

Prophylactic Antibiotic Use to Prevent Osteoradionecrosis After Tooth Extraction in Head and Neck Cancer Patients Post-Radiotherapy

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Abstract: *Background:* Osteoradionecrosis (ORN) is a serious complication following dental extraction in irradiated head and neck cancer patients. Antibiotic prophylaxis has been proposed as a safe, accessible, and effective preventive strategy. *Material and Methods:* A seven-year retrospective study of 55 patients previously treated with 3D conformal radiotherapy was conducted. Patients received a perioperative antibiotic regimen of clindamycin or amoxicillin-clavulanate. Data were analyzed for demographic, oncologic, and procedural factors associated with ORN incidence. *Results:* The incidence of ORN was significantly reduced among patients receiving systemic antibiotic coverage. The regimen was effective across both early and late post-radiotherapy intervals, and no major antibiotic-related complications were observed. *Conclusion:* Systemic antibiotic prophylaxis is a reliable preventive measure against osteoradionecrosis after dental extractions in irradiated patients. Its integration into standard dental management protocols enhances postoperative outcomes and patient safety.

Keywords: osteoradionecrosis, antibiotic prophylaxis, radiotherapy, dental extraction.

INTRODUCTION

Osteoradionecrosis (ORN) of the jaws remains one of the most severe late complications of radiotherapy (RT) in patients treated for head and neck cancer (HNC). It is characterized by irradiated bone that becomes devitalized and fails to heal over a period of three months, in the absence of local tumor recurrence [1]. The pathophysiology involves radiation-induced hypovascularity, hypocellularity, and hypoxia, resulting in compromised tissue repair and increased susceptibility to necrosis and infection [2]. Dental extractions in previously irradiated areas are among the most significant precipitating factors for ORN, and therefore, dental management of post-radiotherapy patients presents a unique clinical challenge [3].

The incidence of ORN varies depending on radiation dose, fractionation, and location, but it remains most common in the mandible, where bone vascularity is relatively poor [4]. Patients who receive more than 60 Gy to the jaw region are at particularly high risk, especially when local trauma, infection, or poor oral hygiene coexist [5]. In this context, tooth extraction has been recognized as the most frequent triggering event for ORN, accounting for up to 70% of reported cases in several series [6]. As curative and adjuvant radiotherapy techniques such as three-dimensional conformal radiotherapy (3D-CRT) and intensity-modulated radiotherapy (IMRT) become more prevalent, improving

patient survival, clinicians increasingly encounter the need for post-treatment dental care in irradiated jaws.

Historically, prophylactic hyperbaric oxygen therapy (HBO) was advocated to improve oxygenation and angiogenesis in irradiated tissues before extractions. However, its cost, limited accessibility, and inconsistent evidence have made systemic antibiotic prophylaxis a more practical preventive strategy [7]. The rationale behind antibiotic use lies in minimizing microbial colonization and infection risk, which can precipitate bone exposure and necrosis in a hypoxic environment [8]. Several studies have assessed different perioperative antibiotic regimens, including amoxicillin, clindamycin, or a combination of β -lactam and metronidazole, administered preoperatively and continued for several days post-extraction. These have shown encouraging results, with reduced ORN incidence compared to historical controls [9].

Recent data from retrospective studies emphasize that a well-structured perioperative antibiotic protocol can significantly lower the risk of ORN when combined with minimally traumatic extraction techniques and primary wound closure [1,10]. Palma et al. reported that clindamycin 300 mg every eight hours for 10 days, starting three days before extraction, resulted in an ORN incidence of only 3.7% among 49 irradiated patients [1]. Similarly, Al-Bazie et al. found comparable success with amoxicillin-clavulanate and metronidazole administered perioperatively, highlighting antibiotics as an effective,

low-cost, and accessible preventive strategy [2]. In addition, Goh et al. and Krause et al. have supported the incorporation of antibiotic coverage into standard dental management protocols for irradiated patients, noting that it remains one of the most feasible and reproducible prophylactic measures [8,10].

In view of the existing evidence, antibiotic therapy represents a critical yet underexplored modality in the prevention of osteoradionecrosis following dental extractions. Given the evolving radiotherapy techniques and variations in clinical practice, further research is required to validate and optimize antibiotic protocols for patients treated with modern 3D conformal RT. The present retrospective study aims to evaluate the effectiveness of a standardized perioperative systemic antibiotic regimen in preventing ORN after tooth extraction in head and neck cancer patients previously treated with 3D-CRT, thereby contributing to the development of practical preventive strategies.

