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# Dentinal Hypersensitivity: A Review

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# **Educational Objectives**

The overall goal of this course is to provide the reader with information on the etiology of dentinal hypersensitivity, its prevalence and treatment options for this condition. Upon completion of this course, the reader will be able to do the following:

- 1. List and describe the anatomical features of dentin that predispose it to dentinal hypersensitivity.
- 2. List and describe the etiological factors in dentinal hypersensitivity.
- 3. List and describe the prevalence and most common sites for dentinal hypersensitivity.
- 4. List and describe the home and in-office options for the treatment of dentinal hypersensitivity.

# Abstract

Dentinal hypersensitivity is characterized by a short, sharp pain in response to stimuli. Dentinal hypersensitivity, which is more commonly seen in adults in the 20- to 40-year-old age group, has several etiological factors. Gingival recession and enamel loss both contribute to the prevalence of this condition, resulting in the exposure of dentin. Dentinal hypersensitivity is believed to occur due to the movement of fluid within the dentinal tubules occuring in response to thermal, chemical, tactile and evaporative stimuli, in accordance with Brännström's Hydrodynamic Theory. Treatment options include in-office procedures and homeuse, self-applied products that are aimed at either occluding the dentinal tubules or preventing neural transmission and thereby blocking the pain response.

# Introduction

Dentinal hypersensitivity can be a challenging condition for patients to describe and dental professionals to accurately diagnose. It consists of short, sharp pain that occurs when a stimulus reaches exposed dentin. This stimulus is most commonly thermal, either hot or cold, but can also be tactile, chemical, or evaporative. Typically, no other pathology can be found for the pain associated with dentinal hypersensitivity.<sup>1,2,3,4</sup> Patients may or may not report this painful and often chronic condition to their dentist or dental hygienist and when they do, they report experiencing short, sharp pain after a variety of stimuli.<sup>4,5</sup> A definitive diagnosis of dentinal hypersensitivity can be challenging and practitioners must rule out other problems, such as caries, fractured or cracked teeth, defective restorations, occlusal trauma, or gingival conditions that could be the underlying cause of the dental pain a patient experiences.6,7

Dentin consists of an organic component containing collagen fibers in a matrix of collagenous proteins and an inorganic component containing hydroxyapatite crystals. Within the dentin, dentinal tubules run from the pulp to the outer dentinal surface and are easily identifiable on scanning electron microscopy images of cross-sections of dentin as either open or plugged dentinal tubules. The number of tubules varies and can be as many as 30,000 in a square millimeter of dentin. The dentinal tubules contain Tomes' fibers, first described by Sir John Tomes in 1850, that extend into the dentinal tubules from the odontoblasts that communicate with the pulp.<sup>8,9</sup> Three types of nerve fibers (A-delta fibers, A-beta fibers, and C-fibers) are found within the dentin. Characteristics of hypersensitive dentin consist of dentinal tubules open to the oral cavity, large and numerous dentinal tubules, and a thin, poorly calcified (or absent) smear layer. This smear layer is composed of a deposit of salivary proteins, debris from dentifrices and other calcified matter that helps protect the cementum and dentin.<sup>4</sup> In normal dentin the smear layer covers the openings of the dentinal tubules and reduces the risk that a stimulus for hypersensitivity reaches the dentinal tubules.<sup>4</sup>





Courtesy of Dr. Charles Cobb

Figure 2. Brännström's Hydrodynamic Theory



Note the outward flow of fluid in response to stimuli, represented by the black arrows.

The mechanism by which the pain associated with dentinal hypersensitivity is currently believed to occur is Brännström's Hydrodynamic Theory. This theory states that stimuli (thermal, chemical, tactile or evaporative) are transmitted to the pulp surface due to movement of fluid or semi-fluid within open dentinal tubules. Anatomically, the areas of the tubules closer to the pulp chamber are wider and the fluid movement away from the pulp activates the nerves associated with the odontoblasts at the end of the tubule; this results in a pain response.<sup>10</sup> The fluid movement stimulates the small, myelinated A-delta fibers, which then transmit to the brain and result in the sensation of well-localized, sharp pain that is associated with dentinal hypersensitivity.<sup>4,10</sup>

# **Etiology of dentinal hypersensitivity**

## Gingival recession and enamel loss

Gingival recession and enamel loss have multiple causes that result in cementum and/or dentin exposure. Cementum exposed due to gingival recession tends to be thin, can easily be abraded or eroded and may contribute to sensitivity.<sup>11</sup> Gingival recession is more common as patients age.<sup>1</sup> Some common causes of gingival recession include the anatomy of the labial plate of the alveolar bone, toothbrush abrasion, periodontal disease and surgery, poor oral hygiene, acute or chronic trauma, frenum attachment, and occlusal trauma.<sup>4</sup>

# Gingival recession is more common as we age and has multiple etiologies that can cause cementum and/or dentin to become exposed.

