Original Paper

A Clinical Study Determining Pulp Vitality in Oropharyngeal Cancer Patients Undergoing Radiotherapy Using Diagnostic Tool-Pulse Oximetry

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ABSTRACT: Pulse oximetry is an equipment that evaluates pulp vitality for concrete endodontic diagnosis and treatment plan. One of the treatment methods of oropharyngeal cancer is radiotherapy. Radiotherapy has some harmful effects on dental pulp that affects pulp vitality. The objective of study was to assess pulp vitality before, at the end of radiotherapy and six months after radiotherapy (RT) in oropharyngeal cancer patients undergoing radiotherapy. 25 patients who were diagnosed with oropharyngeal cancer having asymptomatic intact crowns were selected for the study. Pulp vitality was checked before the commencement of radiotherapy (PV1), immediately after radiotherapy (PV 2) and six months post radiotherapy (PV 3). Pulp vitality of first posterior tooth was selected of each patient and was checked with pulse oximetry. Paired t-test was used as statistical analysis. Statistically significant difference was observed when PV 1 and PV 2, PV 1 and PV 3 and PV 2 and PV 3 were compared amongst each other. There was reduction noted in mean SpO2 value when groups PV 2 and PV1 were compared. This was statistically significant. Statistically significant increase in mean SpO2 value was observed six months post radiotherapy (PV 3). Thus, it can be concluded that statistically significant reduction in mean SpO2 level post radiotherapy recovers after six months.

KEYWORDS: *Irradiation, Oropharyngeal tumour, Pulp vitality, Pulse oximetry.*

Introduction

Oropharyngeal cancer is an entity related to malignancy of oral and para-oral tissues. It mainly involves tonsils, base of tongue, soft palate and walls of pharynx [1].

The treatment of such tumour mainly includes irradiation, chemotherapy or surgical resection of tumour tissue [2].

Irradiation helps in controlling the growth of cancerous cells. Besides treating the malignant cells, it also targets the normal nearby tissue.

Teeth are affected as they appear in the field of ionizing radiation. The core of the tooth contains vital material known as dental pulp. Dental pulp is made up of connective tissue, blood vessels and nerves [3].

Events of inflammation may occur in dental pulp due to irradiation [4].

Early effects of ionizing radiation are inflammatory changes and ischemic changes of dental pulp followed by later effects being fibrosis and pulpal atrophy [5].

The status of pulp is very essential to be understood for an accurate endodontic diagnosis and appropriate treatment planning. Pulp status includes two entities: pulp sensibility and pulp vitality. Pulp sensibility deals with neural response while vitality deals with vascular response of pulp. Pulse oximetry is one such device that measures pulp vitality. Pulse oximetry is an easy-to-use tool and measures oxygen saturation of pulpal blood [6,7].

Many researches are already been carried out suggesting a relation between oxygenation of blood in teeth and index finger [8]. Studies have also proved that pulse oximetry is definitive tool for determination of non-vital tooth. It also identifies pathological events in dental pulp [9].

The aim of the study was to determine the impact of irradiation on pulpal blood flow in oropharyngeal cancer patients using pulse oximetry. The objective was to assess pulp vitality before, immediately after radiotherapy and six months post radiotherapy in irradiated oropharyngeal cancer patients.

Material and Methods

The study was performed corresponding to the Helsinki Declaration principle.

The study was in acceptance to the board of ethics of Manubhai Patel Dental College and Oral Research Institute, Vadodara, Gujarat (REF. NO: IEC/MPDC_137/CONS-27/18).

A total of 25 patients between 30 and 65 years of age with oropharyngeal cancer who were planned to undergo radiation therapy were selected (15 males and 10 females). A dose of

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60-70 Gy radiation was given. A prior informed consent was obtained from all the subjects in the study. Patients having intact tooth and who had signed the informed consent were included in the study. Patients having former report or current history of tooth pain, carious or broken tooth, tooth with history of root canal therapy or filled tooth, discolored tooth, periodontally compromised tooth and tooth having positive sign of pain on palpation apically or percussion horizontally and vertically were excluded from study.

To check pulp vitality

Pulp vitality was checked before the commencement of radiotherapy (PV 1), immediately after radiotherapy (PV 2) and six months post radiotherapy (PV 3). First mandibular premolars were selected of each patient for the study. Pulp vitality of index finger was taken for reference. The results of pulp vitality testing were measured using pulse oximetry (Argus OXM Plus Schiller Healthcare India Pvt Ltd, India) with Y type sensors (Nellor Oximax Dura-Y D-YS sensor, Tyco Healthcare Group LP, Pleasanton, CA). The mandibular premolar was isolated with cotton roll and saliva ejector. The emitting diode was placed on middle third area of buccal surface of the tooth while the receiving diode was placed on the middle third area of lingual surface of the tooth. Figure 1 shows the recorded SpO_2 levels before RT (PV 1), at the end of radiotherapy (PV 2) and six months post RT (PV 3). Paired t-test was used for statistical analysis. Statistical analysis was performed using SPSS 20 software program 20 (SPSS Inc., Chicago, IL, USA).

