

Recent Advances in Endodontic Diagnosis: A Review

¹Vaibhav Jain, ²Buggaveeti P Kumar, ³T Sai Krishna, ⁴Shrikant Parakh, ⁵P Hari Kiran, ⁶Aastha Tiwari

ABSTRACT

Dictionary defines diagnosis as “the art of identifying a disease from its signs and symptoms.” A clinician may afford to be unaware of change in the concept of a certain treatment technique, but cannot be weak clinically in the science of diagnosis. Recent advancements in the knowledge of the basic dental structures and wider intercommunication of clinical experiences make endodontic lesions and conditions nowadays better understood and diagnosed as compared with the past. However, conversely, increase in the knowledge of basic science has also highlighted the limitations of various diagnostic methods that are currently in use.

Keywords: Diagnosis, Cone beam computed tomography, Pulse oximetry, Ultrasound.

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INTRODUCTION

Correct diagnosis leads to the beginning of correct treatment. Arriving at a right diagnosis requires knowledge, skill, and art. Diagnosis is defined as “utilization of scientific knowledge for identifying a diseased process and to differentiate from other disease process.” Diagnosis is the cornerstone in the practice of healing art: It can also be defined as the “correct determination, discrimination, estimation and logical appraisal of condition found during examination as evidenced by distinctive makes, signs and character of health or diseases.”¹

A thorough knowledge of dental and paradental structures, the available methods for diagnosis, and their limitations in diagnosing various dental conditions is essential for the clinician to differentiate odontogenic condition from that of monodontogenic origin.²

A diagnostic procedure actually consists of four steps³:

1. Assembling of all the facts from chief complaints, medical and dental history, tests, and investigations.
2. Analysis and interpretation of the assembled clues to reach a tentative and provisional diagnosis.
3. Making the differential diagnosis of all possible diseases that are consistent with signs, symptoms, and test result gathered.
4. Possible choice is selected.

LASER DOPPLER FLOWMETRY

Laser Doppler flowmeter (LDF) was first developed by Tenland in 1982 and later by Holloway in 1983. The first indication of the ability to measure pulpal blood flow noninvasively using laser Doppler technique was shown in 1986 by Gazelius et al.

The Doppler effect is based on the LDF. The effect was described in 1842 by Austrian physicist Christian. It explains the frequency shift that a wave undergoes when emitted from an object, i.e., moving away from or toward an observer. The particles must be big enough to scatter sufficient light for signal detection, but small enough to follow the flow.⁴ Laser Doppler flowmetry, which is a non-invasive, objective, painless, semiquantitative method, has been shown to be reliable for measuring pulpal blood flow.

Petersson and Oberg designed an LDF instrument for measuring blood flow in human pulp and used it to assess the vitality of pulp in an intact and traumatized tooth. They used an infrared laser diode with a longer wavelength that gave better penetration than the He-Ne wavelength. Sasano and others designed and developed a transmitted laser light flowmeter that used high-power laser light to monitor the pulpal blood flow of teeth rather than conventional light flowmeter apparatus.⁴

Advantages of LDF

- Noninvasiveness.
- Continuous and instantaneous reflection of flow changes and its potential use in humans for clinical purpose.
- It is very easy to apply and accurate results can be recorded.

Disadvantages of LDF

- The apparatus is expensive.
- The procedure is time consuming.

^{1,5}Associate Professor, ^{2,3}Assistant Professor, ^{4,6}Postgraduate Student

^{1,4,6}Department of Conservative Dentistry and Endodontics Chhattisgarh Dental College & Research Institute, Rajnandgaon Chhattisgarh, India

^{2,3,5}Department of Conservative Dentistry and Endodontics Mamata Dental College, Khammam, Telangana, India

Corresponding Author: Vaibhav Jain, Associate Professor Department of Conservative Dentistry and Endodontics Chhattisgarh Dental College & Research Institute, Rajnandgaon Chhattisgarh, India, Phone: +9196304706730, e-mail: Dr.vaibhavj7@gmail.com

- It is impossible to calibrate them in absolute units and their outputs may not be linearly related to the blood flow.

Limitation of LDF

Soo-Ampon et al found that up to 80% of the LDF output signals in human maxillary incisors may be nonpulp in origin, if attempts at tooth isolation are made. These authors observed that humans have a smaller pulp-chamber to crown-root ratio and hence, there is relatively high proportion of nonpulp signals compared with LDF readings taken from animals, such as pigs and cats.