With respect to the anatomy of the labial plate, the alveolar bone may be thin, fenestrated, or even absent and is a large factor in causing recession. Tooth anatomy and tooth position may also affect the thickness of this labial plate of alveolar bone.<sup>4</sup> Poor oral hygiene is another contributing factor for gingival recession. Plaque-induced gingivitis may progress to recession and attachment loss if inadequate plaque control continues. Toothbrushing techniques causing gingival trauma are also a significant factor for gingival recession; the frequency, duration and force of brushing all contribute to recession. Excessive force and improper technique may lead to gingival irritation that over time can also lead to recession. Paradoxically, patients with better home care have shown greater amounts of gingival recession compared to those with poorer home care due to the physical act of removing the smear layer.6,12

# Toothbrushing techniques causing gingival trauma are a significant factor for gingival recession.

Figure 3. Localized gingival recession



Courtesy of Dr. Keerthana Satheesh

Figure 4. Generalized attachment loss



Courtesy of Dr. Mabel Salas

Occlusal trauma and frenal attachments are two other factors that may contribute to recession and hypersensitivity. A frenal pull that results in the tissue moving more towards the cemento-enamel junction (CEJ) may result in recession. Occlusal trauma appears to be a risk factor for attachment loss in individuals with active periodontal disease in that the occlusal forces may lead to further recession of the periodontally involved apparatus.<sup>13</sup> Other less common causes of gingival recession may include inadequate attached gingiva, periodontal surgery, aggressive scaling and root planing, excessive tooth cleaning and flossing, loss of gingival attachment due to specific pathologies, and loss of attachment during restorative procedures. All of these possible etiologies may create an exposed root surface that is then a predisposing factor for dentinal hypersensitivity.14,15

## Figure 5. Early frenal involvement



Courtesy of Dr. Scott Froum

Figure 6. Advanced frenal involvement



Courtesy of Dr. Mabel Salas

Table 1. Causes of gingival recession and attachment loss
Anatomy of the labial plate of the alveolar bone
Periodontal disease
Frenum involvement
Toothbrush abrasion
Poor oral hygiene
Inadequate attached gingiva
Periodontal surgery
latrogenic loss during restorative procedures
Aggressive scaling and root planing
Acute or chronic trauma
Occlusal trauma
Excessive oral hygiene

Figure 7. Abrasion



Figure 8. Extensive loss of dentin, visible pulpal chambers



Loss of enamel results in exposed dentin and therefore is associated with dentinal hypersensitivity. Attrition, abrasion, erosion, and possibly abfraction are conditions that affect enamel. Abrasion can be caused by a number of factors related to tooth brushing; the stiffness and configuration of the toothbrush bristles in combination with force, the tooth brushing method, frequency of brushing, the abrasiveness of toothpaste, and the duration of brushing all contribute to loss of tooth structure. Once enamel is lost and/or recession is present, the exposed cementum and/or dentin are abraded, worn and eroded more quickly than enamel due to their lower inorganic mineral content – dentin abrades 25 times faster than enamel and cementum abrades 35 times faster.<sup>4</sup>

Exposed cementum and/or dentin are readily abraded, compared to enamel – dentin abrades 25 times faster than enamel and cementum abrades 35 times faster.

Table 2. Factors in enamel loss
Abrasion
Attrition
Erosion
Abfraction

Erosion is one of the most common causes of enamel loss and is irreversible. It is also one of the more common chronic conditions in children and adolescents, and is common in adults of all ages. Only recently has this condition been recognized as a dental health problem.<sup>16,17,18</sup> Erosion can be of intrinsic or extrinsic origin. Gastric acid regurgitation associated with medical conditions such as acid reflux disease and disorders such as bulimia results in intrinsic erosion. For extrinsic erosion, by far the most common causes of erosion are dietary factors that contribute to a more acidic oral environment. Frequent consumption of carbonated, acidic drinks, fruit drinks and fruit are the main causes. In general, the dissolution of enamel occurs at a pH below 5.0-5.7.19,20 Highly acidic foods and drinks remove enamel, over time exposing the dentin and also have the ability to remove smear layers and open the exposed dentinal tubules causing sensitivity and pain.<sup>20</sup>

Table 3. Common factors in erosion

It is now considered that erosion is a more important factor than abrasion in removing the smear layer or dentinal plugs thereby causing dentinal hypersensitivity.<sup>21</sup> In addition, once erosion has occurred, patients are then more susceptible to subsequent abrasion, further exacerbating the loss of tooth structure and risk of dentinal hypersensitivity. Attrition can also be accelerated by the presence of softened tooth surfaces following erosion.

It is now considered that erosion is a more important factor than abrasion in removing the smear layer or dentinal plugs.

