Cervical dentin hypersensitivity. Part I: The air indexing method

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The purpose of this article is to introduce an objective method for quantifying cervical dentin hypersensitivity. Air emissions from a standard air-water syringe or a syringe with a Fluid Control Block are directed toward the cervices of teeth at a 45-degree angle to the long axis of test teeth from a distance of 0.5 cm for 0.5 to 1.0 second. An air indexing method has been developed to quantify threshold patient response values for individual teeth to this defined air stimulus. The air indexing method, using the Fluid Control Block, offers the clinician objective information to compare cervical dentin hypersensitivity before and after treatment for this common, painful condition. *(Quintessence Int 2000;31:461–465)*

Key words: abfractive lesion (abfraction), air index mapping, air indexing method, cervical dentin hypersensitivity, Fluid Control Block, hydrodynamic theory, threshold patient response

Numerous patients experience acute or chronic sensitivity and pain in the cervical regions of teeth. An estimated 40 million Americans a year suffer from cervical (dentin) hypersensitivity, and 10 million of this group experience chronic symptoms.[1,2] Cervical pain is a pulpal response resulting from exposure of open dentinal tubules to cold, air, electrical stimulation, acid exposure, tactile stimulation, or combinations of these stimuli.[3–12]

This pulpal response appears to result from changes in osmotic pressure within open tubules, as suggested by Gysi.[9] The hydrodynamic theory, further developed by Brännström[10] and Anderson et al,[11] proposes that pulpal mechanoreceptors are stimulated by evaporation of dentin fluids from open tubules on root surfaces. Teeth with a history of cervical hypersensitivity have been found to have many more open tubules with larger diameters than teeth with no history of hypersensitivity.[8,13,14] Modern techniques to treat symptoms of cervical hypersensitivity include the use of resin composites, strontium chloride, fluoride, oxalates, or other materials that occlude these dentinal tubules.[3,6,7,15] Thus, treatment mimics the physiologic presence of the salivary glycoprotein pellicle layer that occludes tubular root dentin.[3–8] Oral conditions that interrupt the integrity of this pellicle layer may lead to cervical hypersensitivity for teeth with vital pulp tissues.[4,5,7,8]

Open dentinal tubules on root surfaces may result from multiple etiologies. One popular explanation is that excessive force or time during toothbrushing may result in gingival recession and root abrasion, leading to cervical hypersensitivity.[16–23] Other authors have inversely attributed this sensitivity to plaque accumulation.[24,25] The erosive effects of environmental or dietary acids on the dentin surface have been suggested as contributory etiologies.[26–29] Gastric regurgitation, such as occurs with bulimia or esophageal reflux, is a potential source of dentin erosion from exposure to a systemic acidic agent.[27,30,31]

The mechanical effects of excessive occlusal loading stresses in the development of cervical abfractive lesions have not been verified in controlled clinical studies but may also result in open dentinal tubules.[32–46] Xhonga et al[47] found that the rate of formation of abfraction lesions in the presence of bruxism does not decrease following application of topical fluorides. Excessive functional or parafunctional horizontal loading forces seem to have a greater potential to lead to the development of abfractive lesions than do vertical or compressive forces.[37–39] Studies are needed to clarify the roles that these theoretical etiologies play in the development of cervical dentin hypersensitivity.

Methodology for assessing cervical dentin hypersensitivity of individual teeth is based on pulpal response to cold, air, osmotic, tactile, or electrical stimulation.[5,11,12,48–69] Pashley[5] has described available methods

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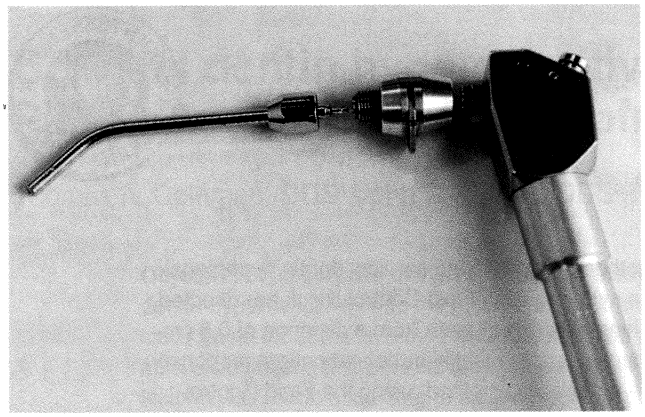

Fig 1 Fluid Control Block (prototype 1): Regulates air and water by disk rotation.

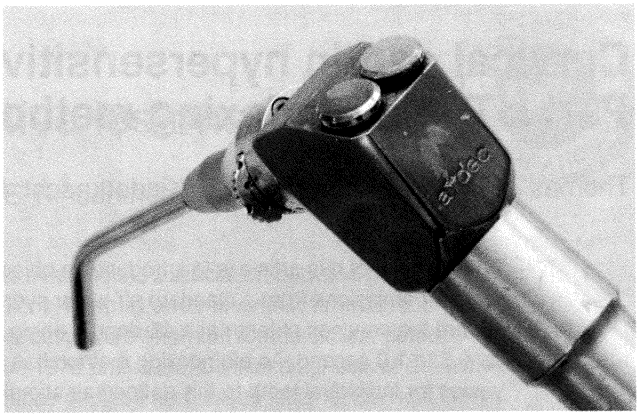

Fig 2 Fluid Control Block (prototype 2): Regulates air by disk rotation; water flow is not interrupted.

