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Comparative Analysis of Radiation-Induced Hypothyroidism in Head and Neck Cancer Patients Treated with 3DCRT Versus IMRT

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Abstract

Background: Neck irradiation for head and neck squamous cell carcinoma (HNSCC) can lead to unintended thyroid exposure, increasing the risk of hypothyroidism. Despite this, thyroid surveillance is not consistently included in follow-up care.

Objective: To compare the incidence and early patterns of hypothyroidism in patients with HNSCC treated using three-dimensional conformal radiotherapy (3DCRT) and intensity-modulated radiotherapy (IMRT).

Methods: Forty euthyroid patients with histologically confirmed HNSCC were randomized to 3DCRT (n=20) or IMRT (n=20). Serum FT4 and TSH levels were measured before treatment, and at 3 and 6 months after therapy. Hypothyroidism was categorized as clinical (low FT4 with elevated TSH) or subclinical (elevated TSH with normal FT4).

Results: Clinical hypothyroidism was detected in 10% of 3DCRT patients at 3 months, compared with none in the IMRT arm. At 6 months, clinical hypothyroidism was present in 25% of 3DCRT and 20% of IMRT patients, while subclinical disease was observed in 50% and 45% of patients, respectively. Serial testing revealed progressively rising TSH and declining FT4, with more pronounced alterations in the 3DCRT group.

Conclusion: Both 3DCRT and IMRT were associated with thyroid dysfunction, though incidence was marginally higher after 3DCRT. These findings support routine thyroid function monitoring as part of survivorship care for all patients undergoing cervical irradiation.

Keywords: head and neck cancer, radiotherapy, hypothyroidism, 3DCRT, IMRT, thyroid dysfunction

Introduction

Head and neck squamous cell carcinoma (HNSCC) is a common malignancy worldwide, managed with combinations of surgery, radiotherapy, and chemotherapy. Radiotherapy remains essential, particularly for advanced disease and for nonsurgical candidates. However, neck irradiation often results in incidental thyroid exposure, leading to hypothyroidism — one of the most underrecognized late toxicities.

3DCRT ensures tumor coverage but with limited organ sparing, whereas IMRT improves conformity and reduces dose to organs at risk. Despite these advantages, both techniques may impair thyroid function. This study prospectively compares post-radiotherapy hypothyroidism rates between 3DCRT and IMRT and emphasizes the importance of structured thyroid surveillance.

Materials and Methods

Study Design: Prospective randomized study of 40 euthyroid patients with confirmed HNSCC (June 2021–November 2022). Patients were allocated to 3DCRT (n=20) or IMRT (n=20) arms.

Radiotherapy Planning:
- 3DCRT: Beam arrangements provided target coverage without thyroid-specific constraints.
- IMRT: Dose optimization included thyroid dose restrictions (V50 <60%).

Thyroid Assessment: Serum FT4 and TSH were tested at baseline, 3 months, and 6 months.
Clinical hypothyroidism: FT4 <5.4 mcg/dl and TSH >4.0 mIU/l
Subclinical hypothyroidism: Elevated TSH with normal FT4

Statistical Analysis: Data analyzed using SPSS v25. Mann–Whitney U and chi-square tests were applied, with significance at $p < 0.05$.

Results

The demographic and clinical profiles of patients were generally well balanced across both groups. Although the median age was slightly higher in the 3DCRT cohort, this difference was not statistically significant. Both arms included predominantly male patients, and the majority maintained an ECOG performance status of 1, indicating preserved baseline functional status. The oral cavity was the leading tumor subsite, more common among those receiving 3DCRT.

Treatment duration was broadly comparable between the two techniques. However, a larger fraction of IMRT patients underwent definitive chemoradiation, while adjuvant radiotherapy was more frequent in the 3DCRT arm.

By the 3-month evaluation, 10% of the 3DCRT group developed clinical hypothyroidism, whereas no such cases were observed in the IMRT arm. At the 6-month assessment, the prevalence increased to 25% for 3DCRT and 20% for IMRT. Subclinical hypothyroidism was also frequent, affecting 50% of 3DCRT and 45% of IMRT patients. This indicates that a considerable proportion of patients already demonstrated biochemical thyroid alterations within six months of completing treatment.

Serial thyroid function testing revealed a consistent pattern of rising TSH and declining FT4 across both groups, with more pronounced alterations among those treated with 3DCRT. At 3 months, mean TSH levels were significantly higher in 3DCRT patients, and by 6 months, both lower FT4 and elevated TSH reached statistical significance. These findings point to earlier and more severe thyroid impact following 3DCRT compared with IMRT, though neither technique eliminated the risk.

