



## Current Endodontic Tests

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### Introduction

Diagnosis is the art and science of detecting and distinguishing deviations from health, and the cause and nature thereof.<sup>1</sup> An appropriate treatment plan cannot be developed until a diagnosis has been made. The aim of this Clinical Update is to review the current endodontic tests available in order to make an accurate pulpal and apical diagnosis.

### Pulpal Diagnosis

Several clinical tests are available to aid in determining a pulpal diagnosis. Vitality tests (pulse oximetry and laser doppler flowmetry (LDF)) provide information about the vascular supply to pulpal tissues. Sensibility tests (cold, electric (EPT) and heat) evaluate the pulp's ability to respond to a stimulus, but they do not detect or measure the blood supply to the pulp. Vitality tests may be especially useful in cases of trauma, where sensibility tests have been inconclusive in pulpal diagnosis.<sup>2-4</sup> No current clinical test can give a 100% accurate diagnosis, as would be determined histologically; however, it has been demonstrated that a clinical diagnosis from multiple sensibility tests is 96.6% accurate when compared with the histologic diagnosis for a normal pulp or reversible pulpitis, and 84.4% accurate for symptomatic irreversible pulpitis.<sup>5</sup> Thus it is more difficult to obtain reliable information from a tooth with a diseased pulp.

### Sensibility Tests

#### Cold Test

Studies have suggested the accuracy of cold testing ranges from 86-94%.<sup>6-10</sup> The use of a refrigerant spray, which has a temperature of -15.1°F, such as Endo Ice® (1,1,1,2-tetrafluoroethane), has been shown to be a predictable method for conducting a cold test.<sup>11</sup> The greatest temperature change within the pulp using a refrigerant spray can be achieved by directly spraying a #2 large cotton pellet<sup>12</sup> and should be applied to the facial surface in the middle third of the crown. A control tooth on the contra-lateral side should be tested to familiarize the patient with the expected sensation as well as with the technique. The cold test should be applied until the patient responds, but not longer than 15 seconds. Cold testing is an effective method for testing intact teeth and those restored with gold, MCR, and all ceramic restorations.<sup>13</sup> In the event the patient's sensitivity to cold can not be reproduced with Endo Ice®, a cold water bath test can be used, in which the tested tooth is isolated with a rubber dam, and ice-cold water is bathed onto the tooth with a syringe.

#### Electric Pulp Test (EPT)

EPT utilizes an electrical current to stimulate sensory nerves of the dental pulp.<sup>1</sup> The accuracy of the EPT ranges from 71% – 89%.<sup>6-10</sup> When using an EPT in conjunction with cold, the accuracy of the pulpal diagnosis, compared to each individual test, is increased.<sup>6,7,9</sup>

When using the EPT, inform the patient of expected or possible sensations such as heat or tingling during testing. The teeth to be

tested should be isolated and dried. A conductive gel, such as tooth paste, is applied to the electrode prior to testing. The electrode should not be applied to restorations as this can lead to erroneous results. Ideal placement of the electrode is in contact with the facial surface of the middle third for incisors, occlusal third for premolars, and mesiobuccal cusp tip for molars.<sup>14-16</sup> For full coverage restorations, a Mini tip® is available and should be placed apical to the cervical margin of the restoration, preventing contact with the gingival crevicular fluid or gingiva. The patient is instructed to place a finger on the handle of the probe and the current flow should be increased slowly, at a rate of 2 µA/sec, allowing the patient time to respond.<sup>17</sup> This rate corresponds to level 4 on the Kerr Vitality Scanner®. If no sensation is felt, the electrode should be applied to other surfaces to ensure the negative reading is not the result of electrode placement or a depleted battery.

