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Prevalence of acute periapical abscesses in head and neck cancer patients receiving radiotherapy

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Abstract

Aims: Head and neck cancer is a serious condition affecting the life of patients. Radiotherapy is commonly used to treat such conditions. The aim of this study was to assess the prevalence of acute periapical abscesses (PAs) in patients who received radiotherapy for head and neck cancer.

Methods and results: Data on acute PAs and oropharyngeal cancer (OPC) diagnosis with or without a history of radiation therapy (RAD) was retrieved by searching the appropriate query in the database. All cases were diagnosed for acute PAs by calibrated dentists for patients admitted to urgent care. The odds ratio (OR) for the prevalence of acute PAs and its association with a history of OPC with or without RAD were then calculated. Adjustment for comorbidities such as diabetes, smoking and gingival and periodontal diseases was also done. The prevalence of acute PAs in patients with a history of OPC was significantly higher as compared to the general hospital patient population (OR 2.92, 95%CI, $p < .0001$). Males were more affected than females and whites were more affected than African Americans and other ethnicities. The prevalence for PAs in patients with a history of OPC and RAD was higher and the difference in prevalence was statistically significant (OR 3.61, 95%CI, $p < .0001$). Whites were more affected than African Americans by more than 3.5-fold. Adjustment for diabetes comorbidly affected mainly the OPC + RAD group, however, the difference remained statistically significant. Adjustment for smoking and gingival and periodontal disease reduced the OR but the difference remained statistically different.

Conclusions: The high prevalence of acute PAs in patients with a history of OPC and RAD may suggest an association between these conditions warranting a meticulous medical and dental examination.

KEYWORDS

Abscess, Cancer, Dental Abscess, Head & Neck Cancer, Oropharynx, Periapical Abscess, Radiotherapy

1 | INTRODUCTION

Head and neck cancer, of all types, is a life-changing event for patients. It presents many challenges to the medical and dental teams, amongst them, treatment and prognosis. Head and neck cancer is a term used to describe a plethora of diseases that originate in the head and neck region. Among them are cancers originating from the oral cavity, nasopharynx, oropharynx, larynx, and hypopharynx.[1] Head and neck cancer is one of the most common malignancies and is ranked sixth among all malignancies worldwide.[2,3]

Cancer of the oral cavity can include the inner lip, dorsal surface of tongue, gums, salivary glands, hard and soft palate, buccal mucosa, floor of the mouth, and other unspecified parts of the oral cavity.[4] Oropharyngeal cancer can include the base of the tongue, tonsils, anterior surface of the epiglottis, the lateral wall of oropharynx, and other unspecified parts of the pharynx.[4]

The standard treatment for early-stage head and neck cancer includes surgery and/or radiotherapy.[1] For advanced head and neck cancer, a multidisciplinary approach is usually applied that includes surgery followed by radiotherapy, with or without chemotherapy.[1]

Several studies suggested that radiotherapy for head and neck cancer is capable of inducing damage to the dentition, including the dental pulp.[5–10] On the other hand, several studies found that certain pulp changes were not long-lasting.[11,12]

Presently, no study has evaluated whether radiotherapy for patients with head and neck cancer may pose increased risk for periapical disease. Therefore, the purpose of this cross-sectional study was to assess the prevalence of acute periapical abscesses (PAs) in patients who received radiotherapy for head and neck cancer.

2 | MATERIAL AND METHODS

The University of Florida (UF) Integrated Data (IDR) i2b2, provided by the UF Health Office of the Chief Data Officer for the period of October 2015 to May 2023, was used. The study was in compliance with the UF IRB and Privacy rules for research on IRB-approved de-identified data sets. The study was exempted by the UF Health Center Institutional Review Board (IRB) as it did not include personal health information (PHI).

Data aggregated from inpatients and outpatients visiting the UF Health Center were recorded using the electronic patient record Epic system (Verona, Wisconsin, US; epic.com). Epic is the preferred electronic medical record system used by more than 250 healthcare organizations nationwide. More than 50% of the US population have their medical records in an Epic system.

The different diagnoses were coded using the international coding system ICD 10. The patient population analyzed was mixed, presenting with different disease conditions including acute PAs without sinus. Individual data was not analyzed, however, all cases were diagnosed by calibrated experienced dentists, in a hospital setting, for patients admitted to urgent care with symptoms of acute PAs. The calibrated dentists followed a strict diagnosis protocol of the emergency clinic.

