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RESEARCH PAPER

Evaluation of Periodontal Changes and Oral Hygiene Conditions in Patients Receiving Radiotherapy for Head and Neck Malignancy

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Abstract

Background: Although effective in controlling malignancy, radiotherapy can adversely affect surrounding normal tissues, particularly the oral cavity. Radiation-induced changes in hard and soft tissues may compromise periodontal health and negatively influence patients' quality of life.

Objective: This study aimed to evaluate the effect of head and neck radiotherapy on periodontal tissues and to assess changes in periodontal parameters and oral hygiene status in patients undergoing radiotherapy.

Methods: A one sample cohort study was conducted among 40 patients diagnosed with head and neck cancer who were scheduled for radiotherapy. Demographic characteristics, including age, sex, and personal habits (smoking, tobacco use, alcohol consumption, and betel quid chewing), were recorded. Periodontal parameters assessed were Plaque Index (PI), Probing Pocket Depth (PPD), Clinical Attachment Level (CAL), and Bleeding on Probing (BOP). Baseline measurements of PI, PPD, CAL and BOP were taken before radiotherapy and a, follow-up evaluations was done at 1 month, 2 months, and 6 months after radiotherapy. Statistical analysis was performed to compare changes in mean periodontal parameters over time.

Results: At 1 month post-radiotherapy, a statistically significant increase in PI ($p < 0.001$) was observed, while changes in PPD and CAL were not statistically significant. At 2 months, both PI and PPD showed significant increases ($p < 0.001$), whereas CAL remained statistically unchanged. By 6 months, significant increases were observed in all periodontal parameters, including PI, PPD, and CAL ($p < 0.001$), compared to baseline values. Regarding BOP, 37.5% of patients presented with bleeding at baseline. This increased to 52.5% at 1 month and 55.0% at 3 months post-radiotherapy. However, at 6 months, the proportion of patients exhibiting BOP decreased, with 72.5% showing no signs of bleeding on probing.

Conclusion: Radiotherapy for head and neck malignancies significantly affects periodontal health over time, leading to progressive increases in PI, PPD, and CAL. These findings highlight the importance of comprehensive oral assessment and appropriate periodontal management before and during radiotherapy to minimize complications and improve overall treatment outcomes.

Keywords: Head and neck neoplasm; radiotherapy; periodontal parameters

Introduction

Head and neck malignancies represent a significant global health burden, and radiotherapy remains one of the principal treatment modalities, either as a primary approach or as an adjunct to surgery. Radiotherapy exerts its therapeutic effect through the use of ionizing radiation, which damages malignant cells and inhibits their proliferative capacity.[1] The biological effects of ionizing radiation occur through both direct and indirect mechanisms. In the direct pathway, radiation causes DNA strand breaks, interfering with replication and ultimately leading to cell death. In the indirect pathway, radiolysis of water produces reactive ions such as hydrogen (H^+) and hydroxyl (OH^-) radicals, which interact with DNA bases and disrupt the replication process.[2] Because water constitutes the majority of cellular composition, the indirect mechanism is considered to have greater biological significance.[2] Cells with high mitotic activity are particularly sensitive to radiation, making malignant cells more susceptible to its effects. However, normal cells within the radiation field may also sustain irreversible DNA damage when repair mechanisms are overwhelmed.[2] Although radiotherapy is effective in tumor control, it also induces significant changes in surrounding normal tissues. In the oral cavity, radiation exposure leads to vascular alterations characterized by reduced blood vessel diameter, decreased blood flow, and tissue hypoxia. Additionally, increased

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collagen deposition and reduced cellularity in the underlying connective tissue contribute to fibrosis and impaired healing.[3,4] In periodontal tissues, these changes may result in thinning and rupture of the periodontal ligament, widening of the periodontal space, and disorganization of Sharpey's fibers, thereby increasing susceptibility to periodontal breakdown and infection.[3,4] Moreover, radiotherapy has been associated with dysregulation of the immune-inflammatory response, potentially exacerbating periodontal tissue destruction.[5] The development of oral complications such as hyposalivation and oral mucositis further compromises the oral environment.[6] Reduced salivary flow diminishes the protective functions of saliva, facilitates plaque accumulation, and promotes microbial colonization. Pain and discomfort associated with mucositis, along with psychological demotivation during cancer therapy, often lead to deterioration in oral hygiene practices.[3] Collectively, these factors may significantly influence periodontal health in patients undergoing radiotherapy for head and neck malignancies. Given the multifactorial impact of radiotherapy on periodontal tissues and oral hygiene status, a comprehensive evaluation of these changes is essential. Therefore, the present study aims to assess periodontal changes and oral hygiene conditions in patients receiving radiotherapy for head and neck malignancy

