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Pulp Vitality Testing on A Crowned Tooth- A Narrative Review

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Abstract:

Accurate assessment of the state of health of the dental pulp is a cornerstone in successful diagnosis and management of the endodontic pathosis. Pulp testing combined with information taken from the history, examination and radiographs leads to the diagnosis of the underlying disease. The commonly used electric pulp test and thermal tests are sensibility tests which extrapolate pulp health from sensory response. Pulp vitality tests attempt to examine the vascularity of pulp, as this is viewed as a better measure of true health than sensibility tests. However, in teeth with full-coverage restoration determining the health of pulp through vitality testing can be challenging due to various reasons pertaining to the tests themselves and the special conditions of teeth. This paper aims to review the literature regarding various pulp vitality testing on teeth with full coverage restoration so we can carefully interpret and closely scrutinise false results that can lead to misdiagnosis.

Introduction:

Pulp vitality represents the state of health of the tooth pulp and serves to establish whether the tooth is still “alive”. Pulpitis is a chronic, intermittent and progressive condition which is unpredictable and may or may not have acute phases. At some stage, the pulp is irreversibly

damaged leading to necrosis of the tooth. The prediction of pulp necrosis dictates the course of treatment.

An Ideal pulp test must be non-invasive, accessible, accurate in detecting disease and clinically easy to perform. The true assessment of pulpal tissues state can be determined only histologically. Pulpal tissues cannot be directly inspected and hence indirect methods that determine the state of pulpal health can be used. One of the ways is assessing the condition of the nerves within the dental pulp is called as pulp sensibility tests and another type assesses the vasculature of the pulp i.e., vitality tests.

Sensibility is defined as "the ability to respond to a stimulus" [1]. Pulp sensibility tests do not assess the pulpal blood supply. All these tests assess whether the pulp responds to the applied stimulus and hence called as Sensibility tests. Sensibility test can be performed with electrical, mechanical, or thermal stimuli. All the test protocols involves an attempt to determine the responsiveness of pulpal sensory neurons and hence the patient's subjective response is used to determine the functionality of the nerve fibres.

Usually combining various pulp sensibility tests has been advocated. Studies by Weisleder [2] et al evaluating the efficiency of 3 pulp testing methods found that use of both cold test and EPT provides a more accurate diagnosis, while studies by Jespersen et al found that combining EPT and cold testing with endo ice yielded an agreement of 67.5%.[3]

The limitations of pulp sensibility tests were overcome by pulp vitality testing methods such as pulse oximetry (PO), laser Doppler flowmetry (LDF) and ultrasound Doppler flowmetry (UDF). All of these methods evaluated pulpal blood flow thereby detecting the integrity of the pulpal vasculature without relying on the patient's response, hence are thought to deliver more accurate pulp status. [4]

All the pulpal tests performed and interpreted must be done in conjunction with other findings and periapical radiographs. Hence, the pulp tests on their own may not be meaningful without other diagnostic aids like radiographs. Vital preparations of crowned teeth pose a diagnostic difficulty due to various challenges including the production of tertiary dentin as a defence mechanism from the pulp while undergoing restorative preparation of the tooth.[6] Another factor is the heat that is produced during crown preparation. Ozturk et al, has evaluated that the temperature change during a cavity preparation is about 5.5% if water coolant is not used.[5] The type of prosthetic material used and the thickness of the restorations themselves with the amount of tooth structure removed interfere with the tests result.[6] It has also been estimated that about 32.5% of vital teeth used as abutment in bridge suffers pulpal damage over a period of time.[7]Another study by Goodacre et al, has concluded that about 7% of resin bonded prosthesis failed due to caries which will warrant further intervention and diagnosis.[8] This review provides information on the reliability and diagnostic accuracy of the pulp vitality and sensitivity test for assessing the pulp status of crowned teeth.