Diagnosis was made based on clinical examination and imaging data confirming the diagnoses of acute PAs without sinus tract. Inclusion criteria encompassed all patients with the corresponding diagnostic code for acute PAs without sinus (ICD 10-K04.7), malignant neoplasm of lip, oral cavity and pharynx (C00-C14), and personal history of radiation treatment (Z92.3). Specific locations of the oral cancer included the anterior tongue and gingiva, and oropharyngeal cancer, such as the base of the tongue, tonsillar area, and pharynx. There were no exclusion criteria since all codes were computerized and specific diagnoses of acute PAs in the total hospital patient population, were searched using the appropriate ICD 10 code.

History of radiotherapy for the head and neck cancer patients was retrieved by searching the appropriate query in the database. Cancer diagnosis and treatment recommendations were done by the patient's physician. Dental treatment included endodontic treatment followed by coronal restoration, whenever the natural tooth was deemed salvageable.

Patients with ICD 10 diagnosis code of acute PAs were recorded and the prevalence of acute PAs in patients with head and neck cancer who received radiotherapy was compared to the prevalence in the total hospital patient population.

The odds ratio (OR) for the prevalence of acute PAs and its association with history of OPC were calculated with a 95% confidence interval and the statistical difference between the study groups was assessed using MEDCALC software. A standard normal deviation (z-value) was calculated as follows: ln(OR)/SE{ln(OR)}. The p-value was the area of the normal distribution that falls outside $\pm$ z. A value of $p < .05$ was considered statistically significant. Logistic regression was also conducted for diabetes, smoking and gingival and periodontal disease using the aggregated counts as weight in the model. SAS 9.4 procedure logistic was used for the statistical evaluation.

The odds ratio (OR) for the prevalence of acute PAs and its association with a history of radiotherapy for head and neck cancer in the hospital patient population was calculated and analyzed. Adjustment for comorbidities such

TABLE 1 Prevalence of periapical abscesses (PAs) in oropharyngeal cancer patients and total hospital patient population.

	PAs	No PAs	Odds Ratio	95% CI	*p*-value
OPC	77 (0.80%)	4,365 (0.28%)	2.92	2.33–3.66	.0001
OPC + RAD	40 (0.41%)	1,834 (0.12%)	3.61	2.64–4.95	.0001
RAD	215 (2.21%)	16,792 (1.06%)	2.12	1.85–2.43	.0001
No OPC No RAD	9,383 (96.58%)	1,554,417 (98.54%)	1	0.97–1.02	Not Significant
Total patients	9,715	1,577,408			

Abbreviations: CI, confidential interval; OR, odds ratio; OPC, oropharyngeal cancer; RAD, history of radiation treatment.

TABLE 2 Demographics (%) of the hospital patient population studied.

	PAs (OPC+RAD)	No PAs (OPC+RAD)	PAs (OPC)	No PAs (OPC)	PAs (RAD)	No PAs (RAD)
Males	56.1%	25.5%	57.1%	49.5%	33.5%	50.3%
Females	43.9%	74.5%	42.9%	50.5%	66.5%	49.7%
Whites	78%	85.4%	74.3%	75.3%	69.1%	80.4%
African Americans	22%	8.3%	17.1%	13.2%	27.7%	12.9%
Other ethnicities	0	6.3%	8.6%	11.5%	3.2%	6.7%

Abbreviations: PAs, periapical abscesses; OPC, oropharyngeal cancer; RAD, history of radiation treatment.

TABLE 3 Prevalence of periapical abscesses (PAs) in oropharyngeal cancer patients and total hospital patient population after adjustment for diabetes comorbidity.

	PAs	No PAs	Odds Ratio	95% CI	*p*-value
OPC	56 (0.70%)	3,635 (0.26%)	2.6	1.99–3.38	.0001
OPC + RAD	167 (2.08%)	14,842 (1.07%)	1.9	1.62–2.21	.0001
RAD	142 (1.77%)	12,683 (0.92%)	1.6	1.36–1.90	.0001
No OPC No RAD	7,665 (95.45%)	1,353,801 (97.75%)	0.95	0.92–0.98	$p = .0037$
Total patients	8,030	1,384,961			

Abbreviations: CI, confidential interval; OR, odds ratio; OPC, oropharyngeal cancer; RAD, history of radiation treatment.

as diabetes, smoking and gingival and periodontal disease was also done.