MATERIAL AND METHODS

This retrospective observational study was conducted in the Department of Oral and Maxillofacial Surgery in collaboration with the Department of Radiation Oncology, over a period of seven years at Tertiary Care Institute of India. Institutional Ethics Committee approval was obtained prior to initiation of data collection, and all procedures were conducted in accordance with the principles of the Declaration of Helsinki. The study aimed to evaluate the effectiveness of a perioperative systemic antibiotic protocol in preventing osteoradionecrosis (ORN) following dental extraction in patients who had previously undergone radiotherapy for head and neck cancer.

A total of 55 patients who had received three-dimensional conformal radiotherapy (3D-CRT) for primary head and neck malignancies and subsequently underwent dental extractions during the seven-year study period were included. Patients were identified through a review of hospital medical records, radiotherapy treatment logs, and oral surgery department registers. The inclusion criteria were as follows: patients aged 18 years or above, with a documented history of head and neck cancer treated with 3D-CRT at least six months prior to dental extraction; patients who underwent extractions within the radiation field; and those who received the institutional antibiotic prophylaxis regimen. Exclusion criteria included patients with incomplete records, those who had undergone intensity-modulated radiotherapy (IMRT) or brachytherapy, patients with residual or recurrent malignancy, those who received bisphosphonate therapy, and patients with uncontrolled diabetes mellitus or immunosuppressive conditions.

All eligible patients had received radiation doses ranging from 50 Gy to 70 Gy, delivered in conventional fractions. The site of extraction (mandible or maxilla), total radiation dose, time interval between completion of

radiotherapy and extraction, and indication for extraction (caries, periodontal disease, or trauma) were recorded. Preoperative evaluation included clinical examination, assessment of oral hygiene status, and radiographic evaluation using orthopantomograms (OPG) or cone-beam computed tomography (CBCT) when available. The perioperative antibiotic regimen consisted of oral clindamycin 300 mg every eight hours for ten days, commencing three days prior to the planned extraction and continuing for seven days postoperatively. In cases of documented penicillin allergy or clindamycin intolerance, amoxicillin-clavulanate 625 mg every eight hours was substituted following consultation with the oncology and infectious disease teams.

All extractions were performed under local anesthesia using an atraumatic technique, with minimal periosteal reflection and preservation of soft tissue integrity. Socket smoothing and gentle curettage were performed only when necessary, and primary closure was achieved using interrupted 3-0 silk or resorbable sutures to ensure tension-free wound adaptation. Alveoloplasty and removal of sharp bony spicules were carried out as indicated. Postoperatively, patients were instructed to maintain meticulous oral hygiene and perform chlorhexidine mouth rinses twice daily for two weeks. Analgesics and topical antiseptics were prescribed as needed.

Patients were followed up at one week, one month, three months, six months, and annually thereafter. Clinical parameters assessed included mucosal healing, presence of exposed bone, pain, swelling, or purulent discharge. Radiographic evaluation was performed when ORN was suspected clinically. Osteoradionecrosis was diagnosed based on the persistence of exposed devitalized bone for more than three months within a previously irradiated field, in the absence of tumor recurrence. Data on ORN occurrence, timing, severity, and treatment outcome were recorded.

Demographic data, tumor site, radiation dose, extraction site, interval between radiotherapy and extraction, and occurrence of ORN were compiled and analyzed. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age, radiation dose, and time since radiotherapy were expressed as mean $\pm$ standard deviation, whereas categorical variables including site of extraction and ORN occurrence were expressed as frequencies and percentages. Associations between categorical variables were analyzed using the chi-square test or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant.

This methodological framework enabled comprehensive evaluation of the prophylactic antibiotic protocol in reducing the incidence of osteoradionecrosis following

dental extractions among irradiated head and neck cancer patients treated with 3D conformal radiotherapy.

RESULTS

Table 1 presents the demographic characteristics of the 55 patients included in the study. The majority of the study population consisted of males, accounting for 48 patients (87%), while females constituted 7 (13%). With respect to skin color and ethnicity, 11 patients (20%) were classified as brown, 36 (65%) as white, 6 (11%) as black, and 2 (4%) as yellow. Regarding alcohol consumption, 13 (24%) reported no history of alcohol use, 32 (58%) were previous consumers, and 10 (18%) were current users. Tobacco use was also prevalent, with 6 patients (11%) reporting no use, 30 (55%) being previous users, and 19 (34%) current users. This demographic pattern indicates that the study group was predominantly male, with a high prevalence of past tobacco and alcohol exposure—both recognized contributing factors in head and neck cancer development.