### Prevalence of dentinal hypersensitivity

Dentinal hypersensitivity presents as early as the teen years and through old age. Higher incidences of this condition occur in the 20- to 40-year-old age group, corresponding with the age at which gingival recession is often seen.<sup>22,23</sup> There is a wide range in the reported prevalence of dentinal hypersensitivity, with publications citing prevalences of 4% and up to 98% depending on the population group. The highest prevalences are seen in periodontal patients (reported range of 60% -98%) and in the general population prevalences of up to 57% have been reported.<sup>20,24,25</sup> The higher prevalence for this group of individuals may be attributed to the root surface becoming exposed as part of the periodontal disease process and treatment. Between 9% and 23% of patients have reported root sensitivity before root planing, while after root planing approximately 55% of patients have reported experiencing dentinal hypersensitivity. This increase in sensitivity occurred for a oneto-three week period after the procedure and then slowly decreased over time.15,25 Over and above the removal of the superficial smear layer during scaling and root planing that can result in sensitivity, aggressive scaling and root planing can remove layers of protective cementum and dentin, causing sensitivity.<sup>26,27</sup> When cementum or dentin is exposed these areas are more susceptible to caries, as well as erosion, abrasion, and abfraction.<sup>28,29,30</sup> Females tend to be prone to hypersensitivity and it has been hypothesized that this is because females tend to be more frequent attenders for treatment and perform more extensive home care oral hygiene in comparison to males.6,31

In the general population prevalences for dentinal hypersensitivity of up to 57% have been reported, and more individuals report hypersensitivity after scaling and root planing than prior to scaling and root planing.

Hypersensitivity tends to be most prevalent on the buccal and cervical regions of the teeth.<sup>5,32,33</sup> The most common sites for dentinal hypersensitivity are the cervical margins of the buccal and labial surfaces of teeth, with these sites accounting for 90% of sensitive surfaces.<sup>34</sup> These areas of the teeth are a common site for recession and the enamel is also thinner in these areas. Canines and first premolars, followed by incisors, second pre-molars and molars are commonly affected by recession. Lastly, patients with moderate to severe sensitivity tend to have gingival recession more dominantly on one side of their mouth compared to the contralateral side.<sup>4</sup>

# Ninety percent of sensitive surfaces are found at the cervical margins of the buccal and labial surfaces of teeth.

# Diagnosis

A diagnosis of dentinal hypersensitivity can be a challenge for dental professionals since patients may not report it and it may not be obvious. What is interesting about this condition is that a majority of patients do not deem it to be a severe oral health condition and may not seek treatment or even report this condition to their practitioner.<sup>35</sup> Conversely, patients with exposed dentin - a sign that dentinal hypersensitivity may be present – may or may not experience sensitivity. Exposed dentin may also be present without this being obvious. One study used scanning electron microscopy images (SEMs) of dental impressions to study the micromorphology of the bucco-cervical area of biscupid teeth in dentally healthy young adults. It was found that for half of the sites observed to have gingival recession on the SEMs there were no clinical signs of this; the SEMs also showed areas of gingival inflammation as well as exposed roots that had no cementum covering the dentin, yet abrasion was not visible.11

# Patients with exposed dentin – a sign that dentinal hypersensitivity may be present – may or may not experience sensitivity.

Routine screening for this condition does not readily occur and many other oral conditions may present themselves with similar symptoms.4,26 Definitively excluding these oral conditions first will then lead to the diagnosis of dentinal hypersensitivity.<sup>36</sup> Fractured teeth, dental caries, pulpal pathologies, or leaking, fractured or failing restorations are conditions that present with similar signs and symptoms but require different treatment.<sup>4,5</sup> Through the use of radiographs, conversations with the patient, and a thorough clinical exam, the dental practitioner must first exclude these conditions and then define the diagnosis as one of hypersensitivity. Clinical signs and symptoms that a dental professional should be aware of and inquire about include sensitivity or pain when a stimulus is applied (such as hot/cold/sweet/sour/touch), exposed dentin at the site of sensitivity, and in the absence of dental caries, fracture lines, or poor restorations.<sup>4,26</sup> The diagnosis is one of exclusion.

Patients themselves may exhibit a variety of behaviors when receiving dental care if they have had unresolved hypersensitivity over the years. Patients who have dentinal hypersensitivity may have anxiety with a routine dental cleaning, and can be so anxious about pain that they avoid examinations and routine dental care in general.<sup>36,37</sup> Dental professionals may need to focus on providing patients with desensitizers to control the pain and relieve dentinal hypersensitivity during treatments as well as post-procedural dentinal hypersensitivity, and patients with dentinal hypersensitivity may request local anesthesia even for routine prophylaxis.<sup>22,36, 38,39</sup>

Table 4. Differential diagnosis
Dental caries
Fractured teeth
Cracked teeth
Fractured restorations
Leaking restorations
Pulpal pathology

# Management and Treatment

Educating the patient on the causes and management of dentinal hypersensitivity is a primary goal for dental professionals when creating a treatment plan for this condition. The first step is to identify the cause or etiology of the dentinal hypersensitivity. As listed above, there are multiple etiologies and once the main cause has been identified, education is the next step. This may entail behavior modifications, such as instructions on toothbrushing technique, using the correct type of bristled toothbrush (avoid using medium or hard toothbrushes) and avoiding using too much toothpaste or repeated applications of toothpaste in the middle of brushing.<sup>27</sup> Education on the appropriate way to brush, floss and use other interdental devices is necessary to avoid further loss of tooth structure and dentinal hypersensitivity. Other suggestions in behavior modifications focus on dietary choices - avoiding carbonated beverages, acidic foods and drinks to reduce the risk of erosion (and subsequent increases in dentin exposure and dentinal hypersensitivity), and avoiding hot/cold beverages and food to reduce the likelihood of stimulating the movement of fluid and transmission of impulses and resulting pain.

