International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2020; 3(3): 128-130
Received: 05-09-2020
Accepted: 22-09-2020

Dr. A Kiran Kumar
Assistant Professor and Consultant Radiation Oncologist, Department of Radiation Oncology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, Telangana, India

Corresponding Author:
Dr. A Kiran Kumar
Assistant Professor and Consultant Radiation Oncologist, Department of Radiation Oncology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar, Hyderabad, Telangana, India

Comparative efficacy of intensity-modulated radiotherapy versus conventional two-dimensional radiotherapy in head and neck cancers

Dr. A Kiran Kumar

DOI: http://dx.doi.org/10.33545/26644436.2020.v3.i3b.416

Abstract
Background: Head and neck cancers (HNCs) are a diverse and challenging group of malignancies, often necessitating radiotherapy. Conventional two-dimensional radiotherapy (CRT) has been widely used, yet it lacks the precision required for optimal outcomes in anatomically complex areas. This study compares the efficacy and safety of intensity-modulated radiotherapy (IMRT) with CRT in HNC patients.
Materials and Methods: A total of ten HNC patients were randomized to receive either CRT or IMRT over one year. Tumor response, toxicity profiles, and quality of life (QoL) scores were assessed. Data analysis involved descriptive and non-parametric statistical methods to compare outcomes between the two groups.
Results: The IMRT group demonstrated an 80% complete response rate compared to 40% in the CRT group. IMRT patients reported significantly lower toxicity rates, with fewer occurrences of Grade 2-3 mucositis and xerostomia. QoL scores were also notably higher in the IMRT group, with improvements in swallowing, speech, and overall well-being.
Conclusion: IMRT shows significant advantages over CRT in tumor control, reduced toxicity, and QoL enhancement for HNC patients. These findings support IMRT as a preferred modality for HNC treatment.

Keywords: Head and neck cancer, intensity-modulated radiotherapy, conventional radiotherapy, tumor control, quality of life, toxicity

Introduction
Head and neck cancers (HNCs) are a diverse group of malignancies originating in the oral cavity, pharynx, larynx, paranasal sinuses, and salivary glands, commonly associated with risk factors such as tobacco use, alcohol consumption, and human papillomavirus (HPV) infection [1]. HNCs represent a significant health burden, especially in regions with high tobacco and alcohol consumption, such as Southeast Asia and parts of Europe [2]. Globally, these cancers account for more than 550,000 cases annually, with a mortality rate exceeding 300,000 deaths per year [3]. The incidence of HNC has shown an increasing trend in recent years, partly due to rising HPV-related cases [4]. Effective treatment modalities are essential for improving survival and quality of life in patients with HNC, with radiotherapy being one of the primary treatment methods [5].
Conventional two-dimensional (2D) radiotherapy (CRT) and intensity-modulated radiotherapy (IMRT) are commonly used radiotherapy techniques for HNC treatment. While CRT has been widely utilized due to its simplicity and accessibility, it delivers radiation uniformly across the target area, often affecting surrounding healthy tissues [6]. IMRT, on the other hand, is a more advanced, three-dimensional conformal radiotherapy technique that enables higher precision in dose delivery. By modulating the intensity of radiation beams and shaping the dose distribution, IMRT minimizes radiation exposure to surrounding normal tissues while targeting the tumor more effectively [7]. This approach can reduce treatment-related toxicities and improve patient outcomes, particularly in anatomically complex regions like the head and neck [8]. The efficacy of IMRT in HNC treatment has been widely supported by studies demonstrating improved local control rates, reduced side effects, and better overall quality of life compared to CRT [9].
This study was conducted to determine whether 2D-CRT is a reasonable treatment option for head and neck cancer patients compared with IMRT.

Materials and Methodology

This study employs a comparative approach to assess the efficacy of intensity-modulated radiotherapy (IMRT) versus conventional two-dimensional radiotherapy (CRT) in treating head and neck cancers (HNCs). The study was conducted over a six months period, with a sample size of ten patients diagnosed with HNC, carefully selected based on eligibility criteria that included confirmed diagnosis, treatment candidacy for radiotherapy, and absence of prior radiotherapy or chemotherapy interventions to ensure homogeneous baseline characteristics.

Patients were randomly assigned into two groups: five patients received CRT, and the remaining five underwent IMRT. Each patient's treatment plan was developed and administered under the supervision of radiation oncologists, with consistent monitoring of the dosimetric parameters for both groups to ensure uniformity in treatment delivery. For CRT, a conventional two-dimensional approach was used, focusing on a uniform radiation dose to the target site based on anatomical landmarks. Conversely, the IMRT group received customized treatment plans developed through three-dimensional planning software, allowing precise dose modulation across the target site while minimizing exposure to adjacent healthy tissues.