3 | RESULTS

The demographics of the hospital patient population studied and the prevalence of PAs are summarized in Tables 1 and 2. The total hospital patient population studied was 1,587,123. Out of the total hospital patient population, 9,715 (0.61%) were diagnosed with PAs. Sixty-six percent of teeth had restorations and the rest were not previously restored.

There were 4,442 patients with a history of OPC, out of which 77 patients had PAs (Table 1). This constituted 1.73% of all hospital patients with OPC, and 0.79% from all patients with PAs. The difference in prevalence was statistically significant (OR 2.92, 95%CI, $p < .0001$) (Table 1). Adjustment for diabetes comorbidity reduced the OR to 2.6. However, the difference remained statistically significant (95%CI, $p < .0001$) (Table 3). Adjustment for smoking comorbidity reduced the OR to 1.47. However, the difference remained statistically significant (95%CI, $p = .0153$) (Table 4). Adjustment for gingival and periodontal comorbidity reduced the OR to 2.13. However, the difference remained statistically significant (95%CI, $p < .0001$) (Table 5).

TABLE 4 Prevalence of periapical abscesses (PAs) in oropharyngeal cancer patients (OPC) and total hospital patient population after adjustment for smoking comorbidity.

	PAs	Total
OPC	40 (0.90%)	4,442
Hospital patients	9,715 (0.61%)	1,587,123
OR	1.47	
95%CI	1.07-2.0	
p-value	$p = .0153$	

Abbreviations: CI, confidential interval; OR, odds ratio.

Males were more affected than females (Table 2). Whites were more affected than African Americans by more than 4-fold (Table 2). Whites were more affected than African Americans combined with other ethnicities by 3-fold (Table 2).

TABLE 5 Prevalence of periapical abscesses (PAs) in oropharyngeal cancer patients (OPC) and total hospital patient population after adjustment for gingival and periodontal disease comorbidities.

	PAs	Total
OPC	58 (1.30%)	4,442
Hospital patients	9,715 (0.61%)	1,587,123
OR	2.13	
95%CI	1.64-2.76	
p-value	$p < .0001$	

Abbreviations: CI, confidential interval; OR, odds ratio.

There were 1,874 patients with oropharyngeal cancer (OPC) and a history of radiation treatment (RAD), out of which 40 patients had PAs (Table 1). This constituted 2.13% of all hospital patients with OPC and a history of RAD, and 0.41% from all patients with PAs. The difference in prevalence was statistically significant (OR 3.61, 95%CI, $p < .0001$) (Table 1). Adjustment for diabetes comorbidly affected the OPC+RAD group and reduced the OR to 1.9. However, the difference remained statistically significant (95%CI, $p < .0001$) (Table 2). Males were more affected than females (Table 2). Whites were more affected than African Americans by more than 3.5-fold (Table 2).

There were 17,007 patients with a history of RAD treatment, out of which 215 patients had PAs (Table 1). This constituted 1.26% of all hospital patients with a history of RAD, and 2.21% from all patients with PAs (Table 1). The difference in prevalence was statistically significant (OR 2.12, 95%CI, $p < .0001$) (Table 1). Adjustment for diabetes comorbidly reduced the OR to 1.6. However, the difference remained statistically significant (95%CI, $p < .0001$) (Table 2). Females were more affected than males by 2-fold (Table 2). Whites were more affected than African Americans by circa 2.5-fold (Table 2). Whites were more affected than African Americans combined with other ethnicities by more than 2-fold (Table 2).

1,563,800 patients had no history of OPC or RAD treatment, out of which 9,383 had PAs (Table 1). This constituted 0.6% of all hospital patients with no history of OPC or RAD treatment, and 96.58% from all patients with PAs (Table 1). The difference in prevalence was not statistically significant (OR 1, 95%CI). Adjustment for diabetes comorbidly reduced the OR slightly to 0.95.

4 | DISCUSSION

The results of the present study suggest that the odds for developing acute PAs are higher in patients with a history of OPC. The odds increase further when such patients also received radiotherapy. This can be due to multiple factors.