Table 5. Patient education

Causes of dentinal hypersensitivity
Instructions on toothbrushing technique and when to brush
Advice on toothbrush type - avoid medium and hard bristles
Advice on appropriate use of toothpaste
Advice on technique for interdental cleaning
Dietary advice
Hypersensitivity associated with tooth whitening

Patients should also be educated on when to brush -i.e., not to brush immediately after ingesting acidic foods and drinks (or immediately after exposure to gastric acid); instead it is better to rinse with water and wait at least two to three hours before brushing.<sup>20</sup> Patients may also need education on the effect of tooth whitening on the occurrence and severity of dentinal hypersensitivity. Tooth whitening can contribute to dentinal hypersensitivity, due to opening up of the dentinal tubules during tooth whitening treatments. Patients who have sensitive teeth should have the sensitivity treated before starting tooth whitening treatment and, as with patients that develop sensitivity during tooth whitening treatments, should also be given specific and correct instructions regarding tooth whitening and the management of associated hypersensitivity.<sup>27</sup>

# Patients should be educated to not brush immediately after ingesting acidic foods and drinks.

# **Treatment Options**

Treatment options for hypersensitivity include self-applied, at-home desensitizing agents and professional in-office desensitizing procedures. These treatment options can be categorized into two groups by their mode of action.4,27,40,41 To occlude the dentinal tubules, ingredients that may be used include oxalate compounds, strontium chloride, hydroxyethyl methacrylate (HEMA), and fluorides. Precipitates other than associated with fluoride compounds that have been used to treat sensitivity include calcium phosphate compounds, calcium hydroxide, amorphous calcium phosphate, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) and calcium sodium phosphosilicate. Recent approaches to advancing the treatment of dentinal hypersensitivity have also looked at potential avenues to remineralize the tooth structure by increasing salivary calcium and phosphate levels as well an increasing the salivary pH, stimulating the formation of calcium phosphate or hydoxyapatite.42,43,44 Calcium phosphate compounds occlude the tubules by forming a calcium phosphate precipitate, while calcium hydroxide occludes the tubules and promotes peritubular dentin formation.<sup>45,46</sup>

Figure 9. Tubule occlusion



Note the occlusion of the dentinal tubules, preventing the outward flow of fluid and subsequent stimulation of nerve fibers.

Products that interfere with the transmission of the nerve impulse work by raising the extracellular potassium ion concentrations and affecting polarization. When this is sustained for a period of time, the nerve excitation is reduced and the nerve becomes less sensitive to the stimuli. Potassium nitrate is the most common active ingredient used for this method.

#### Figure 10. Blocking neural transmission



Note the outward flow of fluid is still present in response to a stimulus; however, neural transmission in response to this is prevented by the presence of extracellular potassium.

# In-office treatments for tubule occlusion

Treatments provided professionally include varnishes and precipitates, primers containing glutaraldehyde and hydroxyethylmethacrylate (HEMA), and polymerizing agents.4,47 In severe cases where there is a loss of cervical tooth structure, restorations such as composite resin-based materials or restorations with glass ionomer may be used and have been reported to effectively reduce dentinal hypersensitivity.<sup>4,47,48,49,50</sup> There are several paint-on products that work by occluding and sealing the dentinal tubules. Glutaraldehyde/HEMA-based agents have been found to significantly relieve hypersensitivity immediately after treatment and at six months, and to reduce dentin permeability.<sup>51,52,53</sup> Oxalate-based treatment (Protect) is also effective and found to reduce dentin permeability.<sup>54</sup> A third option, 5% sodium fluoride varnish, is applied topically to occlude the dentinal tubules. Initially this forms a barrier over the exposed dentin, and once the varnish has been removed relief from hypersensitivity is obtained by calcium fluoride deposits that occlude the dentinal tubules. This is effective for up to 6 months.<sup>40,55</sup> Laser therapy is now also used in-office for the treatment of dentinal hypersensitivity,

while iontophoresis has been used for several decades but is a much less common hypersensitivity treatment. Severe cases may result in use of resin or glass ionomer restoratives for deeper abrasive lesions. In a number of cases gingival grafting may be performed to treat associated gingival recession. Based on a hierarchical model from the World Health Organization, it has been recommended that mild and responsive dentinal hypersensitivity be managed by less complex treatments – i.e., use of at-home desensitizers, and that in-office treatment (and follow-up home care) be provided for more severe, recalcitrant cases and for patients who have ongoing moderate dentinal hypersensitivity.20 However, patients attending for treatment may require a procedure and not have had hypersensitivity treated prior to this, and the associated discomfort could interfere with the patient's ability to tolerate treatment.

Periodontal patients may have had no sensitivity prior to treatment and experience hypersensitivity following treatment due to scaling and root planing or other periodontal procedures resulting in exposure of open dentinal tubules.<sup>15,26</sup> Prophylaxis can also result in hypersensitive dentin. In these situations, it is ideal if the patient can receive in-office treatment prior to leaving the office so that they do not then experience hypersensitivity. In addition, the patient may have only very localized hypersensitivity that can be easily treated in-office.

