European Society for Therapeutic Radiology and Oncology. 2012 09;104(3):324-330.

[12] Nagarajan M, Banu R, Sathya B, Sundaram T, Chellapandian TP. Dosimetric Evaluation and Comparison Between Volumetric Modulated Arc Therapy (VMAT) and Intensity Modulated Radiation Therapy (IMRT) Plan in Head and Neck Cancers. The Gulf Journal of Oncology. 202005;1(33):45-50.