

Dentin hypersensitivity: a review

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ABSTRACT

Dentin hypersensitivity may be defined as brief, sharp pain arising from exposed dentin. It occurs typically in response to chemical, thermal, evaporative or osmotic stimuli and cannot be explained as arising from other dental defects or pathology. The primary cause of dentin hypersensitivity is loss of enamel on the tooth crown and gum recession exposing the tooth root, with subsequent loss of cementum. The exact mechanism of dentin hypersensitivity is still being researched, but many accept the hydrodynamic theory as an explanation of the symptoms. A Hong Kong survey found a prevalence of dentin hypersensitivity greater than 60% among patients attending a dental hospital; lower incisors were the most commonly affected teeth. Studies have found that many dental clinicians have misconceptions about dentin hypersensitivity and lack the confidence to manage this oral health problem. It is important that Hong Kong dentists know how to diagnose dentin hypersensitivity and provide appropriate treatments and recommendations for patients. Many treatments have been proposed but no universally accepted or highly reliable desensitizing agent or treatment has been identified. When a patient presents with symptoms that may be attributed to dentin hypersensitivity, a thorough clinical examination should be carried out to rule out other likely causes before making a diagnosis and embarking on treatment. Depending on the identified cause, a combination of individual oral health behavior instructions, use of self-care products, and professional treatment may be required to manage the problem.

Key words: Fluorides; Hypersensitivity; Tooth erosion

Introduction

Dentin hypersensitivity may be defined as short, sharp pain arising from exposed dentin. It occurs typically in response to chemical, thermal or osmotic stimuli and cannot be explained as arising from any other dental defects or pathology¹. Dentin hypersensitivity is a prevalent oral problem affecting more than 40% of the adults in many places²⁻⁴. Patients with periodontal diseases are at particularly high risk, and some studies have found that over 70% of patients with periodontal disease have experienced dentin hypersensitivity^{5,6}. The condition may last for days, weeks, or indefinitely unless treatments are provided. Many people with dentin hypersensitivity do not specifically seek treatment for this problem but may only mention it at a routine dental visit⁷. This is probably because they do not view it as a significant dental health problem. In fact, dentin hypersensitivity can significantly affect an individual's quality of life, in that dietary choices become limited, effective oral

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hygiene may be impeded, and esthetics can be negatively impacted.

In Hong Kong, a study of 226 patients attending a dental hospital found that two thirds of the patients (68%) had dentin hypersensitivity⁸. In a recent randomly sampled telephone survey conducted in Hong Kong, it was found that 62% of the 520 adult Chinese respondents felt slight twinges upon consumption of hot, cold, sour or sweet food⁹. These symptoms are probably due to dentin hypersensitivity. Furthermore, most respondents reported that consumption of cold drinks was the most common initiating factor. While some overseas studies have found that premolars are most commonly affected^{10,11}, the Hong Kong study found that the lower incisors were the most commonly affected, and the hypersensitive areas were most often on the facial surface of the teeth. While the literature reports that dentin hypersensitivity usually occurs in patients aged 30 to 40 years¹², the Hong Kong study found that dentin hypersensitivity peaked between 40 and 50 years, and declined with age. The probable reason for this drop in dentin hypersensitivity after the fifth decade of life may be pulpal changes occurring with increasing age, in particular, dentinal sclerosis and the laying down of secondary or tertiary dentin. This paper aims to present an overview of the causes, theory and management of dentin hypersensitivity.

Causes of dentin hypersensitivity

In a normal tooth, dentin is covered by enamel in a tooth crown and by a thin protective layer of cementum in most areas of the tooth root. It contains many thousands of microscopic tubular structures that radiate outwards from the pulp (Figure 1). These dentinal tubules are typically 0.5 to 2 microns in diameter and contain plasma-like biological fluid that is connected to the pulp. Each tubule contains a cytoplasmic cell process called Tomes fiber and an odontoblast that communicates with the pulp. Within the dentinal tubules, there are two types of nerve fibers, myelinated (A-fibers) and unmyelinated (C-fibers). The A-fibers are responsible for dentin hypersensitivity, perceived as pain in response to all stimuli. Depending on the depth, about 30,000 tubules can be found in 1 mm² in a cross-section of dentin. One study¹³ found that the number of open dentinal tubules per surface area in the exposed dentin surface of teeth with dentin hypersensitivity can be 8 times

