

Consensus-Based Recommendations for the Diagnosis and Management of Dentin Hypersensitivity

• Canadian Advisory Board on Dentin Hypersensitivity •

A b s t r a c t

These consensus recommendations for the diagnosis and management of dentin hypersensitivity were developed by a broadly constituted board of dentists and dental hygienists drawn from general dental practice, specialist practice, academia and research from across Canada, joined by 2 international dentists with subject matter expertise. The need for consensus recommendations was made evident by the lack of clear and robust evidence in the dental literature, as well as confusion about diagnosis and management demonstrated by an educational needs assessment survey. High prevalence of the condition, underdiagnosis and widespread availability of noninvasive, efficacious and inexpensive preventive treatment further underscored the need for direction. This paper outlines the key elements of the scientific basis for the causes, diagnosis and management of dentin hypersensitivity; where such evidence is deficient, the document relies on the compound experience of the board. A simple algorithm was developed to guide clinicians through the diagnostic process and assist them in determining appropriate case management. Finally, the board makes a series of recommendations to raise awareness, to improve dental education, to develop symbols for charting, to develop an index for case assessment and for further research.

MeSH Key Words: algorithms; consensus; dentin sensitivity/etiology; dentin sensitivity/therapy

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Dentin hypersensitivity has been defined as a “short, sharp pain arising from exposed dentin in response to stimuli typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other form of dental defect or pathology.”¹ Several reviews²⁻⁴ reported that the prevalence of dentin hypersensitivity ranged from 8% to 57% in the general population and that strategies for managing the condition were remarkably varied. Furthermore, scientific support for various therapies was variable, so it could be a challenge for a practitioner to select appropriate therapy. Recognizing these issues, the Canadian Advisory Board on Dentin Hypersensitivity met in Toronto, Ont., in June 2002 to develop consensus-based recommendations on the management and treatment of dentin hypersensitivity.

Methods

The board considered data from 2 sources: an extensive literature search and a survey of knowledge and practices of dentists and hygienists across Canada. Where scientific defi-

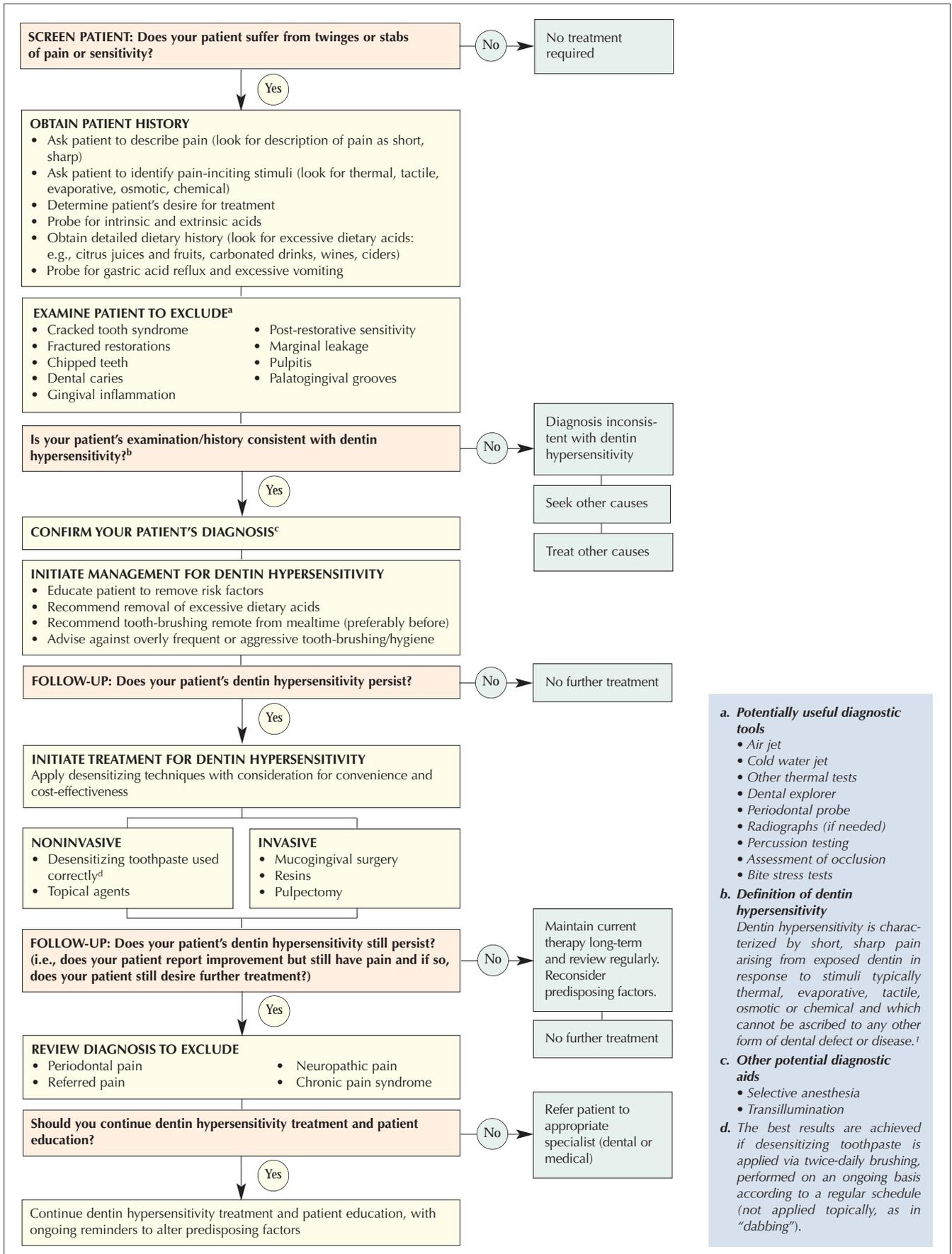
ciencies were identified, the board developed consensus positions drawn from members' own diverse clinical and academic backgrounds. Gaps in knowledge were identified through an educational needs assessment survey. The board brought together all its considerations into a set of consensus recommendations, including an algorithm (Fig. 1) to guide practitioners through diagnosis and case management.

