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A. K. Bobby Mallik, D.M.D.

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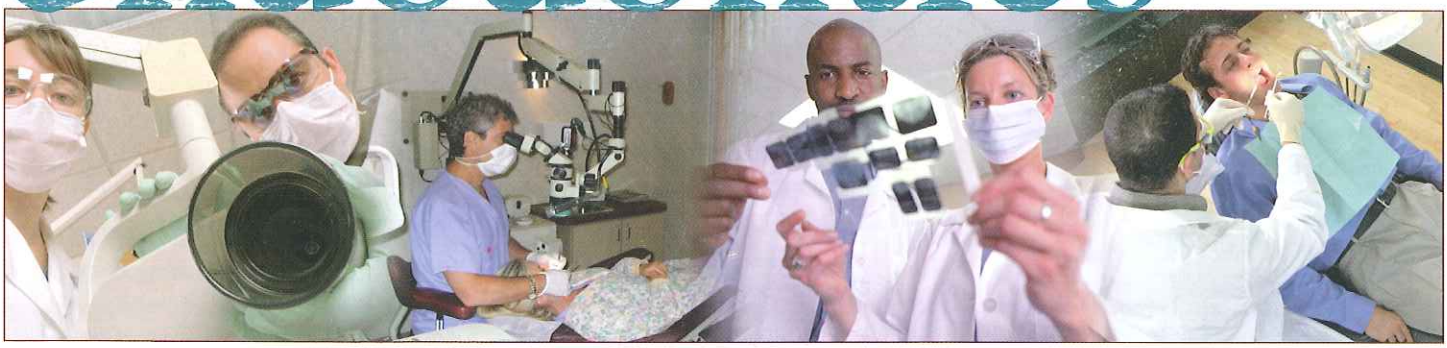

Pulp Sensibility Tests: A Review

Pulp sensibility tests are an essential part of the diagnostic process for pulp disease. When diagnosing pulp pain, these tests can reproduce the symptoms reported by the patient to diagnose the diseased tooth, as well as the disease state. However, these tests only indirectly provide an indication of the state of the pulp by measuring a neural response rather than the vascular supply, leading to false-positive and false-negative results. In a review of the literature, Jafarzadeh from Mashhad University of Medical Sciences, Iran, and Abbott from the University of Western Australia examined the rationale, indications, limitations and interpretation of pulp sensibility tests, as well as the value of these tests.

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Using PubMed and MEDLINE database searches, the authors performed a literature search for relevant articles on pulp sensibility tests in the context of endodontics. This search identified papers published between November 1964 and January 2009 in all languages.

The database review identified the following indications for pulp sensibility testing:

- When diagnosing pain in the trigeminal area, including the presence of referred pain, it is important to assess the pulp status of individual teeth before considering treatment.
- The pulp status is important when periodically monitoring teeth that had been subjected to trauma.
- Before performing restorative dental procedures on a tooth, it is essential to ascertain whether the pulp is healthy.
- Pulp tests are integral to the diagnosis when differentiating periapical radiolucencies from normal landmarks and nonodontogenic lesions.

- Teeth that have undergone pulp preservation procedures, such as a partial pulpotomy, and those that have had extensive restorations should be tested periodically.

A perfect diagnostic test would always provide a response in the presence of disease and no response in the absence of disease. However, false-negative or false-positive results do occur.

Pulp sensibility tests also have several limitations.

- Tests are subjective and measure only pulp nerve responses, not pulp blood flow.
- Tests may not be effective in elderly patients with calcified canals or in teeth with extensive restorations.
- Electric pulp tests (EPTs) are less reliable in teeth with immature apices.
- Tests do not correlate with the histologic status of the pulp.
- They are difficult to administer and may be inconclusive when used on children.
- They may lack reproducibility.

When performing a test, the clinician should evaluate the immediacy, intensity and duration of the response. Diagnoses based on an interpretation of the results:

- Clinically normal pulp—This condition is asymptomatic and produces a mild to moderate transient response to cold and electrical stimuli.
- Reversible pulpitis (localized inflammation)—Thermal stimuli (usually cold) cause a sharp pain that subsides as soon as the stimulus is removed or within a few seconds.
- Irreversible pulpitis (advanced inflammation)—Temperature changes (usually cold) elicit a sharp pain followed by a dull, prolonged ache that might last up to an hour or so in some cases. EPTs are of little value in the diagnosis of this condition.
- Pulp necrosis—A significant relationship exists between the lack of response to these tests and pulp necrosis.
- Chronic apical periodontitis—A significant relationship exists between the lack of response to these tests and root-canal infection.