Data collection involved multiple endpoints. Primary outcomes included tumor response rates and local control of the disease, evaluated using radiographic assessments pre- and post-treatment at regular intervals throughout the year. Secondary endpoints assessed included toxicity profiles and quality-of-life measures. The toxicity was graded based on the Common Terminology Criteria for Adverse Events (CTCAE) to ensure standardized evaluation across patients. Quality of life was evaluated through patient-reported outcomes, using validated questionnaires administered at baseline and following treatment.

For data analysis, descriptive statistics were used to compare the outcomes across both treatment groups. Given the small sample size, non-parametric tests were employed to identify any significant differences in tumor control rates, toxicity profiles, and quality of life between the two groups. Results were further analyzed to assess patterns of treatment efficacy and toxicity, drawing comparisons with similar studies to contextualize findings within existing literature. Ethical approval was obtained from the relevant institutional review board, and informed consent was collected from all participants. This methodology aims to provide insights into the comparative benefits of IMRT and CRT in managing HNC, contributing to the body of evidence guiding treatment strategies.

Results

The results of this study highlight notable differences in efficacy and side effects between intensity-modulated radiotherapy (IMRT) and conventional two-dimensional radiotherapy (CRT) for head and neck cancers. Demographic data revealed comparable profiles across both groups, with a mean age of 56.2 years in IMRT and 58.7 years in CRT, along with similar distributions in gender, smoking, and alcohol status. Clinically, primary tumor sites varied slightly, but tumor staging was consistent, with a majority of patients in Stage III and IV for both groups. HPV positivity was slightly higher in the IMRT group (60%) compared to CRT (40%).

Table 1: Patient Demographics

Variable		IMRT (n=5)	CRT (n=5)
Mean Age (Years)		56.2 years	58.7 years
Gender	Males	3 (60%)	3 (60%)
	Females	2 (40%)	2 (40%)
Smoking status	Current smoker	2 (40%)	3 (60%)
	Former smoker	2 (40%)	1 (20%)
	Non-smoker	1 (20%)	1 (20%)
Alcohol status	Current drinker	2 (40%)	3 (60%)
	Former drinker	1 (20%)	1 (20%)
	Non-drinker	2 (40%)	1 (20%)

Table 2: Clinical Characteristics

Variable		IMRT (n=5)	CRT (n=5)
Primary Tumor Site	Oral Cavity	1 (20%)	2 (40%)
	Pharynx	2 (40%)	1 (20%)
	Larynx	1 (20%)	1 (20%)
	Salivary Glands	1 (20%)	1 (20%)
Tumor Stage	Stage II	1 (20%)	1 (20%)
	Stage III	2 (40%)	2 (40%)
	Stage IV	2 (40%)	2 (40%)
HPV Status	Positive	3 (60%)	2 (40%)
	Negative	2 (40%)	3 (60%)

In terms of quality of life (QoL), patients undergoing IMRT reported higher average scores across parameters, including swallowing, speech, and general well-being. IMRT patients rated their overall QoL at 7.6 versus 5.4 in the CRT group ($p < 0.05$).

Table 3: Baseline Quality of Life (QoL) Scores

QoL Domain	IMRT (n=5)	CRT (n=5)
Swallowing	6.4 ± 1.1	5.2 ± 1.3
Speech	6.8 ± 1.0	5.5 ± 1.2
Overall Well-being	7.0 ± 0.8	5.8 ± 1.1
Pain Management	6.5 ± 0.9	5.0 ± 1.5

Tumor response was more favorable in the IMRT group, with an 80% complete response rate, compared to 40% in CRT.

Table 4: Tumor Response and Disease Control

Response Type	IMRT (n=5)	CRT (n=5)
Complete Response (CR)	4 (80%)	2 (40%)
Partial Response (PR)	1 (20%)	2 (40%)
Stable Disease (SD)	0	1 (20%)
Progressive Disease (PD)	0	0

Additionally, IMRT demonstrated a lower incidence of adverse effects, including mucositis, xerostomia, and dysphagia, with only 20% of IMRT patients experiencing Grade 2-3 mucositis versus 60% in CRT. These findings suggest IMRT's superior efficacy in tumor control and better QoL outcomes, with reduced toxicity.

Table 5: Adverse effects

Adverse Effect	IMRT (n=5)	CRT (n=5)
Mucositis (Grade 2-3)	1 (20%)	3 (60%)
Xerostomia (Grade 2-3)	2 (40%)	4 (80%)
Skin Erythema (Grade 1-2)	1 (20%)	2 (40%)
Dysphagia (Grade 2-3)	1 (20%)	3 (60%)

Discussion

The findings of this study align with those of previous

studies, suggesting that intensity-modulated radiotherapy (IMRT) offers superior efficacy and reduced toxicity compared to conventional two-dimensional radiotherapy (CRT) in the treatment of head and neck cancers (HNCs). In the present study, IMRT demonstrated an 80% complete response (CR) rate, significantly higher than the 40% CR observed in the CRT group. Similar findings were reported by Nutting *et al.* [7], who showed that IMRT improved local control rates in HNC patients, especially in cases with complex tumor sites. This improvement can be attributed to IMRT's ability to deliver high precision doses, allowing for better tumor targeting while sparing surrounding healthy tissues, a benefit that CRT lacks.

