

Interpretation of pulp sensibility tests - A review

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Abstract:

Diagnosis can be defined as the art of distinguishing one disease from another. One of the most essential part of the diagnostic procedure for pulp disease is the use of pulp sensibility tests. When diagnosing pulp pain, these tests can be used to reproduce the symptoms reported by the patient to diagnose the diseased tooth as well as the disease state. There are several pulp sensibility tests available such as thermal tests (heat and cold stimuli), electric pulp tests (EPT), and a test cavity. But which test should be used in which condition still remains a confusion for the dentist.

Keywords: Sensibility tests, heat, cold, electric pulp test

Introduction:

Diagnosis is defined as the correct determination, discriminative estimation and logical appraisal of the conditions found during examination as evidenced by distinctive signs, marks and symptoms.¹ Correct treatment begins with a correct diagnosis. Arriving at a correct diagnosis requires knowledge of the disease and their symptoms, skill to acquire proper test procedures and the art of synthesising impressions, facts, and experiences into understanding.

Diagnostic procedures should follow a consistent logical order which includes comprehensive medical and dental history, radiographic examination, extra oral and intra oral examination including histopathological examination to arrive at a final diagnosis when required. Thus the clinician must have a thorough knowledge of the examination procedures and tests as well as their limitations.

The tests can be divided into pulp sensibility and pulp vitality tests. There are a number of pulp sensibility tests available for the diagnosis such as thermal tests, electric pulp tests and test cavity. When diagnosing pulpal pain, these tests can be used to reproduce the symptoms reported by the patient to diagnose the diseased tooth as

well as the disease state but which test should be used in which condition and what its interpretation would be is still a dilemma. Before jumping to the outcome there should at least be two separate diagnostic test results that indicate to the disease.²

Thus this review focuses on the neurophysiology of the various sensibility tests and their interpretation in different pulpal and periapical disease conditions.

Dental pulp neurophysiology

Diagnosis in endodontics requires through knowledge of pulpal histology, neurology, physiology and their relationship to the various diagnostic tests commonly used in dental practice. Pain is felt when a stimulus strong enough to trigger a nervous response is applied to a tooth. The intensity, location, duration, immediacy and quality of pain will differ depending on the type of stimulus, clinical condition and the type of nerve fibres excited in the process.³

Nerve bundles diverge and branch out towards the pulp-dentine border in the coronal pulp. The divergence continues until each bundle loses its integrity and smaller fibre groups travel towards the dentin. This course is relatively straight until the nerve fibres form a loop and a resultant mesh of nerve fibres termed as the nerve plexus of Rashkow. Terminal axons exit from this plexus and pass between the odontoblasts as free nerve endings.³

The 2 types of sensory nerve fibres in the pulp are myelinated A fibres (A-delta and B-beta fibres) and unmyelinated C fibres.

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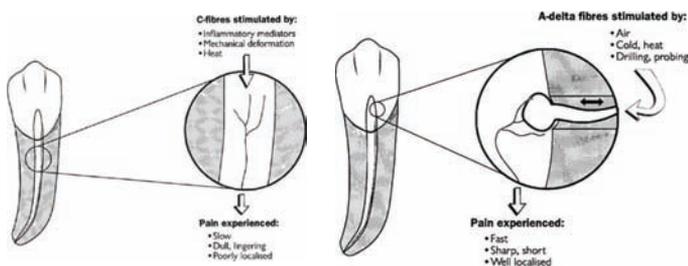
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Ninety percent of the a fibres are A delta fibres, which are mainly located at the pulp– dentin border in the coronal portion of the pulp and concentrated in the pulp horns. The C fibres are located in the core of the pulp, and extend into the cell-free zone underneath the odontoblastic layer.⁴

The A-delta fibres have a small diameter and therefore a faster conduction velocity. They generate a fast and sharp pain that is easily localized. These respond to various stimuli such as probing, drilling and hypertonic solutions through the hydrodynamic effect. This effect depends on the movement of the dentinal fluid in the dentinal tubules in response to a stimulus.⁵

The C fibres are influenced by many interneurons before reaching the thalamus, and therefore are slow in conduction resulting in a slow pain. Pain is characterized as dull, aching and poorly located pain which is activated only when the stimulus reaches the core pulp.⁵ C fibres have a high threshold and can be activated by intense heating or cooling of the tooth crown. Once activated, the pain initiated by C fibres can radiate throughout the face and jaws. C fibre pain is associated with tissue injury and is modulated by inflammatory mediators, vascular changes in blood volume and flow, and increases in pressure.⁶



Movement of nerve fibres within the dentinal tubules.^{5,6}

The three key uses of pulp testing in clinical practice according to Ehrmann are.⁷

- Prior to operative procedures where pulp health may be in question.
- Diagnosis of pain.
- Investigation of radiolucent areas

Terminologies

Sensibility is the ability to respond to a stimulus. Tests are used to determine whether a pulp is likely to be alive (positive response) or necrotic (negative response).⁸

Sensitivity is a condition of being very responsive to a stimulus. Thus, when testing a tooth to determine whether it has pulpitis sensibility tests are used to test the sensitivity of the pulp. However, they are still regarded as sensibility tests.⁸

Hypersensitivity implies a condition of being even more responsive to a stimulus than a very responsive (i.e. Sensitive) tooth; it is subjective and difficult to define or compare between patients. Therefore, the term ‘hypersensitivity’ should not be used because ‘sensitivity’ defines the state of the pulp and the prefix ‘hyper-’ is not required.⁸