Data Collection — Literature Search

An extensive computer (MEDLINE) and hand search of the literature identified original articles and reviews for the period 1966 to 2002 (see Table 1 for search terms). Because of space limitations, only critical findings are presented here.

Definition

After full consideration of the literature the board accepted the definition proposed by Holland and others,¹ with one minor change. The agreed definition was a “short, sharp pain arising from exposed dentin in response to



a. Potentially useful diagnostic tools

- Air jet
- Cold water jet
- Other thermal tests
- Dental explorer
- Periodontal probe
- Radiographs (if needed)
- Percussion testing
- Assessment of occlusion
- Bite stress tests

b. Definition of dentin hypersensitivity
Dentin hypersensitivity is characterized by short, sharp pain arising from exposed dentin in response to stimuli typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other form of dental defect or disease.¹

c. Other potential diagnostic aids

- Selective anesthesia
- Transillumination

d. The best results are achieved if desensitizing toothpaste is applied via twice-daily brushing, performed on an ongoing basis according to a regular schedule (not applied topically, as in "dabbing").

Figure 1: Algorithm for diagnosis and management of dentin hypersensitivity

Table 1 Key words and search terms used in the literature search

Search 1
(clinical trial OR randomized clinical trial OR clinical evaluation) AND (dentinal OR dental OR tooth OR intra-dental nerves) AND (toothpaste OR dentifrice OR mouthwash) AND (hypersensitivity OR sensitivity OR desensitization) AND treatment AND (potassium nitrate OR potassium citrate OR potassium chloride OR ferrous oxide OR sodium fluoride OR sodium monofluorophosphate OR glutaraldehyde OR strontium chloride), limited to humans
Search 2
(dentinal hypersensitivity) OR (dental hygienists) AND (treatment AND (conservative OR operative OR restorative OR varnishes OR resins OR silver nitrate OR glutaraldehyde OR formaldehyde)) NOT potassium NOT toothpaste NOT dentifrice, limited to humans

stimuli typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other form of dental defect or disease” (where “disease” replaces the original “pathology” of Holland and others¹). This definition challenges clinicians to consider other potential causes for pain associated with tooth sensitivity. Many conditions share the symptoms of tooth sensitivity, so a differential diagnosis is essential.

Mechanisms of Dentin Hypersensitivity

The most widely accepted mechanism of dentin hypersensitivity is the hydrodynamic theory proposed by Brännström,⁵ whereby fluid flow within dentinal tubules is altered (increased or changed directionally) by thermal, tactile or chemical stimuli near the exposed surface of the tubules. This alteration would lead to stimulation of the A- δ fibres surrounding the odontoblasts. This putative mechanism requires that individual tubules be open at the dentin surface, as well as within the pulp.

