Dental Pulp Status of Posterior Teeth in Patients with Oral and Oropharyngeal Cancer Treated with Concurrent Chemoradiotherapy

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Abstract

Introduction: The absence of tooth sensitivity has been observed in patients who have undergone radiotherapy. The aim of this investigation was to evaluate the effects of concurrent chemoradiotherapy on the pulp status of posterior teeth in patients with malignant oral and oropharyngeal cancer. **Methods:** Twenty-one patients diagnosed with malignant oral and oropharyngeal cancer undergoing concurrent chemoradiotherapy underwent cold thermal pulp sensitivity testing and electric pulp testing of 4 teeth, 1 from each quadrant, at 4 points in time (PT): before radiotherapy (PT1), after 30–35 Gy (PT2), at the end of radiotherapy at 66–70 Gy (PT3), and 4 months (PT4) after beginning radiotherapy. **Results:** All 84 teeth tested positive to cold thermal pulp sensitivity testing at PT1 (100%) and 25 teeth at PT2. No tooth responded at PT3 and PT4 (100%). A statistically significant difference ($P < .05$) existed in the number of positive responses between different points in time. **Conclusions:** Radiotherapy decreased the number of teeth responding to pulp sensitivity testing after doses greater than 30–35 Gy. *(J Endod 2015;41:1830–1833)*

Key Words

Concurrent chemoradiotherapy, pulp vitality, radiotherapy

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Oral cancer is the sixth most prevalent cancer worldwide and comprises about 85% of all head and neck cancers. Regions with a high incidence of oral cancer (>6.9/100,000) are North America, Brazil, South Africa, Europe, the Indian subcontinent, and Australia (1). A lack of tooth sensitivity was noted during the placement of restorations without anesthesia in patients who had received radiation therapy. Clinical data suggest normal blood flow and sensitivity of dental pulp are impaired in such patients. However, little is known about the direct effects of radiation on pulp status (2).

Ionizing radiation controls cell growth; thus, radiation therapy is a part of the treatment of malignant tumors. Radiation has to pass through healthy tissues to reach target cells, which may damage the DNA of normal cells (3). Radiation side effects are mucositis, loss of taste, xerostomia, dental caries, fungal and bacterial infections, osteoradionecrosis, difficulty in speech and mastication, periodontal disease, fibrosis of soft tissues, trismus, endarteritis, hyperpigmentation of the skin surface in the field of radiation, transient hair loss, and loss of pulpal vitality. A decrease in pulp vascularity has been noted with radiotherapy (4–7).

The determination of pulp vitality is an important step to assess the health or pathology of the pulp. These tests allow us to make decisions regarding endodontic intervention. An electric pulp tester and thermal sensitivity tests are reliable techniques to evaluate pulp status. Very little clinical data are available on pulp vitality after radiotherapy. An online PubMed and MEDLINE search revealed 79 studies using the following key words: radiotherapy, dental pulp, and pulp vitality. Only 8 were directly related to the current investigation. No study exists that determined the pulp status of posterior teeth in all 4 quadrants in patients submitted to radiotherapy.

The aim of this study was to determine the effects of concurrent chemoradiotherapy on the pulp status of posterior teeth in patients with malignant oral and oropharyngeal cancer at 4 different points in time (PTs).

Materials and Methods

Selection of Patients: Inclusion and Exclusion Criteria

The study was approved by the Institutional Review Board, Rajiv Gandhi Cancer Institute and Research Centre, New Delhi, India, and the Ethics Committee of PDM Dental College and Research Institute, Bahadurgarh, Haryana, India.

Informed consent was obtained from all subjects in the study. A total of 21 patients between 40 and 65 years of age with oral or oropharyngeal cancer at Rajiv Gandhi Cancer Institute and Research Centre were selected. None of the patients participating in the study reported impaired or lost sensory functions in the areas innervated by the 3 branches of the trigeminal nerve during the investigations. Four posterior teeth, 1 from each quadrant, were evaluated by the cold thermal test and the electric pulp test (Tables 1–6).

The inclusion criteria were patients in the age group of 40–65 years who received a maximum dose of 60–70 Gy with noncarious intact vital teeth and single surface restoration within the field of irradiation. The exclusion criteria were teeth with periodontal changes (pocket >3 mm, mobility > grade 1), teeth with a history of pain or presence of pain, dental trauma or an active carious lesion, pain during

TABLE 1. Mean Pulp Testing for 4 Quadrants at All Points in Time

Point in time	1st Quadrant		2nd Quadrant		3rd Quadrant		4th Quadrant	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PT1	13.85	4.54	12.52	9.031	14.05	8.435	13.76	7.348
PT2	16.71	9.613	14.81	10.477	15.81	10.458	17.38	13.370
PT3	21.00	9.772	19.62	14.831	18.86	9.194	20.10	13.076
PT4	36.19	10.675	30.76	13.160	31.00	9.899	33.05	15.870
P value	.000		.000		.000		.000	

PT, point in time; PT1, before RT; PT2, at 30–35 Gy; PT3, at 60–70 Gy; PT4, at 2 months after RT; RT, radiation therapy; SD, standard deviation.
Statistically significant change in pulp testing values ($P < .01$).

apical palpation and vertical or horizontal percussion, and teeth restored on more than 1 surface. Concurrent chemoradiotherapy was administered using cisplatin at a dose of 35 mg/m^2 on a weekly basis during the period the patient was undergoing radiotherapy.

