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Original Research Article

Dental Pulp Oxygen Saturation in Periodontally Compromised Teeth

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Abstract: Teeth periodontitis is an infectious disease leading to loosening of surrounding supporting structures, these surrounding tissues are connected to pulp tissue through apical foramen. The aim of this study is to evaluate the pulp health status clinically using pulse oximeter in sound periodontally compromised teeth. Sixty teeth are the experiments were divided into 3 groups, 20 teeth for each group as follows: moderate periodontitis, severe periodontitis and advanced periodontitis. The Pulp oxygen saturation level was 86.7, 84.2 and 78,8 moderate periodontitis, severe periodontitis and advanced periodontitis respectively. According to these results there is a direct proportion between decreased oxygen saturation level of pulp tissue and the severity of periodontitis.

Keywords: Dental Pulp, Oxygen, Periodontitis, Pulse Oximeter.

INTRODUCTION

Periodontitis is an infectious disease affecting the periodontium, leading to losing of periodontal ligaments, alveolar bone and leading to clinical attachment loss with/out gingival recession. There are wide range in periodontitis condition, the latest classification suggested by American academy of periodontitis (AAP) in which there is a new classification include the staging and grading of periodontal diseases depending on amount of clinical attachment loss (CAL) (Caton *et al*., 2018).

The relationship between the pulp of a tooth and its surrounding periodontium is indisputable. A healthy periodontal tissue feeds and supports the dental roots. There is a direct communication between the pulp and the periodontal ligament through dentinal tubules, lateral and/or accessory canals, and apical foramen. Moreover, chronic irritations (periodontitis and caries) may trigger a defense mechanism on the pulp surface. The pulp protects itself by creating secondary or tertiary dentin in the decayed region, which makes the pulp chamber become narrow. Moreover, irritations in the pulp can also cause pulpal calcifications and stone formation (Terlemez *et al*., 2018a)

There is consensus that pulpal disease can initiate or perpetuate periodontal disease through the apical foramen. Later studies demonstrated that teeth affected with chronic periodontitis showed pathologic changes in pulp in the form of inflammatory alterations (Gautam *et al*., 2017).

Assessment the pulp vitality and health condition are a fundamental crucial diagnostic procedure for treatment of carious and traumatized teeth. Most used tests in practice are thermal tests and electrical pulp tests. Radiographs, mobility, percussion, palpation, transillumination, and evaluating the discoloration of a tooth crown have also been used as clinical aids to distinguish between a normal or necrotic pulp (Gopikrishna *et al*., 2007).

Pulse oximetry (PO) can be used as a diagnostic tool to assess vascularization; the subjective test most compared to PO was the cold test. PO has shown a good sensibility and specificity, and it has been used in different clinical situations. Pulse oximetry has a high potential as a tool for the diagnosis of pulp vitality (Almudever-Garcia *et al*., 2021). The knowledge of the oxygen saturation in normal dental pulp is essential for scientific advance about clinical decision-making process. New information's about oxygen saturation is require particularly involving the efficiency of pulse oximetry (Estrela *et al*., 2017). An accurate assessment of the pulpal status is crucial for proper endodontic diagnosis. It is known that the vascular supply of the tooth is a more accurate determinant to pulp vitality. However, the current vitality tests rely on patient response to induced nerve stimulation (Sadique *et al*., 2014). The study designed to assess the pulp oxygen

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saturation level in sound periodontally compromised (moderate, severe and advanced periodontitis) teeth using pulse oximeter.

MATERIAL AND METHODS

Sixty patients complaining periodontal cases attended in Aliraqia dental school clinic, since January 2023 to January 2025. These patients are divided into 3 groups twenty patient each group according to latest AAP classification as follows: moderate periodontitis (stage 2), severe periodontitis (stage 3), advanced periodontitis (stage 4). 20 highest patient's index finger's readings elected and used as positive control.

Inclusion Criteria

1. The teeth selected in this study should being sound and periodontally compromised.
2. The clinical attachment loss, 2mm and more, with/out deep periodontal pocket, with/out vertical and horizontal alveolar resorption, included in study.

Exclusion Criteria:

Abrasion, attrition, erosion, cracked teeth, wedge-shaped defects, trauma, Carious, previously restored teeth and root canal filling teeth are excluded from the study.