OPC has been associated with damage to alveolar bone and associated tissues.[13] This is due to the invasive nature of this type of cancer.[4] Squamous cells constitute over 90% of cases of OPC.[14–16] In more than 60% of patients with OPC, cervical lymph nodes are involved, while 10%–15% can be associated with distant metastases.[15] OPC is classified by two types:[1] HPV-associated, caused by oral human papillomavirus infection; and[2] non-HPV-associated, caused mainly by chronic tobacco smoking and alcohol use.[16] It has been reported that excessive tobacco smoking increased the odds for acute PAs.[17]

Radiotherapy, commonly used to treat head and neck cancer, can induce several serious side effects.[18] The severity of the side effects is directly related to the length of radiotherapy.[13] It has been shown that X-rays and gamma radiation are capable of deteriorating bone properties thereby making the bone more susceptible to infections and to formation of associated lesions, possibly due to the effect on bone vascularity.[19]

Studies have indicated that post-radiation changes in bone and its microenvironment are associated with either inhibition or diminished bone formation.[20,21] Ionizing radiation is damaging to jaw bones due to the formation of hypo-vascular, hypo-cellular, and hypoxic bony tissue.[20] It can also affect the healing ability of the bone by mitigating the inflammatory process associated with residual periapical infection. It has also been demonstrated that radiation can cause functional impairment of the dental pulp.[6,22] The combined deleterious effect on the dental pulp and bone may be the culprit for the increased odds of acute PAs in OPC patients receiving radiation therapy.

Additionally, radiation can cause damage to salivary glands and reduce saliva secretion and pH of the oral environment.[23] This, in turn, can lead to xerostomia and increased risk for caries and pulpal damage resulting in higher risk for PAs.

Several limiting factors should be considered when evaluating the data of this study. Firstly, this was a retrospective study. As such, its design may overestimate the prevalence of pulpal pathology. The onset of caries and the occurrence of periapical lesions might have occurred earlier and cannot be directly attributed to oral cancer or radiotherapy. However, it enabled to analyze a large pool of data of OPC patients. Secondly, the patient population examined may have had additional underlying systemic or dental conditions affecting the odds for acute PAs. However, diabetes and smoking are significant comorbidities that can affect the OR of development of PAs.[17,24] After adjusting our results to diabetes, smoking and gingival and periodontal disease comorbidities, the OR was reduced but not significantly. Thirdly, socio-economic factors may have affected the decision of certain patients to seek medical and dental care in a specific hospital. Therefore, the prevalence of acute PAs in this study may also reflect socioeconomic disparities. Fourthly, as part of the diagnosis, the presence of periapical pathosis was confirmed by radiographic images. However, the specific technique used to take radiographic images (2-D or 3-D) was not assessed. Nevertheless, the present study evidently shows a higher prevalence of PAs in vulnerable population of head and neck cancer patients, especially those with a history radiation therapy. Fifthly, the need for the study is to investigate whether patients with head and neck cancer have additional dental needs that may result from the increase in pulpal pathology.

In conclusion, under the conditions of this study it appears that the odds for acute PAs are significantly higher in patients with a history of OPC. The odds for acute PAs increase further when OPC patients also received radiation therapy. There is further need to investigate whether patients with head and neck cancer have additional dental needs that may result from the increase in pulpal pathology.

INFORMED CONSENT STATEMENT

No patient consent was required for this study. At the University of Florida (UF), a limited data set of patient data, call the Integrated Data (IDR) is placed into the open-source search engine i2b2. i2b2 (informatics for integrating biology and the bedside) is a clinical data informatics framework which aims to create an efficient structure within which patients can be identified for clinical and translational research projects. When queried, the i2b2 search engine provides a totally de-identified data set. Research conducted only using that de-identified data set has been determined by the UF IRB to not meet the definition of human research. The study was reviewed by the UF Institutional Review Board (IRB), ethics, and privacy rules and was found in compliance with the UF IRB and Privacy rules for research on IRB approved de-identified data sets.

CLINICAL SIGNIFICANCE

The chance for development of acute PAs may be significantly higher in patients with a history of OPC and increase further when OPC patients also receive radiation therapy. Oral healthcare provider should be aware of this possible association.

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