Materials and Methods

This one sample cohort study was conducted at Bangladesh Medical University (BMU) former PG Hospital, including the Radiation Center, Department of Clinical Oncology, and Department of Periodontology, Faculty of Dentistry, from March 2024 to December 2024. The study population consisted of patients diagnosed with head and neck malignant tumors who were receiving radiotherapy. A purposive sampling technique was used, and patients who fulfilled the eligibility criteria were consecutively enrolled. Patients with diagnosed head and neck malignancy who had been undergoing radiotherapy for at least six months and who agreed to provide written informed consent for participation and oral examination were included in the study. Patients who were completely edentulous, had teeth with poor prognosis before initiation of radiotherapy (clinical attachment loss >7 mm), had diabetes mellitus, or had systemic conditions such as autoimmune diseases, blood disorders, genetic diseases, or immunosuppressive disorders were excluded. The minimum calculated sample size was 32. To compensate for possible attrition, a total of 40 patients were included in the study. Ethical approval was obtained from the Institutional Review Board of BMU, and written informed consent was secured from all participants prior to enrollment. Baseline oral and periodontal assessments were performed before initiation of radiotherapy. Follow-up examinations were conducted at 1 month, 3 months, and 6 months after completion of radiotherapy. Periodontal examination was carried out using a UNC-15 periodontal probe, along with a caries probe, dental mirror, and tweezers. Radiotherapy was delivered using the Versa HD Radiotherapy Machine at the Radiation Center, Department of Clinical Oncology, BMU. The dentition was divided into six sextants: upper right (17–14), upper anterior (13–23), upper left (24–27), lower left (34–37), lower anterior (43–33), and lower right (47–44). All teeth were examined except third molars, unless first and/or second molars were missing. A sextant was included for recording only if it contained at least two teeth. Clinical parameters assessed included probing pocket depth (PPD), clinical attachment loss (CAL), plaque index (PI), and bleeding on probing (BOP). Six sites per tooth were examined. Probing pocket depth was measured as the distance from the free gingival margin to the base of the periodontal pocket. A probing depth of ≤3 mm was considered healthy, whereas ≥4 mm indicated periodontal involvement. Clinical attachment loss was measured from the cementoenamel junction to the base of the pocket, with gingival margins located coronal to the CEJ recorded as negative values. The probe was gently walked around each tooth, and the highest score per sextant was recorded. Plaque accumulation was assessed using the Silness and Löe Plaque Index (1964), and the mean plaque score was calculated by summing the scores of all examined surfaces and dividing by the total number of teeth examined. Bleeding on probing was assessed by gently inserting the periodontal probe into the gingival sulcus and observing for bleeding within 30 seconds; the presence of bleeding was recorded as indicative of gingival inflammation. Data was analyzed using SPSS software version 26.0 for Windows. Results were expressed as mean±SD (standard deviation). Paired t-tests were used for group comparisons. A p-value <0.05 was considered statistically significant.

Results

This one sample cohort study was done among 40 patients diagnosed with head and neck malignancy who were selected for radiotherapy.