PULSE OXIMETRY

Pulse oximeter is a noninvasive oxygen saturation monitoring device widely used in medical practice for recording blood oxygen saturation levels during the administration of intravenous anesthesia through the use of finger, foot, or ear probes.

Pulse oximetry was introduced by Takuo Aoyagi in Kyoto, Japan, in early 1970s. Pulse oximeter uses red and infrared wavelengths to transilluminate a tissue bed, detecting absorbance peak due to pulsatile blood circulation and uses this information to calculate oxygen saturation and pulse rate. It is the most commonly employed technique to measure oxygen saturation because of its ease and economy.

The measurement of oxygen bound to hemoglobin is a relatively recent advance in anesthetic technology. Oxyhemoglobin absorbs strongly in the red zone, whereas hemoglobin has a low specific absorption coefficient; the situation is reversed in the infrared range. Pulse oximetry takes the advantage of this absorption coefficient difference to monitor oxygen saturation and pulse rate with a single sensor placed on the patient's extremity, and a plethysmograph to measure arterial oxygen saturation in a pulsating vascular bed, such as that of finger.⁵

Principle of Pulse Oximetry

It is based on a modification of Beer's law, which relates the absorption of light by a solute to its concentration and optical properties at a given wavelength. It also depends on the absorbance characteristics of hemoglobin in the red and infrared ranges. In the red region, oxyhemoglobin absorbs less light than deoxyhemoglobin and *vice versa* in the infrared region. As a result, one wavelength was sensitive to changes in oxygenation and the second wavelength was insensitive. The instrument unit of pulse oximeter contains two light-emitting diodes mounted in opposition to the photodetector. Light of the two wavelengths 660 nm (red) and 925 nm (infrared) is emitted from the LEDs to pass through the tissues and then to

the photodetector. The signal passes to a microprocessor, where only pulsatile signals are used to calculate oxygen saturation. The transmitted light is converted into a digital display of both arterial oxygen saturation and pulse rate. The measurement of arterial saturation with this instrument is almost completely independent of the patient's age, physical status, and skin pigmentation.

Advantages of Pulse Oximetry

- Effective and objective method to evaluate the pulp vitality.
- It can be used in traumatic injuries cases where blood supply is intact but nerve supply is damaged.
- Pulpal circulation can be detected independent of gingival circulation.

DIGITAL SUBTRACTION RADIOGRAPHY

Digital subtraction radiography (DSR) with specific software is considered as a valuable tool for the evaluation of periapical lesions owing to the method's ability to detect extremely small bone changes. It was introduced by Zeides Plantes in the 1920s. These methods provide more accuracy in the assessment of bone formation or resorption during or after root canal treatment. The DSR technique is almost twice as sensitive at detecting lesions as conventional radiographic interpretation. Use of specialized software allows the digital subtraction of two superimposed images. The DSR includes tools that allow image manipulation and measurement, minimizing the subjectivity of the evaluation process.

The strength of DSR is because it cancels out the complex anatomic background, against which subtle changes occurs. As a result, the conspicuousness of the changes is greatly increased. Subtraction images are well suited for acquiring quantitative information, such as linear, area, and density measurements.

The DSR has made a significant improvement in the detection of dental and maxilla-facial lesions. It improves the detection of density changes in bony structures, and significantly the sensitivity and accuracy of the evaluations. With DSR, the alveolar bone changes of 1 to 5% per unit volume and significant differences in crestal bone height of 0.78 mm can be detected. Yoshioka et al⁶ evaluated the healing process of periapical lesions using DSR. For a successful DSR, reproducible exposure geometry and also identical contrast and density of serial radiographs are essential prerequisites, and long-time experience shows that this technique is very sensitive to any physical noise occurring between the radiographs and even minor changes leads to large errors in the result.

Uses of DSR

- It is very useful in detection of lesion, such as interproximal caries and also helpful to view the progression of caries from incipient lesion too as the lesion progresses to dentinoenamel junction.
- It also helps to evaluate bony changes or the healing process or repair.

Limitation of DSR

It cannot detect whether the lesion is on buccal or lingual aspect.