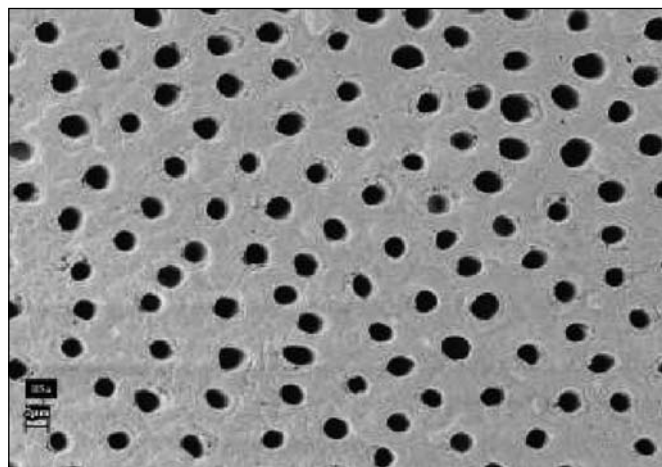


Figure 1 Scanning electron microscopic image of exposed dentine surface (x 2000)

that of teeth non-responsive to stimuli.

The primary cause of dentin hypersensitivity is loss of enamel on the tooth crown (Figure 2) and gum recession exposing the tooth root (Figure 3). Enamel can be lost as a result of aggressive or incorrect toothbrushing, over-consumption of acidic food, and tooth grinding caused by stress and parafunctional behaviors. A recent Hong Kong study⁹ found that many people have a high consumption of fruit, lemon tea, fruit juice, and soft drinks (Figure 4). The frequent intake of these foods and beverages can cause tooth erosion and dentin hypersensitivity. Gum recession may occur as a result of aggressive and incorrect toothbrushing, as well as periodontal diseases. Some dental operative and surgical procedures can also cause the gum to move away from the normal position at the crown-root junction. When the root of the tooth is exposed to the oral cavity environment, the cementum covering the tooth root can be easily removed, resulting in exposure of the underlying dentin and dentin hypersensitivity.

Dentin hypersensitivity has also been reported after external tooth bleaching. The mechanisms governing tooth sensitivity after external tooth bleaching have not yet been fully determined. A study¹⁴ has attempted to evaluate pulpal histology after bleaching, but with contradictory results. It has been suggested that inflammatory mediators may play an important role¹⁴.



Figure 2 Enamel loss exposing dentine in molar teeth



Figure 3 Loss of gingival tissues exposing dentine of tooth roots

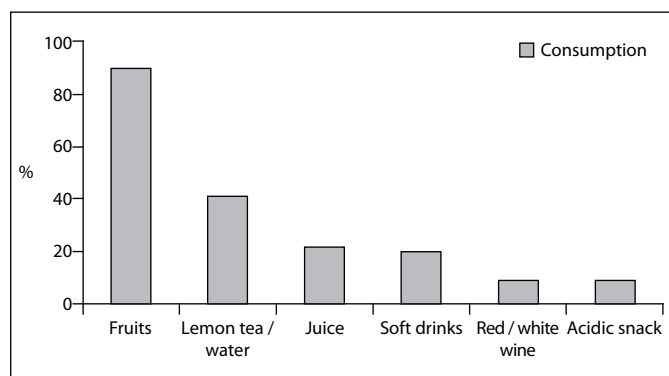


Figure 4 Common acidic food and beverages consumed in Hong Kong⁹

The hydrodynamic theory of dentin hypersensitivity

The exact mechanism of dentin hypersensitivity is still being researched. A commonly accepted theory is the hydrodynamic theory. According to this theory, changes in the flow of the fluid in the dentinal tubules can trigger pain receptors present on nerve endings in the pulpal aspect to fire nerve impulses, thereby causing pain (Figure 5)¹⁵. This hydrodynamic flow can be increased by changes in temperature, humidity, air pressure and osmotic pressure, or forces acting on the tooth. Hot or cold foods and drinks, and

physical pressure are typical triggers in people with dentin hypersensitivity.