Dentin Morphology

In a study to determine differences between sensitive and nonsensitive teeth, Absi and others⁶ reported that nonsensitive teeth were unresponsive to any stimuli and had very few exposed tubules. In contrast, sensitive teeth had much greater numbers of open tubules per unit area (8 times as many tubules at the root surface than nonsensitive teeth). Similarly, the average diameter of tubules in sensitive teeth was almost 2 times greater than that of tubules in nonsensitive teeth (0.83 μm vs. 0.4 μm). According to Poiseuille’s law, which states that fluid flow is proportional to the fourth power of the radius, diameter differences alone would indicate that the fluid flow in tubules of hypersensitive teeth should be 16 (i.e., 2⁴) times greater than that of fluid in nonsensitive teeth. Combining the increased number of open tubules with the increased diameter of the tubules in sensitive teeth, it can be postu-

lated that the fluid flow in sensitive teeth is approximately 100 times greater than in nonsensitive teeth. The number of tubules increases toward the pulp, and this may not only increase the probability of dentin hypersensitivity but also help explain any increase in symptoms as tooth wear advances toward the pulp.

Causes

Two processes are essential for the development of dentin hypersensitivity: dentin must become exposed (lesion localization), through either loss of enamel or gingival recession, and the dentin tubules must be open to both the oral cavity and the pulp (lesion initiation).

Erosion,⁷ abrasion (or their co-effects), attrition⁸ and possibly abfraction⁹ lead to exposure of tubules. Both clinical and laboratory evidence suggests that enamel at the buccal cervical region is lost through a combination of erosion and abrasion.^{7,10} Enamel is resistant to abrasion by tooth-brushing, with or without toothpaste, but is particularly sensitive to the effects of acid; thus, brushing of acid-softened (eroded) enamel has a marked abrasive effect.¹⁰

As indicated in the survey results (see below), many practitioners assume that “abrasive” toothpastes are responsible for lesion development. While it is possible that toothpaste may erode dentin to some extent, the abrasivity might also produce a smear layer, thereby *reducing* sensitivity.¹¹ Interestingly, toothpaste abrasives in combination with detergents may remove the smear layer and open the tubules. Indeed, if predisposing factors (see below) are not eradicated, brushing with nearly any toothpaste may open the tubules.³ Occasionally, some deposits of the abrasive from toothpastes do adhere to the tubules, but they detach easily later.

Gingival recession, another factor in exposure of dentin, has recently been described as an enigma,¹² and its causes are not well understood. However, overzealous brushing, acute necrotizing ulcerative gingivitis, self-inflicted injury and periodontal procedures are the major predisposing factors.

Data Collection — Educational Needs Assessment

A 66-item questionnaire was developed to determine practitioners’ understanding and clinical management of dentin hypersensitivity. Key elements included practice profile, experience with patients suffering hypersensitivity, perceptions of causes and diagnosis, and clinical management. The questionnaire was mailed to a random sample of 5,000 dentists and 3,000 hygienists across Canada. The 7% response rate (331 dentists and 211 hygienists) was reasonable considering the many items on the questionnaire and the method of distribution. An independent research group (The Chapman Group Limited, Unionville,

Ont., unpublished data) compiled the results and convened focus groups to examine knowledge gaps more closely.

A total of 14 key knowledge gaps were identified, which were classified as relating to either the causes and diagnosis or the management of the condition.

Causes and Diagnosis of Dentin Hypersensitivity

1. Prevalence was underestimated, particularly for young adult patients. Approximately 70% of respondents indicated that most of their patients with dentin hypersensitivity were between 35 and 50 years old. Yet an independent research study (by The Chapman Group Limited) of 683 adults drawn from a nationally representative sample of the Canadian population found that the prevalence of sensitive teeth was about 30% in adults throughout the 18- to 64-year age band (28% for those 18–24 years of age, 22% for those 25–34 years of age, 30% for those 36–49 years of age and 30% for those 50–64 years of age).

2. Screening is not routinely conducted, except when prompted by patients.

3. Fewer than half of the respondents considered a differential diagnosis, even though dentin hypersensitivity is by definition¹ a diagnosis of exclusion.

4. Many respondents (64% of the dentists and 77% of the hygienists) identified bruxism and malocclusion as triggers of dentin hypersensitivity, even though neither has been identified as a major causative factor.