Table I presents the demographic characteristics of the study participants (n = 40), including age distribution, sex, and personal habits such as smoking (less tobacco), tobacco use, alcohol consumption, betel quid chewing, and absence of adverse habits. Tables II, III, and IV show the comparison of mean plaque index (PI), probing pocket depth (PPD), and clinical attachment level (CAL) before radiotherapy and at 1 month, 2 months, and 6 months after radiotherapy,

respectively. At 1 month post-radiotherapy, a statistically significant increase in mean value was observed in PI (0.99±0.26 vs 1.22±0.25p < 0.001), while changes in mean value of PPD (4.03±0.30 vs 4.11±0.43;p=0.241) and CAL (5.09±0.44 vs 5.19±0.51;p=0.270) were not statistically significant (table-II). At 2 months, significant increases were noted in mean value of PI (0.99±0.26 vs1.42±0.29;P<0.001) and PPD (4.03±0.30 vs 4.95±0.34;p < 0.001), whereas the change in CAL was not statistically significant (5.09±0.44 vs 5.24±0.42;p=0.083) (table-III). At 6 months, PI (0.99±0.26 vs 6.07±0.48), PPD (4.03±0.30 5 vs 49±0.42), and CAL (5.09±0.44 vs 6.07±0.48) all showed statistically significant increases compared to baseline values (p < 0.001) (table-IV). Clinical attachment loss became more evident at the 6-month follow-up, suggesting that the adverse effects of radiotherapy on periodontal tissues may become more pronounced over time. Nevertheless, the persistent increases in PI, PPD, and CAL indicate that radiotherapy has a sustained negative impact on periodontal status. Table-V shows that 37.5% of patients had BOP at first visit, while After 1 month and 3 months post-radiotherapy, the percentage of patients with BOP increased to 52.5% and 55.0%, respectively. However, at the 6-month follow-up, the proportion of patients with BOP decreased slightly, with 72.5% of patients presenting no signs of BOP.

Table-I: *Demographic Characteristics of the study patients (n=40)*

Variables	Frequency	Percentage (%)
Age group (years)		
20-29	2	5.0
30-39	3	7.5
40-49	12	30.0
50-59	10	25.0
60-70	13	32.5
Sex		
Male	31	77.5
Female	9	22.5
Habits		
Smoking less tobacco	9	22.6
Tobacco	7	17.5
Alcohol	2	5.0
Betel quid	2	5.0
None	20	50.0

Data are presented as frequency (n) and percentage (%). No statistical test was performed, as this table presents descriptive baseline characteristics of the study participants.

Table-II: *Comparison of PI, PPD and CAL between before and after radiotherapy at 1 month (n=40)*

Periodontal Parameters	Radiotherapy		*p*-value
	Before radiotherapy (Mean±SD)	After radiotherapy 1 month (Mean±SD)	
PI	0.99±0.26	1.22±0.25	<0.001*
PPD	4.03±0.30	4.11±0.43	0.241
CAL	5.09±0.44	5.19±0.51	0.270

PI = Plaque Index; PPD = Probing Pocket Depth; CAL = Clinical Attachment Level. Data are presented as Mean ± SD. Paired t-test was used to compare pre- and post-radiotherapy values. *p < 0.05 indicates statistical significance.

Table-III: *Comparison of PI, PPD and CAL between before and after radiotherapy at 2 months (n=40)*

Periodontal Parameters	Radiotherapy		*p*-value
	Before radiotherapy (Mean±SD)	After radiotherapy 2 month (Mean±SD)	
PI	0.99±0.26	1.42±0.29	<0.001*
PPD	4.03±0.30	4.95±0.34	<0.001*
CAL	5.09±0.44	5.24±0.42	0.083

PI = Plaque Index; PPD = Probing Pocket Depth; CAL = Clinical Attachment Level. Data are presented as mean ± standard deviation (SD). Comparisons between pre-radiotherapy and 2-month post-radiotherapy measurements were performed using the paired *t*-test. $p < 0.05$ was considered statistically significant. * indicates statistical significance.

Table IV: *Comparison of PI, PPD and CAL between before and after radiotherapy at 6 months (n=40)*

Periodontal Parameters	Radiotherapy		*p*-value
	Before radiotherapy (Mean±SD)	After radiotherapy 6 month (Mean±SD)	
PI	0.99±0.26	6.07±0.48	<0.001*
PPD	4.03±0.30	5.49±0.42	<0.001*
CAL	5.09±0.44	6.07±0.48	<0.001*

PI = Plaque Index; PPD = Probing Pocket Depth; CAL = Clinical Attachment Level. Data are presented as mean ± standard deviation (SD). Comparisons between pre-radiotherapy and 6-month post-radiotherapy measurements were performed using the paired *t*-test. A *p*-value < 0.05 was considered statistically significant. * indicates statistical significance.