Management of dentin hypersensitivity

There has been no research into how Hong Kong dentists diagnose and manage dentin hypersensitivity, but there is no reason to suppose they are very different from dentists with similar training in other developed countries. The Canadian Advisory Board on Dentin Hypersensitivity (CABDH) formulated a 66-item questionnaire and used it in a survey on dentists and dental hygienists in Canada. The survey (published in 2003) found that fewer than half of the 542 respondents (331 dentists and 211 dental hygienists) considered a differential diagnosis for dentin hypersensitivity, even though it is by definition a diagnosis of exclusion¹⁶. The study also found that many respondents (64% of the dentists and 77% of the hygienists) incorrectly cited bruxism and malocclusion as triggers for dentin hypersensitivity. A low percentage of the respondents (7% of dentists and 5% of dental hygienists) could correctly identify erosion as a primary cause. Furthermore, 17% of dentists and 48% of hygienists were unable to identify the accepted theory of dentin hypersensitivity. About half of the respondents reported that they lacked the confidence to manage a patient's pain due to dentin hypersensitivity, and only half reported that they would try to modify the patient's predisposing factors to control the pain. This survey also revealed a lack of understanding of desensitizing

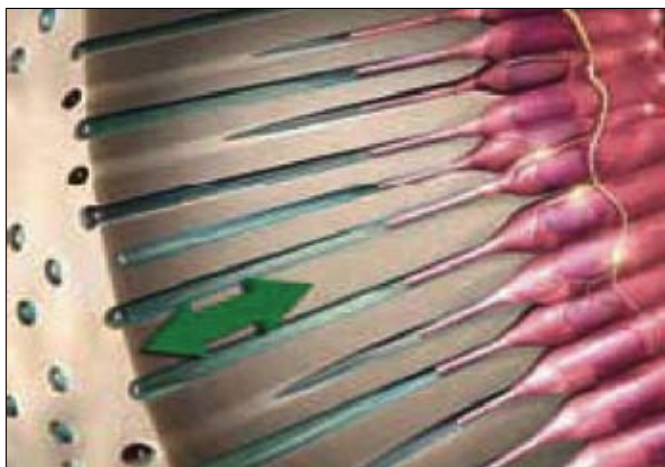


Figure 5 Pain elicited by movement of fluid in dentinal tubules (with permission from Colgate Palmolive [H.K.] Ltd.)



Figure 6 Dental erosion due to frequent intake of acidic beverage

toothpastes among the respondents. Most dentists (56%) and dental hygienists (68%) thought that these toothpastes could prevent dentin hypersensitivity, while 31% and 16% of the dentists and hygienists, respectively, thought that desensitizing toothpastes could not provide relief from dentin hypersensitivity. Thus, continuing dental education on the diagnosis and management of dentin hypersensitivity seems necessary.

Dentin hypersensitivity meets all the criteria to be considered a true pain syndrome¹⁷. It is important for a person who suffers from pain of a nature similar to the symptoms of dentin hypersensitivity to consult a dentist. Dentin hypersensitivity may share similar symptoms with dental caries and advanced periodontal diseases. The cause

of the pain should be identified and a diagnosis made by ruling out other conditions that may require different treatment. Once the diagnosis of dentin hypersensitivity is confirmed, the dentist needs to discuss oral hygiene habits and diet with the patient. Precautions and actions may need to be taken by both the patient and the dentist. A list of preventive recommendations developed by Drisko¹⁸ is shown in the Table.

Dietary changes and behavior modifications, such as decreasing the intake of acid-containing foods or carbonated drinks (Figure 6), are often necessary to manage dentin hypersensitivity. The patient should also be shown the correct brushing technique because improper toothbrushing has often been associated with dentin

Table Recommended actions for preventing dentine hypersensitivity (adapted from Drisko, 2002¹⁸)	
Suggestions for patients	
<ul style="list-style-type: none"> • Avoid using large amounts of dentifrice or reapplying it during brushing • Avoid medium- or hard-bristle toothbrushes • Avoid brushing teeth immediately after ingesting acidic foods • Avoid brushing teeth with excessive pressure or for an extended period of time • Avoid excessive flossing or improper use of other interproximal cleaning devices • Avoid “picking” or scratching at the gumline or using toothpicks inappropriately 	
Suggestions for dental professionals	
<ul style="list-style-type: none"> • Avoid over-instrumenting the root surfaces during scaling and root planing, particularly in the cervical area of the tooth • Avoid over-polishing exposed dentine during stain removal • Avoid violating the biological width during restoration placement, as this may cause recession • Avoid burning the gingival tissues during in-office bleaching, and advise patients to be careful when using home bleaching products 	

hypersensitivity. It has been shown that both a manual and a power brush used with desensitizing toothpaste are almost equivalently effective for reducing the symptoms of dentin hypersensitivity¹⁹. A systematic, structured approach to the problem of dentin hypersensitivity has been developed and incorporated into an easy-reference algorithm for diagnosis and management by the CABDH (Figure 7)¹⁶.