Conclusion

Because of their simplicity and low cost, sensibility tests are commonly performed in clinical practice. It is essential that clinicians understand the limitations of these tests and their usefulness. They are important diagnostic aids; however, their results must be interpreted along with detailed history, symptoms, and clinical and radiographic findings. A clinical pulp diagnosis might not correspond to the histologic state of the pulp tissues.

Jafarzadeh H, Abbott PV. Review of pulp sensibility tests. Part I: general information and thermal tests. Int Endod J *2010;43:738-762.*

Increased Apical Enlargement and Its Effectiveness in Cleaning Curved Canals

Preventing or healing periapical disease is achieved by mechanically shaping (instrumenting) and chemically cleaning (irrigating) the root-canal system. Although the last decades have seen many advances in endodontic instruments, canal preparation is still influenced by the highly variable root-canal anatomy.

Philosophies vary regarding the optimal size and shape of root-canal preparation, and controversy continues about the degree of apical enlargement necessary to achieve success. Fornari et al from the University of Ribeirão Preto, Brazil, performed a histologic evaluation of the influence of apical size on cleaning the apical third of curved canals prepared with nickel–titanium rotary instruments.

In this study, 44 mesiobuccal canals of maxillary molars were instrumented using a crown-down technique to 4 apical sizes (Table 1).

Table 1. *Mean and standard deviation of remaining debris and uninstrumented root-canal dentine perimeter*

Experimental groups	Apical enlargement	Remaining debris (%)	Uninstrumented area (%)
I	#30/0.02	34.62 ± 9.49^{a}	55.64 ± 4.62^{A}
II	#35/0.02	25.33 ± 7.37^{b}	49.03 ± 5.70^{A}
III	#40/0.02	15.82 ± 6.66^{c}	38.08 ± 10.44^{B}
IV	#45/0.02	12.78 ± 3.11^{c}	32.65 ± 8.51^{B}

Uppercase and lowercase letters (A, a, etc.) indicate statistically significant difference at 5% (ANOVA post hoc Tukey test) for remaining debris and uninstrumented root-canal dentine perimeter, respectively.

The teeth were wrapped in wet gauze, and, using a 30-gauge needle placed 1 mm short of the working length, the canals were flushed with 2 mL of distilled water between each instrument. After root-canal preparation, the apical thirds of the roots were analyzed at 40× magnification, and the images were submitted for morphometric analysis to evaluate the percentage of debris and uninstrumented root-canal walls.

The percentage of uninstrumented root-canal dentine was higher when apical enlargement was performed with instrument sizes #30/0.02 taper and #35/0.02 taper than with the size #40 and #45 instruments ($p < .05$). More debris was observed when apical enlargement was performed with instrument sizes #30 and #35 than with instrument sizes #40 and #45. The authors also observed a significant correlation between the amount of remaining debris and the perimeter of uninstrumented root-canal dentine ($p < .001$).

Conclusion

Within the limitations of this study, it can be concluded that file sizes #40/0.02 taper and #45/0.02 taper produced a greater reduction in remaining debris and untouched root-canal walls than did those instrumented with #30/0.02 taper and #35/0.02 taper files at the apical third of mesiobuccal roots of maxillary molars. Nevertheless, no apical enlargement size could prepare all the root-canal walls completely.

Fornari VJ, Silva-Sousa YTC, Vanni JR, et al. Histological evaluation of the effectiveness of increased apical enlargement for cleaning the apical third of curved canals. Int Endod J *2010;43:988-994.*

Management of Invasive Cervical Resorption

Invasive cervical resorption (ICR) describes a relatively common, insidious and often aggressive form of external tooth resorption, which may occur in any tooth in the permanent dentition. Characterized by its cervical location and invasive nature, this resorptive process leads to progressive and usually destructive loss of tooth structure. Resorption of coronal dentin and enamel often creates a clinically obvious pinkish color in the tooth crown as highly vascular resorptive tissue becomes visible through thin residual enamel (Figure 1).

On periapical radiographs, ICR may barely be discernable or dramatically evident. The lesions vary from obvious, well-delineated radiolucencies to poorly defined lesions with irregular borders and sometimes a radiographic resemblance to caries. When ICR is superimposed in the pulp space, pulp space anatomy is usually evident.

When ICR is diagnosed, treatment can involve 3 choices:

- immediate extraction
- no treatment, with eventual extraction when the tooth becomes symptomatic
- access, debridement and restoration of the resorptive lesion (intracanal approach or surgical approach)

Dental implants have led to the increasing use of the first 2 choices,

Figure 1. An x-ray (left) reveals the resorption defects, and a clinical photograph (right) shows a pinkish discoloration secondary to resorption (*photographs courtesy of Dr. Fred Barnett*).

especially for the extensive cases of resorption. However, a tooth may go many years without symptoms.