5. Only 7% of dentists and 5% of hygienists correctly identified erosion as a primary cause of dentin hypersensitivity.¹³ Sixty percent of respondents overall incorrectly identified gingival recession (rather than a predisposing factor) as the most common cause of dentin hypersensitivity.

6. Seventeen percent of dentists and 48% of hygienists failed to identify the accepted theory of dentin hypersensitivity (the hydrodynamic theory⁵).

7. Eighty-five percent of dentists and 94% of hygienists incorrectly cited toothbrush abrasion as a reason for continued tubule exposure, even though toothbrushes with or without toothpaste have no significant effect on tubule exposure.^{14,15}

Management of Dentin Hypersensitivity

8. About 50% of respondents reported that they lacked confidence in managing their patients' pain.

9. Only 50% of respondents reported that they try to modify predisposing factors.

10. Fifty percent of dentists and 73% of hygienists reported, incorrectly, that the most popular desensitizing ingredients in desensitizing toothpastes are fluoride compounds; in fact, the most widely available desensitizing ingredient is potassium nitrate.

11. Only 10% of respondents correctly thought that desensitizing toothpastes disrupt pain transmission by preventing repolarization within the nerve. The remaining

90% responded incorrectly that the principal action of desensitizing toothpastes is tubule occlusion. Potassium nitrate is thought to act by interfering with the transmission of pain, whereas strontium chloride, which is much less widely available, acts by occluding tubules.

12. Although many desensitizing toothpastes offer substantial secondary benefits and are suitable for daily use, misunderstanding exists. For example, 49% of dentists and 40% of hygienists did not believe that desensitizing toothpastes were effective in preventing caries, even though most contain fluoride.

13. Thirty-nine percent of respondents recommended topical application (dabbing) of desensitizing toothpaste, despite a lack of published evidence of the effectiveness of this method.

14. Although most dentists (56%) and hygienists (68%) believed that desensitizing toothpastes were effective in *preventing* dentin hypersensitivity, 31% of dentists and 16% of hygienists did not believe that desensitizing toothpastes *relieved* dentin hypersensitivity.

Developing Consensus

Screening

The advisory board concluded that screening of all dentate patients was essential to avoid underdiagnosis and undertreatment of the condition.

Diagnosis

By definition,¹ dentin hypersensitivity is a diagnosis of exclusion. Therefore, before proceeding to management and treatment, conditions that present with symptoms mimicking dentin hypersensitivity must be ruled out¹⁶ (**Fig. 1**).

Patients with dentin hypersensitivity usually experience a short, sharp pain in response to cold (the most common trigger), touch, evaporation, osmosis or chemical stimuli.¹⁷

It is difficult to quantify dentin hypersensitivity in a clinical setting, and hence clinicians must rely on patient-reported history. In this regard, a patient might indicate that she or he experiences pain but that it does not affect her or his quality of life (and that she or he is not seeking treatment). Others might request intervention to obtain some relief from the pain they experience. Given the many variations in presentation, the board members agreed that objective measures of pain from air blast or thermal stimuli, as are commonly employed in clinical trials, might not be capable of replicating all types of dentin hypersensitivity, which would reduce the reliability of evaluating the outcomes of therapeutic interventions. Given these issues, the board concluded that it would be most appropriate to rely on patients' perception of pain following treatment; the board also agreed that there was a need for a universal pain index. Such an index would constitute a judgement of global transition, meaning that the patient would indicate

that she or he feels an improvement, feels the same or feels even worse after the intervention. In addition, the patient might indicate that she or he desires no further treatment; in this situation and if the problem has been reduced or resolved, further treatment would be inappropriate.

Management: Removal of Predisposing Factors and Causes

Whenever possible, the predisposing factors should first be removed or modified. Otherwise, treatment is likely to provide only short-term success. In their review, Dababneh and others² cited reports of dentin erosion caused by many acidic substances derived either from the diet or from the stomach. A detailed, written dietary history (and investigation into bulimia and other dietary problems, if suspected) can help to identify possible predisposing factors. Contrary to the popular opinion demonstrated in the survey, normal brushing of the teeth with or without toothpaste has relatively little effect on erosion unless the environment has recently been acidified. The results of an *in vitro* study¹⁸ suggested that the timing of tooth-brushing should be remote from meals or ingestion of acidic drinks. The board considered that brushing *before* meals would be more advantageous.