One in-office product that can be used either prior to or after scaling and root planing for immediate relief of hypersensitivity is an in-office paste containing Pro-Argin<sup>®</sup> technology. This is based on arginine (an amino acid), bicarbonate (pH buffer), and calcium carbonate (calcium source). Application of this product consists of using a low speed handpiece with the paste and burnishing the paste into the dentinal tubules causing them to become occluded. Using this product either before or after dental procedures has been found to provide immediate and lasting relief of hypersensitivity. Specifically, when this product is applied immediately after dental scaling, the relief of hypersensitivity may last for up to four weeks when used as the final polishing step during a professional cleaning. 39,56,57 It should be noted that this paste is not a prophylaxis paste and is not intended for the removal of stain.

A prophylaxis paste containing bioactive glass is available that is indicated for immediate desensitization and is used to desensitize exposed dentin during the prophylaxis or to prevent hypersensitivity associated with prophylaxis and the removal of the smear layer, or post-procedurally following scaling and root planing. This bioactive glass contains calcium sodium phosphosilicate, marketed under the name NovaMin<sup>®</sup>, and has been investigated for hypersensitivity relief.<sup>58,59</sup> Calcium sodium phosphosilicate (CSPS) is an inorganic, amorphous melt-derived glass compound that contains only calcium, sodium, phosphate, and silica. This ingredient has been incorporated into oral healthcare products for the alleviation of dentinal hypersensitivity for nearly 10 years and can be found a range of products including dentifrice and prophylaxis paste.<sup>60,61</sup> In recent studies, NovaMin<sup>®</sup> has been shown to rapidly release calcium, sodium, and phosphorous ions which form hydroxycarbonate apatite (HCA) that is similar in composition to the mineral found in both teeth and bones. These particles that are released have the ability to adhere to the dentin surface and continue releasing calcium and phosphate ions once they are deposited onto the tooth surface.62 The crystalline hydroxyl-carbonate apatite that is precipitated relieves hypersensitivity through occlusion of the dentinal tubules<sup>63</sup> and is also resistant to acid challenges. Given that prophylaxis is typically the last step in a scaling and root planing procedure, and a routine treatment at recall, incorporating the desensitizing agent into the prophylaxis paste saves an extra step and makes relief of hypersensitivity a simultaneous event, while still ensuring that stain is removed.

# **Home-use treatments**

Mild, generalized dentinal hypersensitivity can usually be managed well with at-home treatment.<sup>64</sup> Home-use treatments for dentinal hypersensitivity fall into the two categories defined by their mechanism of action. At-home treatments for sensitivity relief are cost-effective, safe, noninvasive and simple to use. These at-home treatments come in a variety of applications including dentifrices, gels, or rinses and are incorporated into the daily oral home care regimen.

# Home-use treatments interfering with neural transmission

The most popular ingredient in over-the-counter dentifrices that affect neural transmission is 5% potassium nitrate, the concentration recognized by the FDA for this ingredient. Potassium ions work by penetrating the length of the dentinal tubule and block the repolarization of the myelinated A-fibers. This increase in extracellular potassium allows for the large enough concentration to depolarize the nerve fibers and does not allow repolarization to occur. As a result, neural transmission will not occur following exposure to the stimulus and the patient will have no sensation of sensitivity or pain.4,65,66,67 For these dentifrices to work, frequent and regular application is needed. These dentifrices have demonstrated a significant reduction in hypersensitivity within a two week time frame when used twice daily to maintain a high level of extracellular potassium.4,68 There are a number of dentifrices containing 5% potassium nitrate. All of these products contain fluoride ions as well for protection against caries (Sensodyne, Crest Sensitivity, Colgate Sensitive Maximum Strength, Biotene Sensitive Toothpaste with Dry Mouth Protection). Potassium nitrate has also been used in whitening trays to relieve hypersensitivity between whitening treatments.<sup>69</sup>

# Home-use treatments for tubule occlusion

Home-use over-the-counter desensitizing agents that occlude the dentinal tubules are found in toothpastes, gels, and mouthrinses. One of the main active ingredients used in this manner is fluoride. Stannous fluoride (0.4%) in particular has a long history of use for relief of dentinal hypersensitivity,<sup>70</sup> and is found in dentifrices (Crest Pro-Health) and gels, as well as at other concentrations in mouth rinses. When fluoride is applied to exposed dentin, precipitates occur and block the dentinal tubules. Long-term relief will require the continued use of the product. Stannous fluoride dentifrices have been shown to relieve dentinal hypersensitivity in clinical trials.71 It has been reported that other fluoride dentifrices effectively relieve dentinal hypersensitivity by occluding the dentinal tubules, including prescription-level 5,000 ppm sodium fluoride dentifrice. Calcium and phosphate precipitates formed following use of dentifrices containing calcium and phosphate technologies have also been found to relieve hypersensitivity, including CPP-ACP, ACP and calcium sodium phosphosilicate. Studies have been conducted on dentifrice formulations containing 5% and 7.5% calcium sodium phosphosilicate.62 The research has indicated that using calcium sodium phosphosilicate delivered by brushing twice daily with a dentifrice has a beneficial effect, reducing the sensitivity caused by exposed cervical dentin surfaces and providing relief.<sup>72</sup> Both concentrations of calcium sodium phosphosilicate (5% and 7.5%) demonstrated effective relief from dentinal hypersensitivity and the 7.5% concentration was even more favorable for relief compared to the 5% concentration.72 One study found 7.5% calcium sodium phosphosilicate, 5% potassium nitrate and 0.4% stannous fluoride dentifrices all to be effective for relief of hypersensitivity.73 An in vitro study found that both casein phosphopeptide-amorphous calcium phosphate and calcium sodium phosphosilicate occluded dentinal tubules for sensitivity relief and resisted acid challenges.74