Schwartz et al, private practitioners from Texas, described 3 cases of ICR and used the Heithersay approach to debride the resorptive lesions. In that approach, the lesion is accessed, and the granulation tissue debrided with a carbide round bur in a slow-speed handpiece.

The resorptive tissue is removed until smooth, clean dentin is present, except for a few small spots that are discolored or bleeding; this represents communication of the resorption with the periodontal ligament. The dentin is then scrubbed for 1 minute with 90% aqueous trichloroacetic acid (TCA) on a cotton ball. TCA cauterizes the residual resorptive tissue, making it more obvious under magnification.

A slow-speed round bur is used to remove additional tooth structure, and the acid is applied again. This process continues until all the penetration points are eliminated (surgical approach) or perforation through the external root surface is imminent (nonsurgical approach).

For nonsurgical treatment, it is impossible to eliminate all the penetration points, and TCA must be relied upon

to cauterize any resorptive tissue that remains. If invading resorptive tissue remains viable, the resorptive process is likely to continue.

When an external approach is necessary and the lesion is accessible, a rubber dam for isolation can be used because

- The caustic TCA will cause burns if it comes in contact with gingival tissue.
- The rubber dam provides better visualization and isolation for the restorative procedures.

For the endodontic treatment and the internal debridement approach, a rubber dam is always recommended. Dentin treated with TCA is severely demineralized and not suitable for bonding with either dentin-bonding agents or glass ionomer materials. It must be "refreshed" with a bur before bonding procedures are applied.

Dentin-bonding agents rely on a shallow demineralization of the dentin surface, which is infiltrated with a resin to form a hybrid layer with the exposed dentinal collagen matrix. Glass ionomer materials rely primarily on ionic bonding to the calcium in hydroxyapatite.

Conclusion

Proper management of ICR requires knowledge and skills in endodontics, surgery and restorative dentistry. Elimination of the resorptive tissue is performed most effectively under a microscope.

Schwartz RS, Robbins JW, Rindler E. Management of invasive cervical resorption: observations from three private practices and a report of three cases. J Endod *2010;36:1721-1730.*

The Effect of Needle-insertion Depth on the Irrigant Flow

Irrigation of root canals with antibacterial solutions—commonly delivered using a syringe and needle—is an integral part of chemomechanical canal preparation. The significance of the needle position has been highlighted in studies, and it has been hypothesized that positioning the needle close to the working length (WL) could improve debris removal and irrigant replacement.

Recently introduced as a method to study root-canal irrigation, a computational fluid dynamics (CFD) model has been validated by comparison with experimental high-speed imaging data. The CFD has been used to evaluate the effect of needle tip design on the flow of irrigant.

Boutsioukis et al from Aristotle University of Thessaloniki, Greece, evaluated the effect of needle-insertion depth on the irrigant flow in a prepared root canal during final irrigation with a syringe and 2 needle types using the CFD model. A CFD model simulated irrigant flow from either a side-vented or an open-ended flat 30-G needle positioned inside a prepared root canal (45/.06) at 1, 2, 3, 4 or 5 mm short of the WL. The authors evaluated velocity, pressure and shear stress in the root canal.

Major differences were observed between the 2 needle types. The side-vented needle achieved irrigant replacement to the WL only at the 1-mm position; the open-ended flat needle achieved complete replacement even when positioned 2 mm short of the WL. As the needles moved away from the WL, the maximum shear stress decreased. The flat needle led to higher mean pressure at the apical foramen. As the distance from the WL increased, both needles showed a similar gradual decrease in apical pressure.

Conclusion

For both needle types, insertion depth affected the extent of irrigant replacement, the shear stress on the canal wall and the pressure at the apical foramen. For the side-vented needle, irrigant replacement reached the WL only when it was placed at 1 mm, suggesting that this needle should be positioned within 1 mm from the WL if possible. The flat needle and probably also similar types should not be placed at 1 mm, because of the high apical pressure developed, which might result in forceful extrusion of irrigant. A reasonable compromise for the open-ended needle would be the 2- or 3-mm position, which would still ensure adequate irrigant exchange.

Boutsioukis C, Lambrianidis T, Verhaagen B, et al. The effect of needle-insertion depth on the irrigant flow in the root canal: evaluation using an unsteady computational fluid dynamics model. J Endod *2010;36:1664-1668.*

In the next issue:

- Preinjury factors of injured teeth
- The mandibular first molar
- Hypertension and endodontics

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