2. Pulp testing methodologies and effectiveness:

2.1 Sensibility tests:

2.1.1 Cold test:

When the tooth or the restoration is introduced to a cold stimulus, there is reduction in the temperature of the tooth. The nerve fibres within the pulp will respond to the change in

the temperature if they are viable but will not respond in the case of necrosed pulp. The response to the stimuli is achieved by the contraction of the dentinal fluid leading to a rapid outflow of liquid within the patent tubules.[9]

Currently, there are several different cold testing agents and methods, the major difference between them is the temperature of the testing material and hence the temperature change produced by them. According to Chen and Abbot, dry ice sticks are the most easily available, reliable and fastest agent to be used in a clinical setting to test the pulpal response to a cold stimulus [10]. In the case of teeth with full coverage restoration like prosthetic crowns frozen carbon dioxide has been said to be effective in conjunction with other testing methods [12]

The most widely used methods for performing the cold test is refrigerant spray due to its easy availability and a reproducible test result. 1,1,1,2- tetrafluoroethane is used as it is environmentally friendly and has a temperature of 226.2°C. It is usually applied in large #2 cotton pellet for maximum effectiveness [12]

Waleed Almutairi et al, tested the efficiency of cold testing on crowned teeth by drying the teeth with 4x4 gauze later testing with endo ice applied at the middle third of the crown for both the control and test tooth and noted that 95% of necrotic teeth had no response to cold test and 66% of vital teeth had response to cold testing [13]

Christopher D. Parks et al, tested the intrapulpal temperature changes using a thermal probe in extracted premolars with various prosthetic crowns. The testing agent of choice 1,1,1,2-tetrafluroethane was applied to the middle third of the tooth for 5 seconds which produced temperature changes similar to that of natural teeth [14]

2.1.2 Electrical pulp testing:

The electric testing of pulp does not reflect the histologic health or disease status of the pulp. A pulpal response to the electric stimulus denotes the presence of viable nerve fibres in the pulp that are capable of responding. The readings of the pulp test are dependent on the comparable readings obtained from the control tooth tested on the same patient with a similar electrode position on both teeth [15]

The principle of electrical pulp testing is to stimulate the A delta fibres present in the pulp- dentin complex by applying an electrical stimulus on the tooth surface. If intact A delta fibres are present, it results in an ionic shift in the dentinal fluid causing depolarization and generation of action potential of the nerve [16]

Tooth should be dried off completely so as to make sure that there is no stimulation of the periodontium. Often a conducting medium is applied on the tooth surface to ensure maximum conduction from the electrode to the tooth surface. EPT test require direct contact with the tooth to be tested and hence this can be a challenge in tooth with extensive restorations. A small tip may be beneficial such that it can be placed well below the crown margin rather than a standard electrode tip. [17] The numerical value of the response is not critical and cannot be used to assess the health or state of the pulpal tissue. Electric pulp tests do not induce pain and therefore they cannot be used to reproduce the symptoms reported by a patient. Hence, the results of electric pulp tests should only be interpreted as “response” or “no response”. [18]

In cases with extensive restoration or when complete coronal coverage is present a bridging technique has been prescribed. Dental instrument like a explorer can be used to contact the remaining natural tooth structure, which is then coated with conducting medium like tooth paste and then the pulp tester probe is kept in contact with the side of the explorer to provide the electrical current which is transmitted through the explorer to the tooth. Testing of EPT by bridging technique by Waleed Almutairi et al on full coverage restorations gave an accuracy of 67% [3]

2.1.3. Vitality tests on crowned teeth:

Combining both cold test and bridging EPT didn't not produce a more accurate results compared to both tests done separately. In teeth with vital and nonvital pulps cold test was found to be more reliable than EPT for determining the pulpal health [6]

2.2 Vitality tests:

The vascular supply of the teeth can provide a better note of the pulpal status of the tooth than sensibility tests, the various technologies used or in development for ascertaining the pulpal vasculature which could prove to be useful are as follows

