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Crown Surface Temperature Assessment Using A Dt8220 Infrared Pen-Type Non-Contact Thermometer For The Measurement Of Pulp Vitality In Primary Teeth.
Short Title: A Novel Thermal Vitality Test–An In-Vivo Study

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PURPOSE: The purpose of this study was toevaluate the efficiency of the DT8220 infrared pen-type non-contact thermometer(manufactured by Shinemap, ASIN : B01DQEK50G) for the measurement of dental pulp vitality by comparing the temperature difference, between vital and nonvital primary teeth.

Materials and methodology: Fifteen patients between 5-9 years of age, with a suspected nonvital primary molar were selected. The selected nonvital tooth and its contralateral tooth were cooled with water and the temperature was assessed using the DT8220 infrared pen-type non-contact thermometer. Following which, the mouth was kept open for 3 minutes and the temperature was assessed again. The result was subjected to statistical analysis.

Results: A significant rise in temperature was noted in vital tooth after cooling in contrast to that found in non-vital tooth.

Conclusion: Thermography using DT8220 infrared pen-type non-contact thermometer is a useful diagnostic technique to determine the pulp vitality in primary molars.

KEYWORDS: PULP, VITALITY TEST, CROWN TEMPERATURE, PRIMARY TEETH

I. INTRODUCTION:

Dental pulp vitality is defined as the normal condition of a dental pulp having vascularity and sensation.[1]A thorough assessment of the pulpal status, principally the pulp vitality is of utmost importance for the diagnosis, treatment planning and the evaluation of the prognosis of various pulpal and periapical pathologies. The dental pulp vitality can be analyzed in relation to the structure and function of two of its major components:Vascularcomponent and Neural component. Conventional methods of testing tooth vitality rely mainly on the appreciation of nervous impulses induced by the stimulation of nerve endings in pulpal tissues.[2] When nervous sensations are inhibited or abolished in the tooth for example following trauma, tooth transplantation procedures, or during a general anestheticconventional tests, accurate assessment of dental pulp vitality with the analysis of neural responses to stimulus will be of little value.[3] However, a method based on the vascular response of the pulp need not be restricted under such conditions.

The assessment of pulp vitality by the critical evaluation of its vascular changes is more reliable in the case of primary dentition due to various factors. The behavioral changes in the child within the clinical set up during the dental procedures like their subjective fear and anxiety can exaggerate the response of the child towards a thermal stimulus and can potentially result in a false positive result.[4]

The unique feature of primary dentition to exhibit variable stages of resorption as well as variable stages of maturationwill in turn result in the alteration of the quantity and quality of the neural component in the dental pulp[4]. This poses a challenge in the reliability of its neural component as a pulpal vitality determinant. The increased chances of occurrence and recurrence of dental trauma that will result in the destruction of the peripheral vascular plexus as well as an exaggerated inflammatory response,again cast a doubt on its reliability as a potential diagnostic aid. Intake of sedation drugs, analgesics also increase the threshold of stimulation of pulpal nerve fiber.

Several studies show lack of correlation between pulp vitality testing method with actual histological condition of the pulp tissue. And there is poor correlation between the symptom and pulp histopathology. Thus, different diagnostic aids that analyze the vascular component of the dental pulp rather than its neural responses have been developed like;The Laser Doppler Flowmetry, Pulse Oxymetry,Photoplethysmography, dual wave length spectrometry etc.[2]

The measurements of temperature in dentistry are done both in vivo and invitro because of the fact that dental procedures can bring on uncontrolled increase in temperature inside the oral cavity. It is known that temperature increase inside the pulp of about 5°C can lead to irreversible changes to the pulp.[5] Temperature measurement as a diagnostic aid in diagnosis of pulp status has been described with the use of thermocouples,infraredthermometers,miniaturethe rmometer, infrared thermography and cholesteric crystals. However, some of these devices, including thermocouples and cholesteric liquid crystals are no longer advocated. There are several invitro studies by Howell et al[6], Fanibunda et al[7]and Pogrel et al[8], that measured the surface temperature of the tooth by using thermocouple devices.The difficulty to use it as a chair side diagnostic aid due to its bulkiness, need for an accurate assembly to bring about a desired result, lack of standardization and technique sensitivity has made its use limited to research purposes.

Therefore, taking this into consideration, there was a growing demand for a more compact, accessible and affordable, less technique sensitive and user-friendly aid that can potentially act as a diagnostic aid that make use of the crown surface temperature assessment for assessment of pulp vitality. Hence, the aim was to introduceDT8220 infrared pen-type non-contact thermometer, that has not been used in dentistry though available in market for various commercial and industrial purposes. It can measure even the slightest differences in temperature and thus,can be inturn used as an efficient tool to measure the temperature of the crown surface for pulp vitality.

II. MATERIALS AND METHODOLOGY:

Fifteen patients between 5-9 years of age who visitedThe Department of Pedodonticsand Preventive Dentistry with a suspected nonvital primary molar and a contralateral vital molar were selected for the study. Grossly carious teeth indicated for extractionbecause of poor prognosis and the teeth undergoing pulpectomy due to extensive carious lesions were included in the study.In each case, the subject wasseated comfortably in a dental chair, the operating lamp was switched off to avoid the effect of radiant heat and care was taken to avoid mouth breathing. The lips and cheeks were retracted with fingers and the enamel surfaces of the tooth to be tested were dried with gauze. The teeth wereisolated using a rubber dam to avoid influence of surrounding structures.