Home management with desensitizing toothpaste

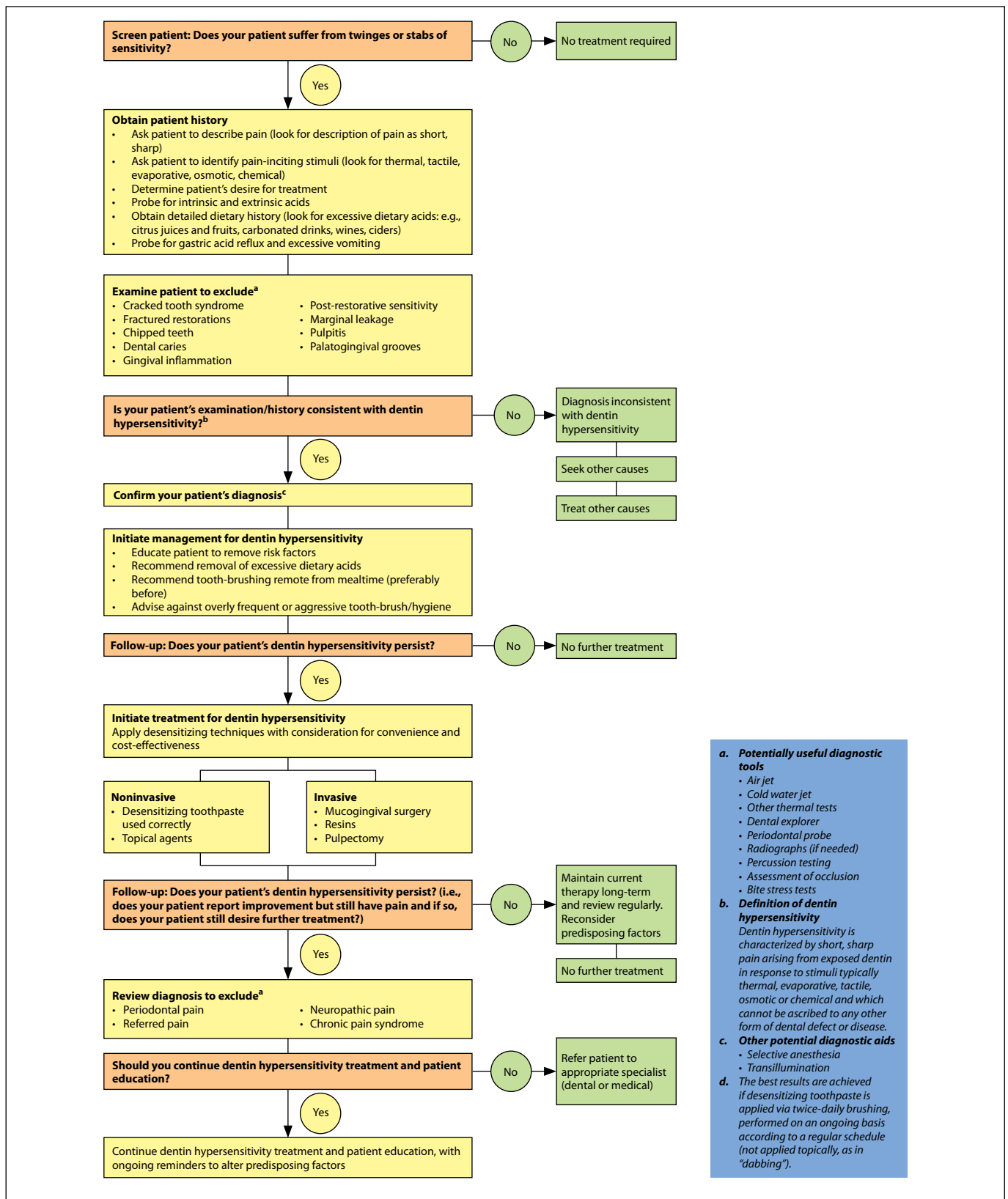
Many commentators consider desensitizing toothpaste a first-option recommendation. It is effective but often takes 4 to 8 weeks to achieve pain relief. Two treatment approaches have been used to provide relief of dentin hypersensitivity. The first approach is to interrupt the neural response to pain stimuli by the penetration of potassium ions through the tubules to the A-fibers of the nerves, thereby decreasing the excitability of these nerves. The second is to occlude the open tubules to block the hydrodynamic mechanism. Many desensitizing toothpastes contain potassium salts, strontium salts and/or fluoride compounds. These compounds use different approaches to produce their desensitizing effects. Potassium salts, such as potassium nitrate and potassium citrate, provide potassium ions to decrease the excitability of the nerves that transmit pain. Strontium salts, such as strontium chloride and strontium acetate, form mineralized deposits within the porous dentinal tubules and on the surface of the exposed dentin. Fluoride compounds such as sodium fluoride form a precipitate of insoluble metal compounds, mainly calcium fluoride globules, which promote remineralisation and occlude dentinal tubule openings on the exposed dentin surface. Desensitizing toothpastes with new chemicals, such as amorphous calcium phosphate, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), arginine-calcium carbonate (Arginine-CaCO₃), and calcium sodium phosphosilicate (CSPS) bioactive glass have become commercially available, but only the first two can be found in Hong Kong at present. The CPP-ACP and Arginine-CaCO₃ products occlude open dentinal tubules, blocking external stimuli associated with dentin hypersensitivity. A recent clinical trial²⁰ showed that brushing with a toothpaste containing 8% Arginine-CaCO₃ can effectively reduce dentin hypersensitivity. The CSPS bioactive glasses are known to induce osteogenesis in physiological systems, and have been shown to be able to seal and clog open dentin tubules²¹.