2.2.1 Laser doppler flowmetry:

Laser Doppler flowmetry (LDF) is used to assess the blood flow in microvascular systems. Various methods are being employed to adapt the technology for assessing the pulpal vasculature which acts as a microvascular system. A diode is used to emit a stream of infrared light beam through the pulp chamber of a tooth. The infrared light then gets scattered as it passes through the pulp tissue. According to Doppler principle there is the frequency of light beam which shifts when passing through the moving red blood cell while staying the same when passing through stationary tissue. The sensor will measure Doppler shift by measuring the speed at which the red blood cells are moving. [19]

Multiple studies have shown the accuracy, reliability, and reproducibility of LDF as a method of assessing pulpal blood flow and hence as a pulp testing method. The major advantages of pulp vitality testing technologies like LDF are that the findings and data gathered are based on objective findings rather than patient subjective responses to various stimuli. [20]

2.2.2 Pulse oximetry:

The pulse oximeter is another non-invasive device widely used in medicine; it is designed to measure the oxygen saturation in the blood. A pulse oximeter transmits two wavelengths of light, red and infrared, through a portion of patient's body which is translucent. Some of light generated gets absorbed as it passes through the tissues, the amount of absorption depends upon the ratio of oxygenated to deoxygenated haemoglobin in the subject's blood. A sensor in the opposite side of the targeted teeth detects the amount of light absorbed. The difference between the emitted light and the received light is used to calculate the oxygen saturation in the blood. The major limitations of the pulp oximetry is that it requires no obstructions in the transmission of light, which limits the use of pulse oximetry in teeth with restorations. [21]

Studies regarding the ability of pulse oximetry to diagnose pulp health have drawn various conclusions. Study by J M Schnettler ,[22] where forty-nine young adults were evaluated for the vitality of their maxillary central incisors reported the reliability of the pulse

oximeter in diagnosis of the pulpal vitality. H Karayilmaz [23] compared the efficacy of LDF, EPT and PO in vitality testing and found that LDF was more significant than EPT and PO in testing the pulp vitality. A study by Anusha et al, has concluded by pulse oximetry is very effective in diagnosing various pulpal pathology especially pulpal necrosis. [24 Some authors have concluded that these devices used for vitality testing is too cumbersome to use in a clinical setting due to their complexity [25]

2.2.3. Vitality tests on crowned teeth:

Tooth preparation procedures for full coronal restorations provide the greatest injury to the underlying dental pulp. A linear increase in pulp blood flow is noticed in all samples after the preparatory procedure [26]. The baseline reading for various types of restorative material will be different and hence needs standardisation. LDF is an estimation of pulp vitality and hence sings of periapical or pulp pathology are still necessary for initiation of endodontic treatment. Still there are no high-quality studies on the methodological validity of these tests and hence there is a need for future in vivo studies examining the accuracies of these pulp vitality testing with consistent outcome parameters. [26]

Conclusion:

Teeth with full coverage restorations often poses a challenge in decerning the pulpal status due to the material cost, time, invasiveness of the treatment and hence the overall prognosis of the teeth. Proper endodontic diagnosis remains to be the cornerstone in management of the tooth in question. Pulp sensibility test is widely used due to their ease in availability and affordability. It can also be used for endodontic diagnosis of crowned tooth. Cold testing with Endo ice in middle third of the crown has an accuracy of 87% while EPT with bridging using a dental explorer in the remaining tooth structure has an accuracy of 67%. EPT and cold test have excellent accuracy differentiating the non-vital tooth but are still subjective responses from the patient and must be judicially used in conjunction with relevant clinical findings

The vitality test, which include LDF and pulp oximetry has promising studies pertaining to their accuracy and efficacies. Due to their lack of ease in availability and apparent lack of standardisation it becomes cumbersome to use in a routine clinical setting. Pulp diagnostic test are essentials tests, but must be interpreted in combination with other relevant clinical findings and symptoms for proper care and management of the tooth. No single test must be used as a solitary measure.

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