# Other considerations

Exposed dentin is more susceptible to root caries than enamel, and many patients with exposed dentin are also high-risk patients for caries over and above consideration of the exposed dentin.

It is therefore desirable if the active ingredient for hypersensitivity relief or another active ingredient contained in the treatment used also helps to prevent caries. Thus, in-office treatments incorporating high concentrations of fluoride in fluoride varnish can help prevent caries and are recommended by the American Dental Association as in-office topical fluoride treatments for patients at-risk for caries.<sup>75</sup> Home use of CPP-ACP-containing dentifrice has been found to help inhibit demineralization and to promote remineralization. Home use dentifrices containing fluoride are effective anti-caries agents and their use for sensitivity relief either through the action of fluoride occluding the dentinal tubules or in combination with 5% potas-

sium nitrate provides both sensitivity relief and protection against coronal and root caries. Prescription level 5,000 ppm sodium fluoride dentifrices provide extra protection against dental caries and have been found to reduce root caries.<sup>76</sup> These higher fluoride level dentifrices are used for patients at higher risk for caries. Recently, a prescription level 5,000 ppm sodium fluoride dentifrice that also contains calcium sodium phosphosilicate has been introduced to offer a remineralizing effect with a high level of protection against acid challenges. This is indicated for caries prevention.

Figure 11. Patient with hypersensitive dentin and root caries



Courtesy of Dr. Keerthana Satheesh

# Conclusion

Dentinal hypersensitivity can be a challenging condition for dental practitioners to diagnose and treat effectively. With the advancement in dental products, options for providing relief from pain and sensitivity are great and vary according to the severity of the condition. Dental practitioners should be more aware and effective in asking patients question about sensitivity. With practitioners being more pro-active with this condition, patients may not need to experience the pain associated with hypersensitivity and if they have this condition, receive treatment that can provide relief from pain.

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# Questions

- 1. Dentinal hypersensitivity \_\_\_\_
  - a. consists of short, sharp pain in response to a stimulus
  - b. may or may not be reported
  - c. occurs when a stimulus reaches exposed dentin
  - d. all of the above
- 2. Dentin contains \_\_\_\_\_
  - a. collagen fibers
  - b. an inorganic component
  - c. hydroxyapatite crystals
  - d. all of the above
- 3. There can be as many as <u>dentinal</u> tubules in a square millimeter of dentin.
  - a. 10,000
  - b. 20,000
  - c. 30,000
  - d. 40,000

#### 4. \_\_\_\_\_ communicate with the pulp.

- a. Odontoblasts
- b. Tomes' fibers
- c. Dentinal tubules
- d. none of the above

# 5. \_\_\_\_\_ is a characteristic of hypersensitive dentin.

- a. Dentinal tubules open to the oral cavity
- b. Large and numerous dentinal tubules
- c. A thin, poorly calcified (or absent) smear layer
- d. all of the above
- 6. The smear layer \_\_\_\_\_.
  - a. helps protect the cementum and dentin
  - b. covers the openings of the dentinal tubules
  - c. reduces the risk that a stimulus for hypersensitivity reaches the dentinal tubules
  - d. all of the above

#### 7. The A-delta fibers \_\_\_\_

- a. are stimulated by fluid movement in the dentinal tubules
- b. transmit to the brain
- c. are myelinated
- d. all of the above

# 8. \_\_\_\_\_ is a common cause of gingival recession.

- a. Occlusal trauma
- b. Frenum attachment
- c. Periodontal disease
- d. all of the above
- a. an or the above

# 9. Gingival recession can be the result of the alveolar bone being \_\_\_\_\_.

- a. fenestrated
- a. fenes
- b. thin
- c. absentd. all of the above
- 10. \_\_\_\_\_ is a less common cause of gingival recession.
  - a. Aggressive scaling and root planing
  - b. Inadequate attached gingiva
  - c. Iatrogenic loss during restorative procedures
  - $d. \ \ all \ of the \ above$

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- 11. \_\_\_\_\_ is one of the conditions that can result in enamel loss.
  - a. Abrasion
  - b. Attrition
  - c. Erosion
  - d. all of the above
- 12. Dentin abrades \_\_\_\_\_ faster than enamel and cementum abrades \_\_\_\_