and discussed the advantages and disadvantages of these methods in significant detail. The use of a Yeaple probe and a calibrated strain gauge in an explorer have been used for tactile stimulation studies.[48,63] Cold water has been found more useful than warm water for assessment of thermal response.[59,60]

Air blasts applied to the cervical regions have been used for study of the hydrodynamic theory and the effectiveness of desensitizing agents.[5-48,61,62] The distance from the tooth, duration, and volume of air have never been standardized by previous studies.[59-67] The effects of evaporation arising from prolonged exposure or increased/decreased distance from air source to the tooth may alter pulpal responses.[5] Osmotic stimulation produces a pulpal response when dentin is exposed to solutions with high solute concentrations.[50-53] Neither osmotic nor electrical stimuli offer practical methods for the detection of dentin hypersensitivity.[5]

The purpose of this article is to introduce a standardized technique for quantifying cervical dentin hypersensitivity. The method uses defined gradients of air, applied from a defined distance and for a defined period of time. The intent is to provide the clinician with a means to document a "threshold patient response" for detecting this hypersensitivity.

TECHNIQUE

Fluid Control Block

From 1979 until 1994, "minor puffs" of air from a standard air-water syringe were used for the detection of sensitive root dentin. The amount of air delivered during hypersensitivity testing was selected by the audible sound of air released from the syringe. The clinician had to become acquainted with the sound of minor puffs of air in an attempt to differentiate hypersensitive from nonhypersensitive teeth. This method of air delivery lacked specificity in exchanging objective information between operators and required a significant learning curve to standardize attenuated air emission.

A standard air-water syringe (eg, A-Dec) was modified in 1994 by insertion of a Fluid Control Block[70,71] between the wand attachment and syringe head (Fig 1). This device offered 5 metered choices for ambient air emission at approximately 40 psi from an air-water syringe (Fig 2). Ambient air was defined at room temperatures of 18°C to 25°C. The color-coded Fluid Control Block dial was rotated by finger pressure to any of 5 air selections: 2 to 3 psi, 4 to 6 psi, 11 to 17 psi, 25 to 30 psi, or 35 to 40 psi. Calibrations were determined by the use of an air gauge following 12 trials with each aperture of the installed Fluid Control Block at incoming pressures of 20 to 40 psi.

Air indexing method

The "air indexing" method was designed to detect sensitivity of dentin to air within an acceptable range of patient comfort. A restricted air stream was directed toward the cementoenamel junction at approximately a 45-degree angle to the long axis of a tooth for a duration of 0.5 to 1.0 second. A short duration of air exposure avoids the potential release of neurotransmitters in pulpal tissue ("neurogenic inflammation") or evaporative phenomena, as discussed by Pashley.[5] The distance from the wand tip to the tooth cervix was approximately 0.5 cm.

Cervical dentin found sensitive to low volumes of air was termed *hypersensitive.* The most posterior tooth of a test zone was evaluated first, by application of air from Fluid Control Block hole 1 (2 to 3 psi) on the facial surface. If the air stream did not elicit a response from the patient, then the next more anterior

tooth was evaluated for sensitivity, and so on, to obtain an air index mapping for this test zone of teeth.

If no sensitivity was found with air from hole 1, the dial was rotated to hole 2 (4 to 6 psi). The same method for detecting cervical dentin sensitivity was repeated, beginning with the most distal tooth of this test zone. If all teeth were reported not sensitive by the patient to the stimulus, the dial was rotated to holes 3 (11 to 17 psi), 4 (25 to 30 psi), or 5 (35 to 40 psi) until a subject tooth or teeth were quantified as sensitive to the air stimulus.

The least air pressure necessary for patient detection of a sensitive tooth was termed the *threshold patient response*. These threshold response values were determined by the patient and recorded as none (0), slight (1), moderate (2), or severe (3). The same method was then applied to lingual cervical regions of teeth for this test zone. Resultant threshold patient responses were then available to track changes in cervical dentin sensitivity over time and in response to treatment.

A diagnosis of cervical dentin hypersensitivity was not made, nor was treatment rendered, unless a verified positive threshold patient response value was found 7 to 10 days after the initial detection.

DISCUSSION

The air indexing method provides a practical way for the clinician to objectively compare pretreatment dentin hypersensitivity with posttreatment results. It generates a quantified threshold patient response for dentin sensitivity to air emission by using a Fluid Control Block on a standard air-water syringe while allowing maximal patient comfort. The air stimulus necessary to elicit a detectable patient response is regulated by the Fluid Control Block, allowing comparisons of dentin sensitivity with minimized stimulation of pulpal mechanoreceptors by evaporation. Initial and follow-up threshold patient responses offer a method of assessing treatment modalities for dentin hypersensitivity.

Information associating abfractive lesions and cervical dentin hypersensitivity, determined with the air indexing method, will be presented in part II of this article. Part III will contain data from a retrospective study disclosing resolution of cervical dentin hypersensitivity following occlusal therapy.

CONCLUSION

The Fluid Control Block, developed in 1994, provides a controlled and quantifiable amount of air in the determination of the threshold patient response to cervical dentin hypersensitivity. The air indexing method provides the foundation for future studies investigating the etiologic factors and treatment modalities related to this common dental complaint.

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