Table 1. Baseline Characteristics

Characteristic	3DCRT (n=20)	IMRT (n=20)
Median Age (years)	51.3 ± 12.5	46.8 ± 11.4
Sex (M:F)	16:4	14:6
ECOG 1	16 (80%)	17 (85%)
ECOG 2	4 (20%)	3 (15%)
Predominant subsite	Oral cavity 85%	Oral cavity 55%

Table 2. Treatment Characteristics

Parameter	3DCRT (n=20)	IMRT (n=20)
Treatment duration (days)	42.7	44.0
Definitive chemoradiation	3 (15%)	11 (55%)
Adjuvant RT	12 (60%)	7 (35%)

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Table 3. Incidence of Hypothyroidism

Time Point	Clinical Hypothyroidism	Subclinical Hypothyroidism
3 months (3DCRT)	2 (10%)	1 (5%)
3 months (IMRT)	0 (0%)	0 (0%)
6 months (3DCRT)	5 (25%)	10 (50%)
6 months (IMRT)	4 (20%)	9 (45%)

Table 4. Mean Biochemical Values

Parameter	3DCRT (Mean ± SD)	IMRT (Mean ± SD)	p-value
Baseline FT4	8.59 ± 1.34	8.44 ± 1.40	0.64
Baseline TSH	2.21 ± 0.81	2.10 ± 1.00	0.59
3M FT4	7.80 ± 1.47	7.50 ± 1.36	0.37
3M TSH	3.16 ± 0.82	2.59 ± 0.96	0.009*
6M FT4	6.48 ± 1.70	5.68 ± 1.03	0.018*
6M TSH	4.67 ± 0.94	4.42 ± 0.94	0.049*

Discussion

The present study demonstrates that biochemical thyroid variations can emerge within the first six months following neck irradiation, highlighting the gland's susceptibility to radiation-induced injury. While IMRT provided some degree of protection, both treatment modalities were associated with a considerable risk of biochemical and clinical hypothyroidism.

Our findings are consistent with prior reports documenting high rates of thyroid impairment after radiotherapy for head and neck cancers. Earlier studies have shown that factors such as the volume of thyroid tissue exposed, total radiation dose, and concurrent systemic therapy are major contributors to thyroid damage. The higher incidence of dysfunction in the 3DCRT arm of our study can be attributed to the broader exposure of normal thyroid tissue, whereas IMRT allowed more precise dose distribution.

The observation that subclinical hypothyroidism affected nearly half of the patients underscores the importance of routine thyroid function testing, since reliance on symptoms alone may delay recognition of dysfunction. Timely detection permits early initiation of thyroid hormone replacement , which can mitigate fatigue, metabolic disturbance, and diminished quality of life often encountered in survivors.

From a clinical perspective, these findings reinforce the need to integrate thyroid surveillance into follow-up protocols for all patients receiving cervical irradiation. Future research with longer follow-up is required to determine the persistence and progression of thyroid dysfunction beyond the early post-treatment phase.

Conclusion

Radiotherapy-induced thyroid dysfunction is common following HNSCC treatment with both 3DCRT and IMRT. IMRT provides slight thyroid sparing but does not eliminate risk. Incorporating routine thyroid function testing into follow-up protocols is strongly recommended for all patients receiving cervical irradiation.

References

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1. Forastiere AA. Management of advanced stage squamous cell carcinoma of the head and neck. Am J Med Sci. 1986;291:405–415.
2. Mendenhall WM, Parsons JT. Radiotherapy plus chemotherapy for head and neck cancer. N Engl J Med. 1993;328:579–580.
3. 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;350:1945–1952.
4. Cooper JS, Pajak TF, Forastiere AA, et al. Postoperative concurrent radiotherapy and chemotherapy for high-risk squamous-cell carcinoma of the head and neck. N Engl J Med. 2004;350:1937–1944.
5. Murthy V, Narang K, Ghosh-Laskar S, Gupta T, Budrukkar A, Agrawal JP. Hypothyroidism after 3DCRT and IMRT for head and neck cancers: prospective data from randomized trials. Head Neck. 2014;36(11):1573–1580.
6. Bhandare N, Kennedy L, Malyapa RS, Morris CG, Mendenhall WM. Primary and central hypothyroidism after radiotherapy for head-and-neck tumors. Int J Radiat Oncol Biol Phys. 2007;68:1131–1139.
7. Alterio D, Jereczek-Fossa BA, Franchi B, et al. Thyroid disorders in patients treated with radiotherapy for head-and-neck cancer: a retrospective analysis. Int J Radiat Oncol Biol Phys. 2007;67:144–150.

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