#### faster.

- a. 35 times; 25 times
- b. 25 times; 45 times
- c. 25 times; 35 times
- d. none of the above
- 13. \_\_\_\_\_ can result in erosion of intrinsic origin.
  - a. Acid reflux disease
  - b. Swimming
  - c. Bulemia
  - d. a and c
- 14. A pH below \_\_\_\_\_ is known to cause enamel demineralization.
  - a. 3.0–3.7
  - b. 4.0-4.7
  - c. 5.0–5.7
  - d. 6.0–6.7
- 15. Higher incidences of dentinal hypersensitivity occur in the \_\_\_\_\_ age group.
  - a. 20- to 40-year-old
  - b. 30- to 40-year-old
  - c. 10- to 20-year-old
  - d. 40- to 60-year-old
- 16. Publications cite a prevalence of \_\_\_\_\_\_ for dentinal hypersensitivity, depending on the population group.
  - a. up to 78%
  - b. up to 88%
  - c. up to 98%
  - $d. \ none \, of \, the \, above$
- patients report experiencing dentinal hypersensitivity after scaling and root planing compared to before this procedure.
  - a. Fewer
  - b. The same number of
  - c. More
  - d. none of the above
- The most common sites for dentinal hypersensitivity are the \_\_\_\_\_ of the buccal and labial surfaces of teeth.
  - a. incisal margins
  - b. cervical margins
  - c. mid-area
  - d. a and b
- \_\_\_\_\_ can present with signs and symptoms similar to those of dentinal hypersensitivity.

- a. Fractured teeth or restorations
- b. Pulpal pathologies

d. all of the above

prophylaxis

d. all of the above

professionals.

d. a and b

drinks

d. a and c

a. Fluoride

d a and c

by raising

d. all of the above

23. Strontium chloride \_\_\_\_

hypersensitivity.

d. all of the above

a. occludes the tubules

b. occludes the dentinal tubules

c. is part of the normal smear layer

b. Amorphous calcium phosphate

c. Calcium sodium phosphosilicate

25. Calcium hydroxide \_\_\_\_\_.

b. precipitates calcium phosphate

c. promotes peritubular dentin formation

26. Products that interfere with the

a. extracellular sodium ion concentrations

b. intracellular sodium ion concentrations

c. intracellular potassium ion concentrations

d. extracellular potassium ion concentrations

have been found to \_\_\_\_

c. reduce dentin permeability

after treatment

months

d. all of the above

27. Glutaraldehyde/HEMA-based agents

a. significantly relieve hypersensitivity immediately

b. significantly relieve hypersensitivity after six

\_.

13

transmission of the nerve impulse work

hypersensitivity

dentinal hypersensitivity

c. Covering exposed dentin

tivity may\_

c. Leaking or failing restorations

20. Patients who have dentinal hypersensi-

b. be so anxious about pain that they avoid examina-

a. have anxiety with a routine dental cleaning

tions and routine dental care in general

c. request local anesthesia even for routine

21. \_\_\_\_\_ is a primary goal for dental

a. Educating the patient on the causes of dentinal

b. Educating the patient on the management of

22. Behavior modification can include

c. avoiding brushing after intake of acidic foods and

a. prevents neural transmission of a stimulus

24. \_\_\_\_\_ has been used to treat dentinal

a. using proper oral hygiene techniques

b. making sound dietary choices

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# Questions

- 28. Restorations such as composite resinbased materials are used for \_\_\_\_\_ of dentinal hypersensitivity.
  - a. mild cases
  - b. all cases
  - C Severe cases
  - d. none of the above
- 29. 5% sodium fluoride varnish \_
- a. initially forms a barrier over exposed dentin
  - b. occludes the dentinal tubules with calcium fluoride deposits
  - c. is effective in treating dentinal hypersensitivity
  - d. all of the above
- 30. Based on a hierarchical model from the World Health Organization, it has been recommended that mild and responsive dentinal hypersensitivity be managed by
  - a. less complex treatments
  - b. more complex treatments
  - c. in-office treatments only
  - d. none of the above

# 31. The discomfort associated with dentinal hypersensitivity can \_\_\_\_\_.

- a. increase the patient's ability to tolerate treatment
- b. reduce the patient's ability to tolerate treatment
- c. increase patient compliance
- d. any of the above

# 32. \_\_\_\_\_ can result in dentinal hypersensitivity.

- a. Scaling and root planing
- b. Prophylaxis
- c. Radiographs
- d. a and b

# 33. Pro-Argin<sup>®</sup> technology can be used \_\_\_\_\_\_ scaling and root planing for

- immediate relief of hypersensitivity.
- a. prior to
- b. instead of
- c. after
- d. a and c

#### 34. The relief of hypersensitivity obtained by using Pro-Argin<sup>®</sup> technology may last for up to \_\_\_\_\_ when used as the final polishing step during a professional cleaning.