Figure 1. Pulse oximetry readings before radiotherapy (PV 1) (a), at the end of radiotherapy (PV 2) (b) and six months post radiotherapy (PV 3) (c).

Results

The mean age of the participants was 46.04 years. Out of 25 patients, 15 were males (60%) and 10 were females (40%). There were 16 patients of carcinoma of oropharynx (64%) and 9 patients of oral cancer (36%). All the teeth taken in the study were mandibular first premolar (100%). The mean SpO_2 before RT (PV 1) was 93.60, after radiotherapy (PV 2) was 75.12 and six months after RT (PV 3) was 81.04 as shown in Table 1.

There was a statistically significant decrease in mean SpO_2 at the end of radiotherapy while increase in the mean SpO_2 six months after radiotherapy. While comparing different groups, the mean value difference between PV 1 and PV 2 was 18.480, between PV 1 and PV 3 was 12.560 and between PV 2 and PV 3 was-5.920. This was statistically significant ($p<0.001$) as provided in Table 2.

The Figure 2 shows comparison of mean SpO_2 between finger and teeth at different time intervals. The mean SpO_2 of teeth before RT was 93.6, immediately after RT was 75.12 and 6 months after RT was 81.04. The mean SpO_2 of index finger before RT was 95.16, immediately after RT was 94.6 and 6 months after RT was 94.92. Thus, the mean SpO2 value remained constant for index finger at different time intervals and variable dosage. While mean SpO_2 value of tooth dropped after RT (PV 2) and gradual raise was noted after six months after RT (PV 3).

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Table 1. Mean, standard deviation and standard error mean of oxygenation level of pulp at different time interval.

	N	Mean	Std. Deviation	Std. Error Mean
Before Radiotherapy (PV 1)	25	93.60	0.707	0.141
Between 60-70 Gy (PV 2)	25	75.12	1.013	0.203
After 6 months of Radiotherapy (PV 3)	25	81.04	0.841	0.168

Table 2. Mean, standard deviation, standard error mean and p-value differences comparing pulp oxygenation of different groups.

Difference	Paired Differences					t	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
Before RT (PV 1)- Between 60-70 Gy (PV 2)	18.480	1.229	.246	17.973	18.987	75.194	<0.001
Before RT (PV 1)- After 6 months of RT (PV 3)	12.560	1.294	.259	12.026	13.094	48.548	<0.001
Between 60-70 Gy (PV 2)- After 6 months of RT (PV 3)	-5.920	1.320	.264	-6.465	-5.375	-22.418	<0.001

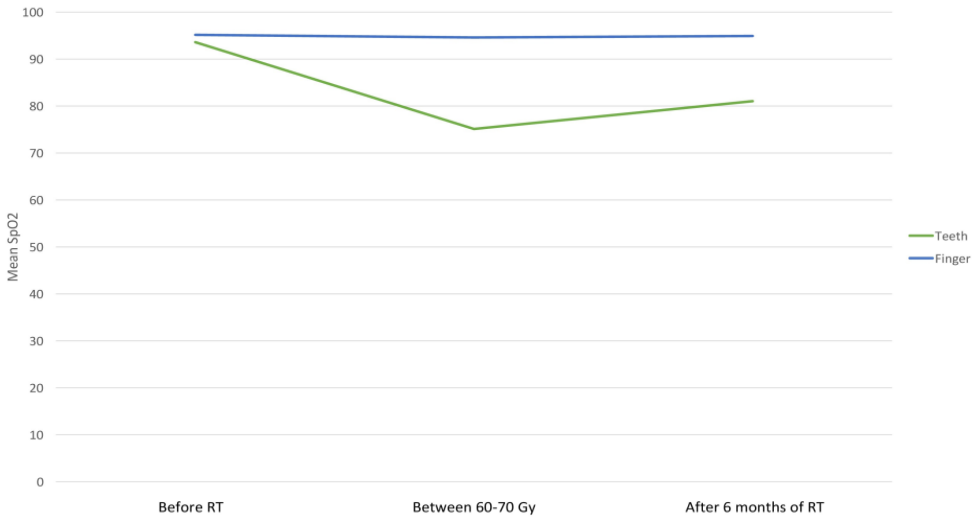

Figure 2. Comparison of mean SpO2 between finger and teeth at different time intervals.

Discussion

There is a wide range of knowledge and studies suggesting the role of radiotherapy in rapid development of carious microbes in oral environment but its knowledge pertaining to effect on dental pulp is scarce [10,11].