The temperature of the teeth under the study were assessed using the DT8220 infrared pen-type non-contact thermometer.The nonvital tooth and its contralateral tooth were cooled with water from the chair side three way syringe for 15 seconds and the temperature was assessed using the DT8220 infrared pen-type non-contact thermometer. Following which, the mouth was kept open for 3 minutes and the temperature was assessed again. The result were subjected to statistical analysis.

III. RESULTS.

It was found that the temperature range for each type of tooth was so wide, and the overlap between adjacent teeth so considerable, that it was impossible to assign a temperature to any one type of tooth. However, information in respect of tooth vitality could be gained from the time-temperature relationship method. At the end of the cooling period a rise in temperature of about 4.89˚C was observed in the recordings of those teeth known to be vital. While such rise in a temperature was not evident in most of the recordings for the teeth found to be non-vital.

There was a statistically significant temperature gain in vital teeth after cooling compared to that of the nonvital teeth. As the physiological rate of blood flow through a tooth is reported to be in the range 12–36 mL/h, this sudden rise in temperature in vital teeth can be attributed to its intact vascular supply which is absent in the case of nonvital teeth.[9]

IV. DISCUSSION.

Conventional methods of testing tooth vitality rely on the appreciation of nervous impulses induced by the stimulation of nerve endings in pulpal tissues. When nervous sensations are inhibited or abolished in a tooth, conventional tests are of little value especially in primary dentition. However, a method based on the vascular response of the pulp need not be restricted under such conditions.[4]

Baumann (1952)[10], Herrman (1953)[11], Goldberg and Brown (1965)[12] and Beynon (1973) using thermocouples, and Stanfill and Plakun[13] (1966), Crandell and Hill (1966)[14] and Hartley et al. (1967)[15] using infrared thermography found no differences between the temperatures of vital and non-vital teeth. On the other hand, Howell et al. (1970) who used liquid cholesteric crystals, found that non-vital teeth have lower temperatures than vital teeth. In other studies, Shapiro and Ershoff (1958) concluded that the warmest part of the surface of the anatomical crown of an anterior tooth is the upper middle ninth quadrant on the labial surface. Abakumova and Semenov (1964)[16] and Goldberg and Brown (1965) assigned temperatures to each type of tooth, and Baumann (1952), Herrman (1953) and Goldberg and Brown (1965) concluded that teeth essentially attain their temperatures by heat conduction from the surrounding tissues rather than from the pulp. Abakumova and Semenov (1964); and Schuchard and Watkins (1965) also noted that ambient temperature affected the crown-surface temperature.

In our study, the normal crown surface temperatures of the vital and nonvital teeth was found to be almost comparable before it was cooled by water and was found to fall between 26 ᵒ C – 28 ᵒ C. On cooling, the vital tooth with water, the temperature dropped to about 24 ᵒ C invital tooth and to about 22.5 ᵒ C in case of non vital tooth. The mouth was kept open for 3 minutes to let the tooth regain its temperature. The temperature was assessed again with the help of the infrared thermometer and it was found that there was a significant rise in temperature at an average of about 4.89 ᵒ C in vital tooth and a rise in temperature of about 1.34 ᵒ C in case of nonvital tooth. The difference in the rise in temperature of vital tooth was much higher as compared to that of nonvital tooth. This clearly indicates that there was a significant crown surface temperature difference between vital and nonvital teeth.

Infrared technology is not a new phenomenon. It has been utilized successfully in industrial and research settings for decades. Newer innovations have reduced costs, increased reliability and resulted in noncontact infrared sensors offering smaller units of measurement. All of these factors have led infrared technology to become an area of interest for new kinds of applications and users.

Each object with temperature above zero(-275.15 deg c= zero –kelvin) emits electromagnetic radiation from its surface due to the internal mechanical movement of its molecules, which is proportional to its intrinsic temperature. Since the molecule movement represents charge displacement, electromagnetic radiation (photon particles) is emitted which move at the speed of light and behave according to the known optical principles. They can be deflected, focused with a lens, or reflected from reflective surfaces. The spectrum of this radiation ranges from 0.7 to 1000 µm wavelength.[17]

The accuracy of infrared temperature can be quite accurate but it is significantly affected by several factors likedistance to spot ratio. This indicates the size of the area measured relative to the distance away from the object being measured. Infrared thermometer does not emit any infrared radiation. It only measures it. However laser guided models should not be used for medical application. Lowest level radiation may affect eyes. The optic system of infrared thermometer picks up infrared energy emitted from circular measurement spot and focuses it on the detector. The target should completely fill the spot.

Thus the study supports the probability of using this non-contact thermometer for the evaluation of pulp vitality with higher accuracy.This device need improvement and further research is needed to compare it with the thermocouple and thermographic methods to establish its reliability in determining tooth surface temperature in future.

V. CONCLUSION

- Dental pulp vitality assessment in children is a very tedious and unreliable process when undertaken using traditional methods.
- Crown surface temperature measurement is a reliable technique for the assessment of pulp vitality.
- The temperature assessment can be efficiently undertaken using the DT8220 infrared pen-type non-contact thermometer.
- The device with few research-oriented modificationscan make it a highly reliable patient and technique friendly aid for determining tooth surface temperature for measurement of dental pulp vitality in the future.

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