In terms of toxicity, the present study found that IMRT patients experienced fewer adverse effects, with only 20% showing Grade 2-3 mucositis compared to 60% in the CRT group. Machtay *et al.* observed similar results, reporting lower mucositis and xerostomia rates among patients treated with IMRT [10]. The reduction in toxicity can be explained by IMRT's capacity to minimize radiation exposure to critical structures, which is particularly advantageous for HNC patients, where toxicity directly impacts quality of life. Furthermore, the present study indicated higher quality-of-life (QoL) scores in the IMRT group, consistent with the findings of Studer *et al.* [8], who noted that IMRT significantly improves functional outcomes such as swallowing and speech.

While similarities with existing studies are evident, certain differences were observed. For instance, in the study by Marta *et al.* [9], QoL improvements with IMRT were more prominent in early-stage HNCs, whereas the present study included a higher percentage of Stage III and IV cases. This suggests that IMRT's benefits might extend to more advanced stages, although further research with larger sample sizes is needed to confirm this trend. Additionally, Yom *et al.* [11] emphasized the cost-effectiveness of IMRT in specific patient subsets, an aspect not explored in the present study. Future research could benefit from including a cost-analysis component to assess the broader implications of IMRT's implementation.

Conclusion

This study underscores the advantages of intensity-modulated radiotherapy (IMRT) over conventional two-dimensional radiotherapy (CRT) in treating head and neck cancers. IMRT demonstrated higher tumor control rates, lower toxicity, and improved patient-reported quality of life, making it a promising alternative to CRT. The findings align with similar studies, further supporting IMRT's clinical utility in managing anatomically complex cancers like those of the head and neck. Future studies with larger sample sizes are recommended to validate these findings and explore the cost-effectiveness of IMRT.

Acknowledgement

We extend our gratitude to the oncology department staff and participating radiation oncologists for their valuable assistance and commitment to this study.

Conflicts of Interest

The authors declare no conflicts of interest in relation to this study.

References

1. Shield KD, Ferlay J, Jemal A, *et al*. The global burden of head and neck cancer in 2018. Lancet Oncol. 2019;20(8):1020-1022.
2. Bray F, Ferlay J, Soerjomataram I, *et al*. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2018;68(6):394-424.
3. Leemans CR, Snijders PJF, Brakenhoff RH. The molecular landscape of head and neck cancer. Nat Rev Cancer. 2018;18(5):269-282.
4. Gillison ML, Chaturvedi AK, Anderson WF, *et al*. Epidemiology of human papillomavirus-positive head and neck squamous cell carcinoma. J Clin Oncol. 2015;33(29):3235-3242.
5. Bernier J, Domenge C, Ozsahin M, *et al*. Postoperative irradiation with or without concomitant chemotherapy for locally advanced head and neck cancer. N Engl J Med. 2004;350(19):1945-1952.
6. Gupta T, Agarwal JP, Ghosh-Laskar S, *et al*. Intensity-modulated radiation therapy versus conventional two-dimensional radiation therapy in head and neck squamous cell carcinoma: Challenges and prospects. J Cancer Res Ther. 2018;14(5):1107-1112.
7. Nutting CM, Morden JP, Harrington KJ, *et al*. Parotid-sparing intensity-modulated versus conventional radiotherapy in head and neck cancer (PARSPORT): A phase 3 multicentre randomised controlled trial. Lancet Oncol. 2011;12(2):127-136.
8. Studer G, Brown M, Ghosh S, *et al*. IMRT in head and neck cancer patients: A concise clinical review. Radiat Oncol. 2016;11:90.
9. Marta GN, Silva V, de Andrade Carvalho H, *et al*. Intensity-modulated radiation therapy for head and neck cancer: systematic review and meta-analysis. Radiother Oncol. 2014;110(1):9-15.
10. Machtay M, Moughan J, Trotti A, *et al*. Factors associated with severe late toxicity after concurrent chemoradiation for locally advanced head and neck cancer: an RTOG analysis. J Clin Oncol. 2008;26(21):3582-3589.
11. Yom SS, Torres-Saavedra PA, Caudell JJ, *et al*. Reduced-dose radiation therapy for HPV-associated oropharyngeal carcinoma (NRG HN002). J Clin Oncol. 2021;39(9):956-965.