COMPUTERIZED TOMOGRAPHY

It is also known as computed axial tomography scanners. Tachibana has reported the use of X-ray computerized tomography (CT) in endodontics. It is possible to determine the buccolingual and mesiodistal widths of the teeth and the presence or absence of root canal filling materials and metal posts. Anbu et al⁷ evaluated the volumetric analysis of root filling using CT in 40 extracted maxillary central incisors obturated by lateral compaction, thermafill, obtura II, and system B. They found the greatest percentage of obturated volume was obtained with system B and thermafill. The advantages of CT scan machine are observation of the structures which are difficult to visualize with conventional X-rays while also providing three-dimensional (3D) images of roots, root canals, and teeth. The disadvantages of CT scan are that it is expensive, needs larger skin dose, and is time consuming.⁸

COMPUTED INFRARED THERMOGRAPHIC IMAGING

The diagnosis of pulpal status is fraught with difficulty and uncertainty. Several methods have been developed to assess the pulpal blood flow, but none is presently suitable for routine use in clinical practice. Thermographic imaging is a noninvasive and highly accurate method of measuring the surface temperature of a body. Computer-controlled infrared thermographic imaging is highly technique sensitive and is accurate and allows comparisons of different areas of the tooth.

Before operating a computed thermography, a 20-minute equilibration period is recommended. The infrared scanner unit is focused on tooth within the field of the macrolens of the camera and imaged simultaneously, thus allowing data collection from the teeth. Crandell and Hill attempted to use thermography in dental patients. They made a scan of a patient with a known periapical abscess and then compared the results from infrared thermography with the results obtained from the use of electric pulp test.⁹ No correlation was found between electric pulp

test results and infrared temperatures or between decayed and filled surfaces and infrared temperatures.

CONE BEAM COMPUTED VOLUMETRIC TOMOGRAPHY

The interest and demand for 3D imaging studies is accelerating faster than for any previous image modality in the dental profession. The current application of cone beam computed tomography (CBCT) appears to have impact upon dental specialists. The CBCT uses a cone-shaped beam rather than fan beam. It uses a computer program to construct a 3D volume image in single 360° rotation. The digital picture is subdivided into pixels, the volume acquired by CBCT is in voxel, and instead of pixel, essentially voxel is 3D pixel.

Patel et al⁸ used CBCT for the detection of root resorption lesions. They took the intraoral radiographs and CBCT scans of patients with internal resorption, external cervical resorption, and no resorption. The CBCT was effective and reliable than intraoral radiographs in detecting the presence of resorption lesions. Huybrechts et al¹⁰ detected the voids in root filling using intraoral analogue, intraoral digital, and CBCT. Voids larger than 300 µm were determined using all imaging techniques. For small voids detection, all digital intraoral techniques were better than intraoral analogue and CBCT. Periapical lesions are difficult to be differentially diagnosed into radicular cysts and granulomas based on clinical findings and periapical radiograph alone. Computerized tomography can be used as a noninvasive method of differentiating a cyst from a periapical granuloma. Despite CBCT doses being an order of magnitude or more below doses from conventional CT, they are still significantly higher than those from conventional dental radiography. Therefore, risk/benefits analysis must be carried out before a CBCT investigation is requested.

ULTRASOUND

It is a noninvasive investigation that uses a very high frequency (7.5–20 MHz) pulsed ultrasound beam, rather than ionizing radiation, to produce high-resolution images of more superficial structures. The use of color Doppler allows blood flow to be detected.

Lauria et al¹¹ in their study evaluated bone lesions of jaws using ultrasonography. They used ultrasound in 72 intraosseous lesions of jaw, to examine the content present in the lesion before treatment and matched the findings with that of histological findings obtained. Result was in agreement with histopathological findings in 24 (92.3%) cases with solid content, 17 (73.9%) cases with liquid content, 7 (7.7%) cases with dense liquid content, and 13 (92.8%) cases with mixed content.

CONCLUSION

To conclude, one could say that the determination of exact pulpal status, i.e., vital or necrotic, is complex and is dependent on a number of factors viz, patient history, clinical examination, and various diagnostic tests conducted. However, with the advent of newer diagnostic techniques, such as pulse oximetry, LDF, and radiovi-siography, these provide a quicker, easier, and precise diagnostic means. The results of newer diagnostic tests should never be relied upon individually, but, on the contrary, they should be utilized in combination in order to arrive at a correct final diagnosis.

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