Pulse Oximeter

The oxygen saturation evaluated by handheld oximeter CONTEC (CMS60D) with pediatric prob, its previously used in this study conducted by (Estrela *et al*., 2017).

Teeth isolated by cotton roll ensure a secured fixed support of oximeter prob on tooth surface (figure 2,3) to allow correct measuring as the probe diodes are parallel.

The oxygen saturation level % were registered from experimental teeth, and patient's index fingers as positive control group.

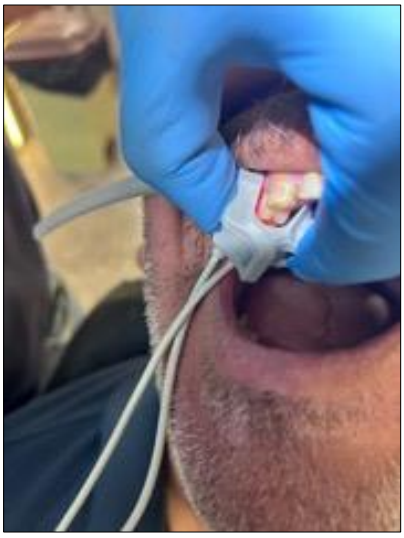

Figure 1: Shows the oximeter application on tooth

Figure 2: Shows the pulp oxygen level 82 %

RESULT

This study considers the mean variables and standard deviations as quantitative data. After application of PO, the mean values of Sao2 of pulp structure were 86.7 (sd 3.03) and 84.2 (sd 2.96) moderate periodontitis and severe periodontitis respectively, there was non-significant difference as the p value 0.27 (table 1). The data showed decreased So2 level of pulp tissue mean in advanced periodontitis 78.8 (sd 1.35) when compared to moderate periodontitis with non-significant difference as p value 0.87(table 2). After comparing the mean values of severe periodontitis and advanced periodontitis there was non-significant difference as the p value 0.17 (table 3).

Assessment the pulp oxygen saturation of all periodontitis groups compared with index finger So2 (positive control group) we found that the po2 mean value was 96.7 which is much higher than experimental groups.

Table 1: Comparison between moderate periodontitis and severe periodontitis oxygen saturation level

	mean (sd)	**median [Q25-75]**	**min**	**max**	**n**
MPER	86.7 (3.03)	86.0 [84.0; 88.0]	83.0	94.0	20
SPER	84.2 (2.96)	83.0 [82.0; 85.2]	81.0	92.0	20
	correlation coefficient		n	p	Test
SPER	0.258		20	0.27	Spearman

Table 2: Comparison between moderate periodontitis and advanced periodontitis pulp tissue oxygen saturation level

	mean (sd)	median [Q25-75]	min	max	n
MPER	86.7 (3.03)	86.0 [84.0; 88.0]	83.0	94.0	20
APER	78.8 (1.35)	79.0 [78.0; 80.0]	76.0	82.0	20
		correlation coefficient	n	p	test
APER		-0.0379	20	0.87	Spearman

Table 3: Comparison between moderate periodontitis and advanced periodontitis pulp tissue oxygen saturation level

	mean (sd)	**median [Q25-75]**	**min**	**max**	**n**
APER	78.8 (1.35)	79.0 [78.0; 80.0]	76.0	82.0	20
SPER	84.2 (2.96)	83.0 [82.0; 85.2]	81.0	92.0	20
	correlation coefficient		n	p	test
SPER	0.317		20	0.17	Spearman

Table 4: The mean and SD od pulp tissue So2 level of all periodontitis groups compared to the control.

	n	**Mean**	**Std. Deviation**
MPER	20	86.65	3.03
SPER	20	84.15	2.96
APER	20	78.85	1.35
IND	20	96.7	1.22

