
The stressed pulp condition: An endodontic-restorative diagnostic concept

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The term "stressed pulp" describes a vital dental pulp that has been subjected to repeated damage, including operative trauma, accidents, or other pathologic changes. The stressed pulp condition is a clinical concept and not a histologic entity.

The stressed pulp condition should be considered prior to any extensive restorative dentistry or other dental procedures. Although a stressed pulp is usually asymptomatic clinically, it may deteriorate rapidly to a diseased or necrotic condition. Crown preparations, pin buildups, restorative failures, tooth structure cracks, and poor systemic conditions can transform the pulp from a state of asymptomatic stress to a state of pulpal disease.

DIAGNOSIS OF A STRESSED PULP CONDITION

Determining pulpal vitality is of utmost importance to the restorative dentist. Pulpal complications following restorative dentistry can be caused by (1) new operative trauma, (2) exacerbation of undiagnosed pulpal disease, and (3) transformation of stressed pulp to a state of disease.

The traditional thinking on pulpal vitality and pulp-testing methods is simplistic, casual, and fraught with myth and fallacies. Most in-depth pulpal diagnosis is performed infrequently or is made only when symptoms develop.

At best this diagnosis is based on observation of an anxious patient's reaction to a thermal or electric stimulation. The variability and complexity of human response to disease and injury and the unreliability of pain as a measure of tissue damage show the inadequacy of these methods.

The true histologic condition of the dental pulp may not be correlated with the way it responds to stimulation. Clinical pulpal vitality cannot be measured directly. It is usually inferred from test results. Pulp response

to stimulation is dependent on many variables, such as tooth age, type, systemic condition, previous trauma and pathology, and patient threshold to noxious stimuli.

Pulp-testing methods can be improved if the dentist incorporates the results of pulp tests with a careful review of past and present conditions of the pulp.

Clinical methods to evaluate live pulpal tissue directly are not available. Therefore, pulp tests should include a combination of all available clinical methods or findings, such as: (1) patient report on tooth history; (2) radiographic evaluation of the pulp cavity outline; (3) tooth and tissue examination; and (4) tooth response to thermal or physical stimulation.

Patient report on tooth history. In most instances the patient does not have a history of pain or discomfort. The tooth has been functioning well, but its history is lengthy and indicates evidence of cumulative injury to the pulp, including past trauma, orthodontic treatment, multiple restorations, or poor systemic health.

Tooth and tissue examination. The clinical crown usually contains multiple restorations. In addition, there may be evidence of cracks, attrition, or erosion. The tooth color may be altered by aging. Transillumination is useful to detect tooth structure cracks or defective restorations.

Radiographic evaluation. Pulp chambers of stressed pulps may have receded or may show evidence of pulp stones, reparative dentin, narrow canals, pins, deep restorations, or previous pulp capping.

Tooth response to stimuli. The application of thermal, physical, or electric stimuli to a tooth with a stressed pulp elicits a sluggish, weak, and delayed response. If the stimulus is not of sufficient potency and duration, the pulp response may not occur and the pulp may be erroneously considered nonresponsive or nonvital.

When a response is obtained, the patient interprets it as a *feeling* rather than as *pain*. Percussion and palpation produce no response. One of the most

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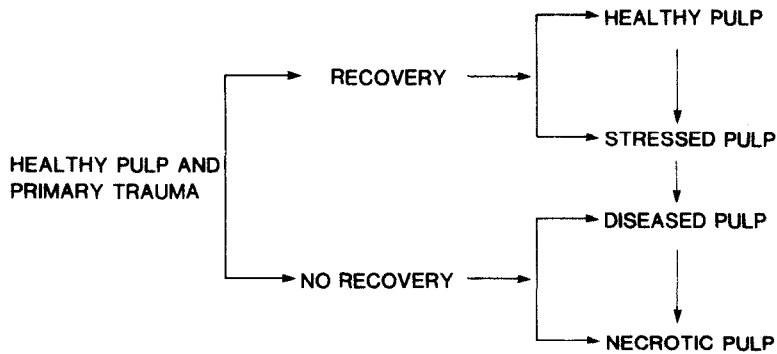


Fig. 1. Possible reactions of pulp to trauma.

effective methods for thermal testing is the use of carbon dioxide ice at -79°C to elicit a response. The provoked response should be evaluated in terms of duration and intensity. The stressed pulp is a vital pulp with diminished responses and should not be mistaken for a healthy pulp or a nonvital pulp (Table I). Stimulation of a control contralateral tooth is usually needed for purposes of comparison.