A clinical study²² reported a significant reduction in dentin hypersensitivity after brushing with toothpaste containing CSPS bioactive glass.

In-office professional care

Apart from asking the patient to use desensitizing toothpastes at home, dentists may apply a variety of professional products onto the exposed dentin surfaces to reduce dentin hypersensitivity. Products that have been used include resin-based materials, sodium fluoride varnish, silver fluoride solution, oxalates, and an aqueous solution of glutaraldehyde and hydroxyethylmethacrylate. These products generally occlude and seal the exposed dentinal tubules. Iontophoresis, a technique that utilizes a low galvanic current to accelerate ionic exchanges and the precipitation of insoluble calcium with fluoride gels, has also been suggested as a means of occluding the open dentinal tubules²³. This technique delivers sodium fluoride gel using a special spoon tray with a low electric current to minimize dentin hypersensitivity. Two to three treatments usually lasting 4 minutes each are required to eliminate or reduce dentin hypersensitivity for a period of 2 to 6 months. Arginine-CaCO₃ is also used as an active ingredient in a professionally used prophylaxis paste to manage dentin hypersensitivity. A clinical study²⁴ on 390 patients in Hong Kong found that professional prophylaxis by dentists and dental hygienists using Arginine-CaCO₃ paste could significantly reduce dentin hypersensitivity. Furthermore, dentists may apply a dental sealant and cavity varnish to cover the exposed dentin surface. In conditions where enamel and/or dentin is lost due to abrasion, erosion and/or abfraction leaving a notching of the root, filling materials such as glass ionomer and composite resin can be used to cover the exposed root and restore the tooth morphology.

Besides topical application of various products, other clinical treatment methods have also been used. Lasers can be used either alone or with surface treatments, such as topical fluoride application, to manage dentin hypersensitivity²⁵. Gingival grafts can be considered, particularly where gingival recession is progressive, when there are esthetic concerns or the dentin hypersensitivity is unresponsive to the more conservative treatments. A clinical study of 11 cases reported success with a two-stage surgical technique²⁶.



- 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.
- 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 7 Algorithm for diagnosis and management of dentin hypersensitivity (reproduced with permission from the Canadian Advisory Board on Dentin Hypersensitivity¹⁶)

Conclusion

Although dentin hypersensitivity is a common oral health problem in adults, high-quality scientific studies on the epidemiology, biological mechanism, and treatment of this condition are scanty. Many treatment methods have been proposed but no universally accepted or highly reliable desensitizing agent or treatment has been identified.

When a patient presents with symptoms that may be attributed to dentin hypersensitivity, a thorough clinical examination should be carried out to rule out other likely causes before making a diagnosis and embarking on

treatment. Based on the identified cause, a combination of individualized instructions on proper oral health behaviors, use of self-care products, and professional treatment may be required to manage the problem. Well-conducted clinical trials are needed to provide high-quality evidence able to guide clinicians and patients when choosing the most appropriate treatments for dentin hypersensitivity.

Declaration

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