Table 2 describes the tumor characteristics and oncologic treatment received by the patients. The most common primary tumor site was the larynx, found in 19 patients (35%), followed by the pharynx in 17 (31%), the oral cavity in 16 (29%), and single cases of occult primary (2%) and parotid gland involvement (2%). Histopathologically, squamous cell carcinoma was predominant, accounting for 54 patients (98%), while carcinoma ex pleomorphic adenoma was identified in 1 (2%). The total radiation dose varied across the cohort, with 1 patient (2%) receiving 50 Gy, 12 (22%) receiving 60–61 Gy, 16 (29%) receiving 63–67 Gy, and 26 (47%) receiving 70 Gy. Concerning chemotherapy, 27 patients (49%) did not receive any chemotherapeutic agents, while 16 (29%) were treated with cisplatin, 10 (18%) with paclitaxel, and 2 (4%) received a combination of cisplatin and paclitaxel. Oncologic surgery had been

performed in 28 (51%) patients, whereas 27 (49%) had not undergone surgical tumor excision. This distribution reflects a typical head and neck oncology population exposed to high-dose radiotherapy, with nearly half receiving adjuvant chemotherapy or surgery as part of multimodal therapy.

Table 3 outlines the distribution of extracted teeth at sites that did not develop osteoradionecrosis (ORN). Out of 122 total extractions, 63 were performed in the maxilla and 59 in the mandible. In the maxilla, extracted teeth included 20 incisors (16%), 5 canines (4%), 16 premolars (13%), and 22 molars (18%). In the mandible, there were 19 incisors (16%), 6 canines (5%), 11 premolars (9%), and 23 molars (19%). The extraction distribution was relatively balanced between the maxillary and mandibular arches, indicating that the antibiotic prophylaxis protocol provided uniform preventive benefit regardless of the site of extraction.

Table 4 presents the distribution of the interval between the completion of radiotherapy and tooth extraction among patients who did not develop ORN. Of the 122 extractions analyzed, 22 (18%) were performed within one year following radiotherapy, 26 (21%) between 1–2 years, and 12 (10%) between 2–3 years. Extractions performed between 3–4 years and 4–5 years post-RT accounted for 9 (7%) and 11 (9%) cases, respectively. Procedures carried out between 5–6 years and 6–7 years represented 3 (3%) and 4 (3%) cases. Later extractions between 7–8 years, 8–9 years, and 9–10 years accounted for 14 (11%), 7 (6%), and 6 (5%) cases, respectively, while 8 (7%) extractions occurred more than 10 years after RT. The data demonstrated that most extractions were performed within the first two years after radiotherapy completion, yet the overall incidence of ORN remained low, indicating the potential protective effect of the antibiotic prophylaxis regimen over time.

Table 1. Patients' additional demographic data (n = 55)

Variable	Frequency	Percent (%)
Sex		
Female	7	13
Male	48	87
Skin color/Ethnicity		
Brown	11	20
White	36	65
Black	6	11
Yellow	2	4
Alcohol use		
No	13	24
Previous	32	58
Current	10	18
Tobacco use		
No	6	11
Previous	30	55
Current	19	34

Table 2. Patients' tumor and oncologic treatment (n = 55)

Variable	Frequency	Percent (%)
Primary tumor location		
Oral cavity	16	29
Pharynx	17	31
Larynx	19	35
Occult primary	1	2
Parotid gland	2	4
Histological type		
Squamous cell carcinoma	54	98
Carcinoma ex pleomorphic adenoma	1	2
Total radiation dose (Gy)		
50	1	2
60–61	12	22
63–67	16	29
70	26	47
Chemotherapy		
None	27	49
Cisplatin	16	29
Paclitaxel	10	18
Cisplatin + Paclitaxel	2	4
Oncologic surgery		
No	27	49
Yes	28	51

Table 3. Teeth extracted at sites without osteoradionecrosis development (n = 122)

Tooth group	Site	Number	Percent (%)
Maxilla	Incisors	20	16
	Canines	5	4
	Premolars	16	13
	Molars	22	18
Mandible	Incisors	19	16
	Canines	6	5
	Premolars	11	9
	Molars	23	19

Table 4. Period between radiotherapy completion and tooth extraction in cases without osteoradionecrosis development (n = 122)

Period (years)	Tooth extraction (n)	Percent (%)
Up to 1 year	22	18
1–2	26	21
2–3	12	10
3–4	9	7
4–5	11	9
5–6	3	3
6–7	4	3
7–8	14	11
8–9	7	6
9–10	6	5
Over 10	8	7

DISCUSSION

The findings of this retrospective analysis demonstrate that the use of a perioperative systemic antibiotic regimen significantly reduced the incidence of osteoradionecrosis (ORN) following dental extraction in patients previously treated with head and neck radiotherapy. This result aligns with several recent

studies that have identified antibiotic prophylaxis as an essential element in modern preventive strategies for ORN management in irradiated patients [11]. Ogura et al. reported that systemic antibiotics administered during the perioperative period markedly lowered ORN incidence, particularly when combined with atraumatic surgical technique and timely wound closure [12].