The pulp response should always be analyzed with a thorough understanding of the limitations of thermal, physical, and electric stimuli. The information obtained from the patient report on tooth history, clinical examination, radiographic evaluation, and stimulus-response tests is compared to develop a diagnostic trend. This trend is then considered in the future treatment plan.

SOME ASPECTS OF PULPAL INJURY

The dental pulp is a unique anatomic and physiologic organ. It can recover from primary injury. However, such recovery is dependent on many factors that can produce debilitating and permanent effects and reduce the reparative potential of the pulp. Following additional trauma the pulp may or may not recover (Fig. 1).

Operative procedures and materials that cause pulpal injury and may lead to pulpal stress include the following:

- Application of topical medications on cavity preparations¹
- Continuous air-drying of preparation
- Cement with high acidity
- Direct pulp capping
- Deep tooth preparation (where less than 2 mm of remaining dentin covers the pulp)
- High-speed tooth cutting without coolant
- Local anesthesia of long duration (while full-crown preparation is made)
- Unfilled resin restoration
- Unbased restoration allowing for thermal conductivity

- Raising pulp temperature up to 10°F by impression materials, polishing of castings, or cutting dentin without coolant
- Orthodontic tooth movement of heavily restored adult teeth
- Periodontal surgical exposure of cementum and lateral canals

The following diseases, conditions, and treatment cause pulpal injury and may lead to pulpal stress:

- Chronic bruxism
- Chronic caries
- Chronic periodontal disease²
- Chronic trauma from occlusion³
- Chronic occlusal attrition and erosion
- Cracks in tooth structure
- Radiation therapy
- Systemic diseases of oral manifestation
- Diabetes, vitamin C deficiency, leukemia, endocrine disturbances

The ability of the pulp to recover from pathologic and operative trauma is related to:

Type of injury. Mild injury is believed to be of no significance, and repair can be expected.

Duration of injury. A primary injury of short duration provides the best chance for recovery.

Thickness of remaining dentin. Remaining dentin between the cavity floor or crown preparation and the pulp is necessary to protect the pulp. If the remaining dentin is less than 2 mm thick,⁴ trauma to the pulp becomes more damaging and the recovery chances are reduced.

Physiologic age of the tooth. The pulp chamber and apical foramen size should be large enough to allow adequate vascular flow to the tooth. A receded pulp chamber or pulp chamber filled with calcification stones or reparative dentin may not have a good reparative potential due to its deprivation of vascular and cellular elements.⁵⁻⁷

Host factors. Patient age and systemic health play an important role in pulp recovery potentials. Young, healthy patients have better healing responses.

Table I. Classification of clinical pulp conditions and their differential diagnosis

Clinical evaluation	Healthy pulp	Diseased pulp	Stressed pulp	Necrotic pulp
Patient report	No significant dental history Tooth use in mastication Recent dental work	Pain complaint Long history of dental procedures, disease, or trauma	No complaint Previous complex dental history	History of spontaneous pain or no pain Tooth used in mastication Pain with hot food
Radiographic evaluation	Well-defined pulp chamber and canals Minimal restoration distance from pulp No calcification or resorption No osseous changes Normal root resorption	Deep restorations or caries Pulp cavity outline altered by calcification or internal resorption Root resorption Osseous changes	Pulp chamber recession Narrow pulp canal Partial calcification Deep restorations Normal apical area Periodontal lesion	Variable and may show any of the findings Present with healthy, diseased, or stressed pulp
Tooth and tissue examination	Minimal caries or restorations Normal color of tissue and tooth	Disease or defects in dentin Normal surrounding tissue or symptomatic supporting tissue	Defective restorations Dental disease or defects with multiple restorations Evidence of trauma Occlusal trauma	Variable and may show any of the findings Present with healthy, diseased, or stressed pulp
Pulp response to stimuli*	Immediate, severe transient pain, mostly provoked	Very rapid and severe or very late response Provoked and/or spontaneous linger-on Similar to patient's chief complaint	Late, weak, sluggish, inconsistent response requiring high degree of stimulation and longer time to produce	No response to stimuli or to heat, pain