Patients who brush excessively or use undue pressure while brushing should be instructed on proper tooth-brushing techniques to avoid gingival recession, the latter being a predisposing factor for both dental erosion and dentin hypersensitivity that is difficult to correct. Although debates continue on the correct method for brushing teeth, technique has little effect on dentin hypersensitivity (apart from the effects on gingival root coverage), unless the predisposing factors for erosion are still in place.

Treatment

Treatment can be designed to reduce fluid flow in the tubules, block the nerve response in the pulp or possibly both. An extensive analysis of review papers that focused on the use of desensitizing agents indicated a wide array of potential treatments for dentin hypersensitivity, most involving attempts to interrupt neural activation and pain transmission with either potassium nitrate or potassium chloride. Fluid flow can be reduced by a variety of physical and chemical agents that induce a smear layer or block the tubules. Tubule-blocking agents include resins, glass-ionomer cements and bonding agents; strontium chloride or acetate; aluminium, potassium or ferric oxalates; silica-calcium-containing materials; and protein precipitants.

Although there is little evidence to determine the superiority of one desensitizing agent over another, there is evidence that desensitizing toothpastes do provide benefit.^{4,19-21}

The board, in considering the use of desensitizing toothpastes, echoed the conclusion of Dababneh and others² that

“improvement for a majority of cases will be obtained by the recommendation of a desensitizing agent.”

Follow-up

The members of the board endorsed the concept that follow-up was necessary. If pain persists, a review of the diagnosis is mandatory to rule out other causes (Fig. 1). More invasive techniques, such as mucogingival surgery for root coverage, application of resins (to seal exposed tubules) or even pulpectomy may be necessary. In some cases the pain may be refractory and should be referred to a specialist (ideally before pulpectomy).

If the pain abates after treatment but recurs thereafter, and a review of the patient's medical history is still consistent with a diagnosis of dentin hypersensitivity, then further counselling regarding the removal of predisposing factors, combined with continuous long-term desensitization treatment, should be considered.

Educational Issues

Academic members of the advisory board (both dentists and dental hygienists) indicated that little time is allotted to dentin hypersensitivity in the curriculum. School curricula should offer greater focus on the diagnosis and management of pain in general, and give increased emphasis to dentin hypersensitivity. Resources for and approaches to teaching dentin hypersensitivity are highly variable and should be reviewed to ensure greater effectiveness.

Development of a Diagnostic Algorithm

Given the knowledge gaps identified by the educational needs assessment survey and practitioners' expressed lack of confidence in management, a systematic, structured approach to the problem of dentin hypersensitivity was developed and incorporated into an easy-reference algorithm (Fig. 1).

The algorithm reflects the published science on this topic and, where such evidence is lacking, the clinical experience of the board members. Its framework includes the fundamental elements and critical steps required to increase the likelihood of correct differential diagnosis and successful management of dentin hypersensitivity, and, where appropriate, it directs the clinician to other causes, no further treatment or referral. This algorithm can be used to guide the practitioner in making correct diagnostic decisions and then in acting upon the findings in a systematic manner.

Consensus Recommendations

Screening and Diagnosis

- Screening is critical for identifying dentin hypersensitivity.
- Conditions that have symptoms in common with dentin hypersensitivity must be excluded.

- Universal symbols should be devised to indicate the severity and extent of condition.
- A universal index combining an analogue pain measure with the patient's own rating of the effect of pain on their quality of life should be developed.
- A detailed dietary history assessing erosive influences is essential.

Management

- Predisposing factors and causes of dentin hypersensitivity should be removed or modified.
- Everyday use of desensitizing toothpastes should be considered and recommended as a noninvasive, inexpensive, efficacious first line of treatment, without necessarily sacrificing other benefits that patients seek (e.g., cavity prevention, whitening).
- Brushing with desensitizing toothpaste (at least twice daily) is the only clinically supported method of application of such agents. There is no published evidence to support topical application (dabbing).
- Depending upon the severity and extent of the condition, reversible procedures should be employed before nonreversible procedures.
- Follow-up is essential.

Research Needs

- Long-term follow-up studies are required. Ideally, studies would be randomized, placebo-controlled and double-blinded.
- The mechanisms underlying dentin hypersensitivity should be explored further; it is then conceivable that more effective therapies can be developed.

Education

- Clinical education should provide greater focus on the predisposing factors, diagnosis and management of dentin hypersensitivity and other forms of chronic pain. ❖

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