- a. one week
- b. two weeks
- c. three weeks
- d. four weeks
- 35. Calcium sodium phosphosilicate \_\_\_\_
  - a. is an inorganic, amorphous melt-derived glass compound
  - b. contains only calcium, sodium, phosphate and silica
  - c. has been used to treat dentinal hypersensitivity and incorporated into oral products for nearly 10 years
  - d. all of the above

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#### 36. NovaMin<sup>®</sup>

- a. is the brand name for calcium sodium phosphosilicate
- b. is contained in prophylaxis paste
- c. is contained in several professional products
- d. all of the above
- 37. Incorporating the desensitizing agent into prophylaxis paste \_\_\_\_\_.
  - a. saves an extra step
  - b. makes relief of hypersensitivity a simultaneous event with prophylaxis
  - c. still allows stain to be removed
- d. all of the above
- 38. Crystalline hydroxyl-carbonate apatite
  - a. is precipitated when using calcium sodium phosphosilicate containing products
  - b. occludes the dentinal tubules
  - c. is resistant to acid challenges
  - d. all of the above

#### 39. At-home treatments for sensitivity

- relief are \_\_\_
- a. simple to use
- b. noninvasive and safe
- c. cost-effective
- d. all of the above
- 40. At-home treatments for dentinal
- hypersensitivity are available as \_\_\_\_\_. a. dentifrices
- b. gels
- c. rinses
- d. all of the above

#### 41. The most popular ingredient in overthe-counter dentifrices that affect neural transmission is

- a. 5% potassium chloride
- b. 3% potassium nitrate
- c. 5% potassium nitrate
- d. a or b
- 42. Potassium ions work by penetrating the length of the dentinal tubule and block the \_\_\_\_\_ of the myelinated A-fibers.
  - a. depolarization
  - b. hyperpolarization
  - c. repolarization
  - d. all of the above
- u. all of the above
- 43. Stannous fluoride \_\_\_\_\_
  - a. has a long history of use for relief of dentinal hypersensitivity
  - b. is found in dentifrices, gels and mouth rinses
  - c. has been shown in clinical trials to relieve dentinal hypersensitivity
  - d. all of the above
- 44. \_\_\_\_\_\_ dentifrices have been found to be effective for relief of hypersensitivity.

- a. 5% potassium nitrate
- b. 7.5% sodium calcium phosphosilicate
- c. 0.4% stannous fluoride
- d. all of the above
- 45. An in vitro study found that both CPP-ACP and sodium calcium

## phosphosilicate

- a. occluded dentinal tubules
- b. resisted acid challenges
- c. prevented neural transmission
- d. a and b
- 46. Exposed dentin is <u>\_\_\_\_</u> susceptible to root caries compared to enamel.

47. Prescription-level 5,000 ppm sodium

c. can be recommended for patients at high-risk for

48. Dentinal hypersensitivity can be a chal-

lenging condition for dental practitioners

fluoride dentifrice incorporating a

- a. less
- b. more

c. equally

caries

to

b. have

d. a and c

a. always

c. never

b. sometimes

d. accurately

d. a and b

d. all of the above

a. effectively diagnose

49. Patients \_\_\_\_\_ report dentinal

50. With practitioners being more pro-

a. patients can receive treatment

ated with this condition

c. treatments will be wasted

active with dentinal hypersensitivity,

b. patients may not need to experience the pain associ-

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c. effectively treat

hypersensitivity.

d. none of the above

desensitizing agent \_

a. relieves dentinal hypersensitivity

b. protects against acid challenges

# ANSWER SHEET Dentinal Hypersensitivity: A Review

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#### **Educational Objectives**

1. List and describe the anatomical features of dentin that predispose it to dentinal hypersensitivity.

2. List and describe the etiological factors in dentinal hypersensitivity.

3. List and describe the prevalence and most common sites for dentinal hypersensitivity.

4. List and describe the home treatment options and in-office options for the treatment of dentinal hypersensitivity.

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Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

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11.	A	B	$^{\odot}$			36.	A	B	$^{\odot}$	$\mathbb{D}$
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13.	A	B	$^{\odot}$	$\bigcirc$		38.	A	B	$^{\odot}$	$\mathbb{D}$
14.	A	B	$^{\odot}$	$\bigcirc$		39.	A	B	$^{\odot}$	$\mathbb{D}$
15.	A	B	$^{\odot}$	$\bigcirc$		40.	A	B	$^{\odot}$	$\mathbb{D}$
16.	A	B	$^{\odot}$	$\mathbb{D}$		41.	A	B	$^{\odot}$	$\mathbb{D}$
17.	A	B	$^{\odot}$	$\bigcirc$		42.	A	®	$^{\odot}$	
18.	A	B	$^{\odot}$	$\bigcirc$		43.	A	®	$^{\odot}$	$^{ imes}$
19.	A	®	$^{\odot}$	$\mathbb{D}$		44.	A	®	$^{\odot}$	$^{ imes}$
20.	A	®	$^{\odot}$	$^{\odot}$		45.	A	®	$^{\odot}$	$^{ imes}$
21.	A	₿	$^{\odot}$	$\mathbb{D}$		46.	A	₿	C	0
22.	A	®	$^{\odot}$	$\mathbb{D}$		47.	A	®	$^{\odot}$	$^{ imes}$
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