*Stimuli = Cold, heat, percussion, cavity test (electric pulp tester; optional).

Past trauma. Dental diseases and operative trauma may produce residual damage to the pulp. Although the pulp may recover and survive the primary trauma, it will have less chance of surviving future trauma.

These factors are closely interrelated and should be considered together. The analysis of past and present treatment on a tooth, combined with the results of pulp testing, can produce a more reliable evaluation and differential diagnosis of the pulp for the future.

CLINICAL MANAGEMENT OF TEETH WITH STRESSED PULPS

The concept of the stressed pulp is a preventive concept developed to describe pulps that are neither healthy nor obviously diseased.

Many patients have one or more teeth with stressed pulp conditions that do not require treatment. However, patients should be advised that the teeth may become symptomatic in the future. If restorative treatment is indicated on teeth with stressed pulps, the

dentist should perform endodontic therapy before the new restorative effort. Placing pulp caps, deep extensive restorations, or composite pin-buildups in teeth with stressed pulps are common causes for endodontic complications following restorative therapy. Orthodontic movement of pulpally stressed teeth can also necessitate endodontic therapy later.

When dental caries and defective restorations are removed from the tooth crown, endodontic procedures are simple, straightforward, and uneventful. However, when a tooth is built up with pins and restored with crowns, endodontics can be complex and the possibility of perforations and other procedural errors leading to pain and complications is increased. Endodontics should be considered strongly before beginning restorative therapy, orthodontics, or other traumatic procedures on teeth with stressed pulps.

SUMMARY

The stressed pulp condition is a clinical concept that describes pulps that have received repeated previous

injury and survived with diminished responses and lessened repair potentials.

Before performing restorative dentistry the dentist should conduct a comprehensive pulpal health evaluation on teeth to be restored. This evaluation should include (1) traditional pulp-testing methods and (2) a review of the *past, present, and planned future treatment* of the tooth. This analysis will usually identify teeth with stressed pulp conditions.

Teeth with stressed pulps should be treated before complex restorative dentistry.

REFERENCES

1. Seltzer, S., Bender, I. B., and Kaufman, I. J.: Histologic changes in dental pulps of dogs and monkeys following application of pressure, drugs, and microorganisms on prepared cavities. Parts I and II. *Oral Surg* **14**:327, 856, 1961.
2. Seltzer, S., Bender, I. B., and Ziontz, M.: The interrelationship of pulp and periodontal disease. *Oral Surg* **16**:1474, 1963.

3. Landay, M. A., Nazimov, H., and Seltzer, S.: The effects of excessive occlusal force on the pulp. *J Periodontol* **41**:3, 1970.
4. Kawahara, H., and Yagami, A.: In vitro studies of cellular response to heat and vibration in cavity preparation. *J Dent Res* **49**:829, 1970.
5. Langeland, K., Dowden, W. E., Tronstad, L., and Langeland, L. K.: Human pulp changes of iatrogenic origin. In Siskin, M., editor: *Biology of the Human Dental Pulp*. St. Louis, 1973. The C. V. Mosby Co., pp 122-159.
6. Langeland, K., and Langeland, L. K.: Pulp reaction to cavity and crown preparation. *Aust Dent J* **15**:261, 1970.
7. Saygh, F. S., and Reed, A. J.: Calcification in the dental pulp. *Oral Surg* **25**:873, 1968.

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