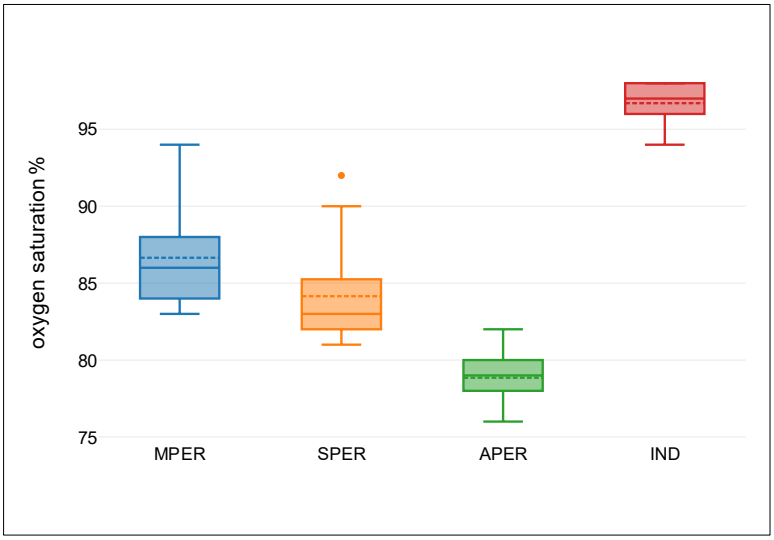

Figure 3: Shows the percentages of oxygen saturation % in different groups

DISCUSSION

The relationship between periodontal disease and pulp tissue change has been reported in many studies, chronic irritations (periodontitis and caries) may trigger a defense mechanism on the pulp surface. Teeth affected with chronic periodontitis showed pathologic changes in pulp in the form of inflammatory alterations, ocalized necrosis, calcification, root resorption. (Terlemez *et al*., 2018b) (Gautam *et al*., 2017).

In this study the assessment of pulp condition in different periodontitis stages and severity, was done by using the pulse oximeter assuming the oxygen saturation level and the result were indicating there are considerable decrease in pulp oxygen saturation level as periodontitis progression rate increase which means inversely proportional with severity of the periodontal disease., mean values were 86.7%, 84.2%, 78.8% for moderate periodontitis, severe periodontitis and advanced periodontitis respectively.

These result convenient with previous study conducted by (Gautam *et al*., 2017).

His finding was 52% of severe periodontitis teeth showed pulp calcification and pupl paritial necrosis. oxygen saturation levels in the normal pulp could be established was 88.45% (minimum 83.97%, maximum 92.93%) in primary incisor teeth, which could be helpful as a clinical reference criterion (Saikiran *et al*., 2022).

(Anusha *et al*., 2017) there orginal study findings were 85.4 % So2 level in reversible pulpitis, 81.6% Irreversible pulpitis and 70.7% in necrotic pulp.

Inflmation of pulp, pulp necrosis, vasodilation of pulp tissue blood vessels, vascular atrophy, and pulp volume change (pulp edema) associated with severe and advanced periodontitis teeth with different membrane level (Tan *et al*., 2020).

Laser doppler flowmetry (LDF) device used to assess the pulpal blood flow and oxygen saturation level in primary teeth in comparison to pulse oximeter (PO) there was non-significant differences in sound primary molars, however there was a significant difference between LDF and PO readings in physiologic root resorption primary molars (Hüseyin Karayılmaz & Zuhal Kırzıoğlu, 2011).

Pulse oximeter is an atraumatic investigation device hence can be used in children to assess the pulp vascularization in both immature and mature teeth, the mean oxygen saturation level in immature teeth is higher than mature teeth this is attributed to that closed apex will reduce the blood flow unlike open apex (Bargrizan *et al*., 2016).

Two essential requirements for a PO sensor dedicatedto dental use are: to be shaped in a way that allows the transmitter and the detector to be parallel while fixed onto the tooth, and to be self-mounting (rather than hand-held), in order to provide more reliable readings (Igna *et al*., 2022).

There are many strategies in Periodontitis treatment plan ranged from non-surgical to guided tissue regeneration (surgical approach). The dental pulp health in periodontally compromised teeth usually neglected, it supposed to be checked in advanced stages of periodontal disease. According to our and previous studies results we suggest that the pulse oximeter is a good noninvasive diagnostic tool also it provides quantitively readings for dental pulp vascularization, and oxygen saturation level for both sound periodontally compromised teeth and traumatized teeth. The values of oxygen saturation level bellow 80% the pulp tissue health is questionable and may need an endodontic treatment as an adjunct treatment along with long period management of periodontitis.

Ethical Approval: This study was approved by ethical research committee/College of Dentistry/Al-Iraqia University (The Ethical approval Number is: ESA & HER- 21-04-10-2025 on 10th April 2025). The patients received a complete information regarding the aim and nature of the study before enrollment and then signed an informed consent form. All procedures were done according to the Helsinki Declaration and later amendments for human research.

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