#### Heat Test

Heat testing is most commonly used to reproduce a patient's chief complaint of sensitivity to hot temperatures. The accuracy of the heat test has been suggested to have a range from 71-86%.<sup>6,9</sup> Different methods of heat testing include heated pellets of gutta percha, a heated ball burnisher, a hot water bath (similar to the cold water bath test, but with hot water), and the heated testing tips of a System B® or Elements® unit. The Elements unit with a heat-testing tip at a setting of 200°C, activated over 60 seconds, provides the most consistent warming of the dental pulp.<sup>18</sup>

### Vitality Tests

#### Pulse oximetry

The Pulse Oximeter is a device that emits light from a photoelectric diode across tooth structure into a receptor. The instrument detects changes in absorption of both red and infrared light caused by alteration in tissue volume (tissue perfusion) during the cardiac cycle.<sup>19</sup> The assessment of a healthy pulp using a pulse oximeter has produced median oxygen saturation levels ranging from 75% to 94%.<sup>2,20</sup> However, there are currently no established guidelines of median oxygen saturation levels to indicate whether a pulp can be considered healthy, inflamed, or necrotic.<sup>19</sup>

Limitations of pulse oximetry include the effects of increased acidity and metabolic rate, which cause deoxygenating of hemoglobin and changes in the blood oxygen saturation, as well as, movements of the body or probe which can complicate readings. Other limitations include cost, the inability to differentiate between the gingiva and pulp, and the lack of established guidelines of oxygenation levels for pulpal status.<sup>20</sup>

#### Laser Doppler Flowmetry (LDF)

LDF uses a laser beam of known wavelength that is directed through the natural crown of the tooth to the blood vessels within the pulp. Moving red blood cells cause the frequency of the light to change. This change in frequency is the Doppler shift. Some of the light is back-scattered out of the tooth. This reflected light is detected by a

photocell on the tooth surface, the output of which is proportional to the number and velocity of the red blood cells.<sup>21</sup>

Limitations include cost, the high susceptibility to environmental and technique-related factors, as well as the presence of restorations or the size of the pulp chamber. Also, non-pulpal signals, principally from periodontal blood flow, may affect the signal.<sup>21</sup>

### **Apical Diagnosis**

Percussion, palpation, and the bite test are the clinical tests that aid in determining apical diagnosis in conjunction with appropriate radiographic analysis. Patients presenting with odontogenic pain can localize a painful tooth 73.3% of the time. Patients with percussion sensitivity can localize the offending tooth more often (89%) than patients without apical symptoms (30%).<sup>22</sup>

### **Percussion, Palpation, Bite Test**

Evaluation for percussion is performed by tapping on the incisal or occlusal surface of the tooth with the end of a mirror handle or by digital pressure for teeth that are very sensitive. The use of a bite test (Tooth Slooth®) can also be used to determine the apical diagnosis. A painful response to percussion or the bite test indicates the presence of apical inflammation. If a painful response is obtained by tapping on the facial surface but not the occlusal/incisal surface, periodontal inflammation is suspected.<sup>23</sup>

Like percussion, the palpation test determines the extent of inflammation. Discomfort on palpation in the buccal vestibule indicates periapical inflammation. Emphasis should be placed on evaluation for any soft tissue swelling or boney expansion, compared with the adjacent and contralateral tissues.<sup>24</sup>

### **Conclusion**

Obtaining an accurate pulpal and apical endodontic diagnosis can be quite challenging. Pulp tests include cold, heat, EPT, pulse oximetry, and LDF. Percussion, palpation, the bite test, and radiographs are used to develop an apical diagnosis. Familiarization with and utilization of all appropriate tests, including high quality diagnostic radiographs and the ability to reproduce the patient's chief complaint, should increase the clinician's diagnostic confidence and help determine the most appropriate treatment plan. Clinicians should have confidence in the results of these endodontic diagnostic tests. If there are inconsistencies between the test results and the clinical findings, further diagnostic information should be gathered and a consultation with an endodontist would be indicated. Previous Clinical Updates should be reviewed so the most current pulpal and apical diagnoses, as well as diagnosis and management of cracked teeth are utilized.<sup>25,26</sup>

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