Pulse oximetry is a device that is used to record vitality of dental pulp. Vitality is mainly recorded in case of dental trauma due to reduced oxygenation levels of injured dental pulp [12,13].

However, knowledge of condition leading to lowered oxygenation other than trauma is limited [7].

The purpose of the study was to check changes in pulp oxygenation levels after radiation therapy in teeth with a clinical diagnosis of a healthy pulp. The investigated teeth were free from large restorations or decay as well as significant periodontal disease. Teeth with extensive restorations are generally inappropriate for pulse oximetry measurements.

Also, teeth with large restorations or decay may show signs of inflammation or tertiary dentin formation in the pulp chamber. This affects pulse oximetry readings. Periodontal

disease may also lead to endodontic disease. Thus, teeth with large restoration, caries or periodontitis may provide altered readings [14].

Subjects between 30-65 years were selected as oropharyngeal cancer is mainly observed in this particular age group.

Previously studies have been performed on maxillary incisors, maxillary canines, mandibular incisors and mandibular canines which are mono-radicular [14].

In our study, first mandibular premolars were selected. First mandibular premolars are mainly mono-radicular [15].

The method used for measuring pulse oximetry was also in accordance to various studies carried out previously [14,16,17].

The vitality of index finger was taken as a control group in our study. The value of pulp vitality of teeth and vitality of index finger were compared at different time intervals.

The effect of radiation not only alters the configuration of cancerous tissue but also affects the normal vasculature and connective tissue like pulp. Thus, changes like hyperemia, vascular inflammation, ischemia followed by tissue hypoxia and finally necrosis can be noted in pulp [18].

Low SpO_2 is mainly due to inflammatory reaction that occurs in the pulpal tissue. The results of this study supported the results of previous studies stating that inflammatory events take place in the pulp tissue after the commencement of radiotherapy treatment. In our study, mean SpO_2 at 60-70Gy was 75.12% which is nearer to the value obtained in study done by Kataoka et al which was 77%. Decrease SpO_2 observed in PV 2 category in the study is due to incomplete/partial necrosis of pulp with continuation of blood flow in rest of the healthy pulp tissue [14].

Dimitrievich et al and Yang et al studied changes in vasculature which stated that irradiation of 2 Gy significantly destroys small capillaries with diameter below 10nm. Dosage of 20 Gy damages venules and capillaries having diameter more than 10nm. So, it is presumed that injury to vasculature is more severe at 60-70 Gy leading to reduced SpO_2 levels [19,20,21].

There was decrease in SpO_2 after RT of 60-70Gy (PV 2) and increase in SpO_2 was noted again 6 months after completion of RT (PV 3) which was statistically significant. The results were in accordance to study done by Kataoka et al. Dental pulp has the characteristic of self-healing and remodeling. It can reconstruct new blood vessels and thereby render angiogenesis [14].

When radiation has effect on dental pulp, there is reduction of microcirculation and oxygenation leading to hypoxia that may initiate vasculogenesis both in normal as well as cancerous tissue. Vascular endothelial growth factor is stimulated during this phase which plays an important role in angiogenesis [22-26].

Rabbani et al. stated that condition causing hypoxia stimulates HIF-1∝ factor (Hypoxia inducible factor) which helps in stimulating VEGF factor (Vascular Endothelial growth factor) via cytokines that render angiogenesis [27,28].

Thus, although the effect of RT on dental pulp that leads to inflammatory effects, hypoxia, fibrosis and cellular death of pulp, the pulp has capacity to regenerate new blood vessels with the help of growth factors after a period of 6 months of RT.

Detrimental effects like osteoradionecrosis and radiation caries also occur as a consequence of radiotherapy. Radiation caries is a rapidly spreading dental disease. Periapical tissue may also get affected due to radiotherapy leading to osteoradionecrosis. Thus, in such condition, proper diagnosis of vitality status of pulp with clinical and radiographic finding is required in oral and oropharyngeal cancer patients.

Long term follow-up of 6 months-1 year is required before attempting root canal therapy. Periapical changes and negative or reduced response of pulp vitality if noted even after a long-term follow-up, initiation of endodontic treatment should be taken into consideration. Further, follow up studies are required to show the consequences of RT on dental pulp for longer period of time.

A drawback of our study is related to the presence of hard tissue like enamel and dentin that surrounds soft connective tissue-dental pulp. SpO_2 reading vary because of the thickness of enamel and dentin. As the age progresses, secondary dentin formation occurs. This can affect the penetration depth of light beam leading to reduced SpO_2 reading.

Conclusion

Thus, from the results of the study, it can be concluded that there is decrease in SpO2 from initiation till end of radiotherapy (between 60-70 Gy) but after 6 months there is increase in SpO2 which is statistically significant.

So, it is very crucial to wait for a period of 6 months-1 year to check vitality status of pulp.

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Conflict of interests

None to declare.

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