Vitality implies that a blood supply is present within the tissues. Hence, only a test that actually measures or assesses pulp blood flow can be called a vitality test.⁸

Pulp tests

The ideal technique for the evaluation of pulp status should be non-invasive, painless, standardized, reproducible, reliable, inexpensive, objective and easily completed.⁹ The rationale for innervation of any structure in the body is to provide a warning of damage that is occurring or impending.^{10,11}

Pulp tests can be classified as:

- **Vitality tests**
 - Laser doppler flowmetry
 - Pulp oxymeter
 - Tooth temperature measurement
- **Sensibility tests**
 - Electric Pulp Testing (EPT)
 - Thermal tests
 - Heat tests
 - Cold tests
- **Test cavity**

Cold tests

Cold thermal testing causes contraction of the dentinal fluid within the dentinal tubules, resulting in a rapid outward flow of fluid within the patent tubules. This rapid movement of fluid results in ‘hydrodynamic forces’ acting on the nerve fibres within the pulp–dentin complex, leading to a sharp sensation lasting only till the duration of the thermal test.

The cold test may be used to differentiate between reversible and irreversible pulpitis. If the patient feels a lingering pain, even after the cold stimulus is removed, a diagnosis of irreversible pulpitis may be reached. But, if the pain subsides immediately after stimulus removal, a diagnosis of reversible pulpitis is more likely.^{12,13}

Heat tests

Heat thermal testing causes expansion of the dentinal fluid within the dentinal tubules, resulting in a slow inward flow of fluid within the patent tubules. Heat causes the fluid to expand, stimulating the A delta fibres; however, when heat is applied to an inflamed pulp, the pressure increase stimulates the C fibres and produces a long lasting pain.¹⁴

Two types of thermal tests are available, cold and hot stimuli. Although these tests may not be considered as sophisticated as an EPT, evidence-based studies support the reliability of cold test over EPT.⁸ However, neither cold nor heat is totally reliable in all cases. Major advantage of thermal tests over EPTs is that the equipment required is usually inexpensive and easy to use.^{8, 15}

Interpretation of test results

When performing a test, the clinician should evaluate the immediacy, the intensity and duration of the response. These factors can vary substantially depending on many factors including the individual patient's response to any form of stimulus, the depth of caries, the placement of a new restoration, recent periodontal surgery, etc.^{10, 11}

When a cold test is applied to a healthy pulp, it usually results in a sharp localized sensation for the duration of the applied test and for a few seconds after removal of the stimulus.¹⁰ A pulp response that lingers for some time after the stimulus has been removed usually indicates an irreversibly inflamed pulp. No response from the tooth to such stimulation is normally regarded as an indication of pulp necrosis or that the tooth has become pulp less.^{10, 15} The outcome of such testing is never absolutely certain, and that is why diagnosis must not rely on a single test¹⁵

Clinically normal pulp

This condition is asymptomatic and produces a mild to moderate transient response to cold and electrical stimuli.¹⁰ When the stimulus is removed, the response subsides within a few seconds.¹⁵ Clinically normal pulps do not usually respond to heat tests.¹⁰

Reversible pulpitis

Thermal stimuli (usually cold) and electric pulp test causes a sharp pain that subsides as soon as the stimulus is removed or within a few seconds.¹⁶

Irreversible pulpitis

In initial stages cold test causes a sharp pain followed by a dull prolonged pain that might last up to an hour. However in later stages pain is increased by heat tests and sometimes relieved by cold tests.¹

Pulp necrosis

EPT is the instrument of choice for determining pulp necrosis.¹¹ Nerve fibres of the pulp are relatively resistant to necrosis and will be the last part of the pulp to die,¹⁷ the necrotic pulp may continue to respond to stimulation for some time.¹⁸ However, no response will be obtained with EPTs and thermal tests from teeth with pulp necrosis.

Acute apical periodontitis

In some patients, there may be acute apical periodontitis associated with pulpitis, and therefore, a full and accurate assessment of the pulp status is required before any treatment can be considered. The pulp tests might have different results in this condition.

Acute apical abscess and acute lateral periodontal abscess

In lateral periodontal abscess, the tooth responds to pulp sensibility tests, and therefore, the pulp can be diagnosed as being clinically normal.¹¹ In contrast, a tooth with an acute apical abscess would not respond to pulp sensibility tests as they are a sequel to a necrotic and infected pulp, a pulp less infected root canal system, or a previously root filled tooth that has become infected.^{7, 10}

Sensibility versus Vitality

A study by Evans et al showed highest levels of sensitivity and specificity for LDF similar to cold test¹⁹ and EPT pulse oximetry has been shown to be as accurate as cold test and electric tests in determining tooth vitality.²⁰ Despite the high accuracy, LDF and pulse oximetry as a pulp test have the disadvantages of being time-consuming and technique-sensitive as well as relatively expensive. In addition, the patients must be relaxed and sitting very still, because sudden movements can create artefacts on the flux recordings. Therefore, LDF might not be practical for everyday clinical use.¹⁹

Conclusion

It is essential that the clinicians understand the usefulness and the limitations of sensibility tests. They are important diagnostic aids however their results must be interpreted in conjunction with detailed history, symptoms, clinical findings and radiographic observations. Correct treatment begins with a correct diagnosis.

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How to cite this article:

Kanav J, Ashwini J, Shivamurthy GB. Interpretation of pulp sensibility tests – A review. *CODS J Dent* 2014;6:108-111

Source of support: Nil. **Conflict of interest:** None Declared.