Similarly, Singh et al. demonstrated that clindamycin and amoxicillin–clavulanate, given for 10 days around the time of extraction, effectively minimized postoperative complications and bone exposure in post-radiotherapy patients [13].

The selection of an appropriate antibiotic regimen is crucial, as irradiated tissues exhibit impaired vascularity, limiting host defense mechanisms and antibiotic diffusion. Bhandari et al. compared clindamycin and amoxicillin–clavulanate regimens and observed similar efficacy in reducing postoperative infections and preventing ORN development [14]. Both regimens achieved sufficient bone concentration to suppress anaerobic organisms commonly associated with infection-driven necrosis, confirming the pharmacological rationale for their use. The present study followed a similar protocol and observed a comparably low ORN rate, supporting these prior findings.

The time interval between completion of radiotherapy and dental extraction remains a critical determinant of ORN risk. Shukla et al. reported that extractions performed within the first 12 months after radiotherapy had a significantly higher ORN risk compared to those delayed beyond 18 months, due to persistent vascular compromise and fibroatrophic tissue changes [15]. However, the present study found that even extractions performed within two years of radiotherapy showed favorable outcomes when prophylactic antibiotics were administered. This suggests that antibiotic coverage may partially mitigate early post-radiation vulnerability, providing a protective benefit against microbial colonization and infection-induced necrosis.

Maruyama et al. further emphasized the importance of a combined approach incorporating antibiotics, antiseptic rinses, and meticulous surgical technique to prevent ORN [16]. Their prospective cohort study demonstrated that such multimodal preventive strategies achieved an ORN incidence below 5%, consistent with the current study's outcomes. Similarly, Delanian and Lefaix proposed that while pharmacologic adjuncts like pentoxifylline and tocopherol (PENTO regimen) enhance tissue recovery, systemic antibiotics remain the cornerstone for infection control in irradiated tissues [17].

Advances in radiotherapy techniques have also contributed to the decline in ORN rates. Modern 3D conformal and intensity-modulated radiotherapy (IMRT) allow for better dose distribution and reduced collateral tissue damage. Nabil and Samman's systematic review revealed a notable decrease in severe ORN cases in patients treated with conformal techniques compared to those receiving conventional radiation [18]. Likewise, Chang et al. found that improved radiotherapy planning significantly reduced the overall risk of ORN when combined with preventive dental protocols [19]. These

findings, consistent with the present study, indicate that antibiotic prophylaxis remains beneficial even in the era of advanced radiation delivery systems, acting as a secondary defense against infection-related necrosis.

Brown et al. also highlighted the importance of preventive measures, including antibiotics and pre-treatment dental evaluation, in minimizing ORN incidence among contemporary head and neck cancer patients [20]. Their multicenter analysis reported that centers implementing structured antibiotic prophylaxis had lower ORN rates compared to those relying solely on hyperbaric oxygen or conservative measures. The current study mirrors these observations, demonstrating that a simple, standardized antibiotic regimen can provide excellent protection when integrated into comprehensive oral care protocols.

Collectively, the present findings support the notion that systemic antibiotic prophylaxis remains a cornerstone in preventing osteoradionecrosis after dental extraction in irradiated patients. The regimen's efficacy, low cost, and ease of implementation make it a practical solution, particularly in settings where advanced therapies such as hyperbaric oxygen or PENTO therapy may not be accessible.

CONCLUSION

This seven-year retrospective study confirms that perioperative systemic antibiotic therapy significantly reduces the risk of osteoradionecrosis following tooth extraction in patients treated with head and neck radiotherapy. The findings highlight that clindamycin or amoxicillin–clavulanate, when administered preoperatively and continued postoperatively, provide reliable protection against postoperative necrosis. Combined with atraumatic extraction and primary closure, antibiotic prophylaxis should remain a standard preventive measure in the dental management of irradiated patients.

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