Data Collection

All teeth were examined and showed no signs of pulp necrosis, such as changes in crown color, history of pain, or pain on apical palpation and percussion. Patients' dental and medical history were recorded including name, age, sex, tumor site, location, diagnosis, and TNM stage. The results of pulp sensitivity testing to cold testing by difluorodichloromethane at −50°C (Endofrost; Roeko, Langenace, Germany) were recorded at 4 different intervals:

PT1 (before radiotherapy)
PT2 (after 30–35 Gy)
PT3 (at the end of radiotherapy at 66–70 Gy)
PT4 (4 months after beginning radiotherapy)

After relative isolation, cold testing with an iced cotton pellet and electric pulp testing were performed.

Radiation Technique

Most of the patients with head and neck carcinomas treated with a curative intent receive a dose between 66 and 70 Gy. This dose is usually given over a period of 7 weeks once a day for 5 days a week at a dose of 2 Gy per fraction. Radiation was performed using intensity-modulated radiotherapy. Using fusion software, computed tomographic imaging, magnetic resonance imaging, and positron emission tomographic scans were combined, and contouring was performed by a radiation oncologist to obtain a color dose wash with a dose volume histogram (Fig. 1).

TABLE 2. Mean and Maximum Radiation Dose at All Points in Time

Point in time	Correlation	Maximum dose	Mean dose
PT1	Pearson correlation	0.207	0.235
	P value	.367	.304
PT2	Pearson correlation	0.287	0.283
	P value	.208	.213
PT3	Pearson correlation	0.383	0.425
	P value	.087	.055
PT4	Pearson correlation	0.452	0.455
	P value	.040	.038

PT, point in time; PT1, before RT; PT2, at 30–35 Gy; PT3, at 60–70 Gy; PT4, at 2 months after RT; RT, radiation therapy.
Statistically significant correlation at PT4 ($P < .05$).

TABLE 3. Cold Test Responses in First Quadrant at All Points in Time

1st Quadrant	Cold testing				Total	*P* value
	PT1	PT2	PT3	PT4		
Negative response	0 0.00%	16 76.2%	21 100.0%	21 100.0%	58 69.05%	.000
Positive response	21 100.0%	5 23.8%	0 0.0%	0 0.0%	26 30.95%	
Total patients	21 100.0%	21 100.0%	21 100.0%	21 100.0%	84 100.0%	

PT, point in time; PT1, before RT; PT2, at 30–35 Gy; PT3, at 60–70 Gy; PT4, at 2 months after RT; RT, radiation therapy; SD, standard deviation.
Statistically significant change in response ($P < .05$).

Statistical Analysis

The analysis of variance and chi-square tests were used for statistical analysis at a significance level of $P < .05$.

Results

A total of 84 posterior teeth in 21 patients with a mean age of 52.5 years were tested. All teeth showed positive responses to the cold thermal sensitivity test at PT1 (100%) and 25 at PT2. No tooth responded to pulp sensitivity testing at PT3 and PT4 (0%). A highly statistically significant difference ($P < .05$) existed in the number of positive responses between the different points in time (PT1 through PT4) for all the patients receiving radiotherapy.

A statistically significant correlation ($P < .05$) was found between the maximum dose per tooth in each quadrant and decreased sensitivity at PT4. No statistically significant correlation existed between the tumor site and the tooth affected during radiotherapy.

Discussion

It has been suggested that radiotherapy may lead to decreased vascularization, fibrosis, and atrophy of the dental pulp (8). Patients undergoing radiotherapy may present with teeth reacting negatively to pulp sensitivity testing. Root canal therapy may be indicated to prevent apical periodontitis or extraction, which would possibly have more serious complications (osteoradionecrosis) in a patient undergoing radiotherapy (9). Ionizing radiation during radiotherapy in the head and neck region usually results in complex oral complications such as hyposalivation, mucositis, taste loss, trismus, and osteoradionecrosis. Mucositis and taste loss are reversible consequences, usually subsiding early after irradiation, whereas hyposalivation is commonly irreversible (10).

Irradiated mucocutaneous tissues show increased vascular permeability that leads to fibrous deposition, subsequent collagen formation, and eventual fibrosis. Irradiated salivary tissue degenerates after a relatively small dose, leading to markedly diminished salivary output (7). Blood vessels that have received ionizing radiation may

TABLE 4. Cold Test Responses in Second Quadrant at All Points in Time

2nd Quadrant	Cold testing				Total	*P* value
	PT1	PT2	PT3	PT4		
Negative response	0 0.00%	13 61.9%	21 100.0%	21 100.0%	55 65.47%	.000
Positive response	21 100.0%	8 38.1%	0 0.0%	0 0.0%	29 34.5%	
Total patients	21 100.0%	21 100.0%	21 100.0%	21 100.0%	84 100.0%	

PT, point in time; PT1, before RT; PT2, at 30–35 Gy; PT3, at 60–70 Gy; PT4, at 2 months after RT; RT, radiation therapy.
Statistically significant change in response ($P < .05$).