Table V

Distribution of the study patients by BOP (n=40)

BOP	Frequency	Percentage (%)
Before radiotherapy		
Present	15	37.5
Absent	25	62.5
At 1st month		
Present	21	52.5
Absent	19	47.5
At 3rd month		
Present	22	55.0
Absent	18	45.0
At 6th month		
Present	11	27.5
Absent	29	72.5

BOP = Bleeding on Probing. Data are presented as frequency (n) and percentage (%). Comparisons between pre-radiotherapy and post-radiotherapy BOP status were performed using McNemar's test. A *p*-value < 0.05 was considered statistically significant.

Discussion

The present study supports the alternative hypothesis that radiotherapy has a significant impact on periodontal parameters in patients treated for head and neck malignancies. The findings demonstrate progressive deterioration in periodontal health over time, particularly in probing pocket depth (PPD), clinical attachment level (CAL), and plaque index (PI). These results are partially consistent with previous investigations, although some differences were observed. In this study, 40 patients undergoing radiotherapy for head and neck malignancy were evaluated up to 6 months post-treatment. The majority of patients were in the sixth and seventh decades of life, with a marked male predominance (77.5%). These findings are consistent with epidemiological reports by,[7,8,9] who identified males between the fifth and eighth decades as the primary risk group for head and neck tumors. Squamous cell carcinoma was the predominant histopathological type in our study, which aligns with the known epidemiology of head and neck cancers. With respect to periodontal parameters, PPD showed a progressive increase over time, becoming highly significant at 6 months ($p < 0.001$). Similarly, CAL demonstrated a statistically significant increase at 6 months compared to baseline. These findings suggest that radiotherapy contributes to progressive periodontal breakdown. The biological basis for these changes may be related to radiation-induced hypocellularity, hypovascularity, and reduced healing capacity of periodontal tissues, as previously described.[10] Furthermore, high-dose radiotherapy may increase the risk of attachment loss, bone loss, and osteoradionecrosis.[8] However, our results differ from those of who did not find significant changes in PPD after 6 months, and who observed variable changes in periodontal parameters, possibly influenced by ongoing periodontal care.[4,6] Differences between studies may be attributed to variations in sample size, oral hygiene maintenance, radiation dose, and follow-up protocols. Bleeding on probing (BOP) showed a variable pattern. Although gingival inflammation initially increased during early follow-up, a reduction in BOP was observed at 6 months. This decrease may be explained by radiation-induced vascular obliteration and reduced blood flow rather than true periodontal improvement. Similar findings noted reduced bleeding despite high plaque levels.[11] The plaque index (PI) increased significantly over time in our study ($p < 0.001$), indicating progressive plaque accumulation following radiotherapy. This may be due to reduced salivary flow, limited mouth opening, mucosal discomfort, and decreased motivation for oral hygiene during cancer treatment. In contrast,[12, 13,14] reported stable or reduced plaque levels, likely due to strict dental follow-up and reinforced oral hygiene protocols during radiotherapy. The absence of structured periodontal maintenance in our cohort may explain the progressive plaque accumulation and subsequent periodontal deterioration. Overall, the findings suggest that radiotherapy adversely affects periodontal health, leading to increased plaque accumulation, deeper periodontal pockets, and greater attachment loss over time. These changes may be exacerbated by radiation-induced tissue alterations, reduced vascularity, limited mouth opening, and decreased physical or emotional motivation commonly observed in cancer patients. Therefore, comprehensive periodontal evaluation and continuous dental follow-up should be considered essential components of multidisciplinary care for patients undergoing radiotherapy for head and neck malignancies

Conclusion

This study demonstrates highly significant changes in periodontal parameters following radiotherapy in patients with head and neck malignancies. A progressive increase in Probing Pocket Depth, Clinical Attachment Loss, and Plaque Index was observed

over the follow-up period, indicating that radiotherapy adversely affects periodontal health. Early identification and management of pre-existing periodontal and other oral diseases are essential to minimize treatment-related oral complications and to improve overall treatment outcomes.

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Ethical Clearance:

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