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Dentine hypersensitivity: bleaching and restorative considerations for successful management

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The presenting symptoms of sensitive teeth are multi-factorial, and from the perspective of restorative dentistry, make a differential diagnosis of true dentine hypersensitivity a challenge. This paper discusses the common causes of tooth sensitivity, focusing on restorative (operative) aspects and tooth whitening (bleaching). Restorative strategies for managing the condition and recommended dental materials are reviewed.

Key words: Sensitive, hypersensitive, restorative dentistry, tooth bleaching

Historically, probably the most common concern that brings people to the dental practice is a tooth that hurts. A diagnosis of the cause of tooth sensitivity can range from an abscessed or cracked tooth (*Figure 1*), to dental decay or some form of hypersensitivity. Symptoms of one condition can often be confused with another, and pain level can be directly or indirectly related to severity of the cause. This paper will discuss the causes of sensitive or hypersensitive teeth that the dentist may encounter, and possible treatments from a restorative perspective. The focus will be on sensitivity problems with no obvious pathology.

A differential diagnosis of sensitivity must take into consideration a number of variables (*Table 1*), such as problems with the tooth (*Figure 2*), problems with the surrounding periodontium, insults to the tooth and predisposing conditions.

When the patient presents with sensitivity, the first step in management is to take a complete history of the condition. Essential information to be assessed includes:

- The history and nature of the pain (sharp, dull, or throbbing)
- The number and location of sensitive teeth, and whether the same teeth are always involved
- The area of the tooth from which the sensitivity originates
- The intensity of the pain (on a

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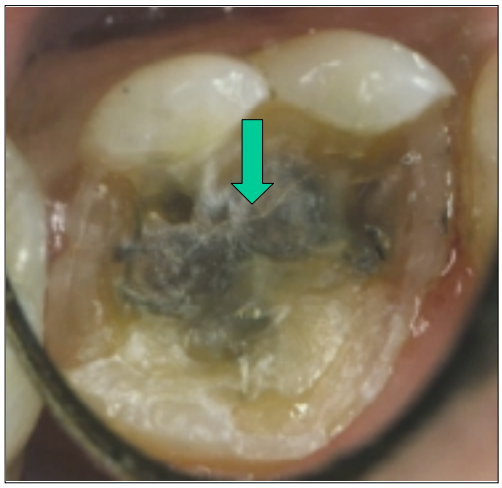

Figure 1. Cracked tooth. Upon removal of a large amalgam restoration for which the patient complained of sensitivity to biting, a fracture was noted from mesial to distal

Table 1

1. **Abscessed or non-vital tooth.** With periapical radiolucency or draining fistula; necrotic with sensitivity to occlusion; partially necrotic in one canal, with vital tissue elsewhere (in which case tooth tests vital to stimuli). Pain typically occurs spontaneously or upon occlusion or tapping.
2. **Cracked tooth.** Vertical fracture or single cusp partial fracture. Pain typically occurs on release of biting or tapping of a single cusp (*Figure 1*).
3. **Dental caries.** Greatest degree of sensitivity experienced when dental decay passes the dentine-enamel junction. As caries penetrates further into the tooth, sensitivity lessens until pulp becomes involved.
4. **Gingival recession.** Often occurs post-periodontal surgery, when a large portion of the root is exposed, or due to ageing, mechanical trauma, fraenum attachment pull or occlusal trauma (*Figure 3*).
5. **Toothbrush abrasion.** Caused by use of a hard toothbrush or a soft toothbrush with abrasive toothpaste or by aggressive brushing, and generally located on the side opposite the dominant hand. Abrasion may either instigate gingival recession or stem from greater accessibility to softer root surfaces from recession.
6. **Abfraction lesions.** Generally associated with occlusal trauma where the anatomic crown of the tooth has flexure. Although non-carious, these lesions can become very sensitive and even progress into the pulp. They may be multi-factorial where abrasion and erosive forces combine to produce tooth surface loss (*Figure 4–6*).
7. **Erosive lesions.** Associated with acid reflux, hiatus hernia, purging, bulimia (intrinsic causes), and diet (extrinsic causes). Intrinsic acid lesions typically occur on the palatal surfaces, while extrinsic acid lesions tend to occur on the buccal surfaces. Consuming large quantities of carbonated cola drinks and fruit drinks, which have a very low pH, causes tooth surface loss[1-3], as does toothbrushing following an acidic assault, which removes the acid-softened enamel or dentine.
8. **Diet sensitivity.** Generally associated with a low pH material, such as fresh tomatoes, orange juice, cola drinks[4-6]. Areas with exposed dentine are etched, causing sudden sensitivity. Diet choices may aggravate sensitivity from erosion.
9. **Genetic sensitivity**. Patients reporting history of sensitive teeth. It is not known whether sensitivity correlates to the 10 per cent of teeth that do not have cementum covering all the dentine at the DEJ[7], or is a factor of lower overall patient pain threshold values.
10. **Restorative sensitivity.** Triggered following placement of a restoration for several possible reasons: certain amalgams (such as Tytin) having a history of 24–48 hours sensitivity due to shrinkage, rather than the usual expansion, during setting; contamination of composites during placement or improper etching of the tooth on composites, which results in micro-leakage; improper tooth-drying technique; incorrect preparation of glass ionomer or zinc phosphate cements; general pulpal insult from cavity preparation technique; thermal or occlusal causes; galvanic reaction to dissimilar metals that creates a sudden shock or 'tin foil' taste in the mouth.
11. **Medication sensitivity.** Due to medications that dry the mouth (e.g. antihistamines, high blood pressure medication), thereby compromising the protective effects of saliva and aggravating diet-related trauma or proliferating plaque. Even a reduction in salivary flow due to ageing or medications can lower the pH of the saliva below the level at which caries occurs (6.0–6.8 for Dentine caries; < 5.5 for enamel caries) and increase erosive lesions to exposed dentine[8].
12. **Bleaching sensitivity.** Commonly associated with carbamide peroxide vital tooth bleaching[9] and thought to be due to the by-products of 10 per cent carbamide peroxide (3 per cent hydrogen peroxide and 7 per cent urea) readily passing through the enamel and dentine into the pulp in a matter of minutes[11]. Sensitivity takes the form of a reversible pulpitis caused from the dentine fluid flow and pulpal contact of the material, which changes osmolarity, without apparent harm to the pulp. Sensitivity is caused by all other forms of bleaching (in-office, with or without light activation, and new, over-the-counter) depends on peroxide concentration.

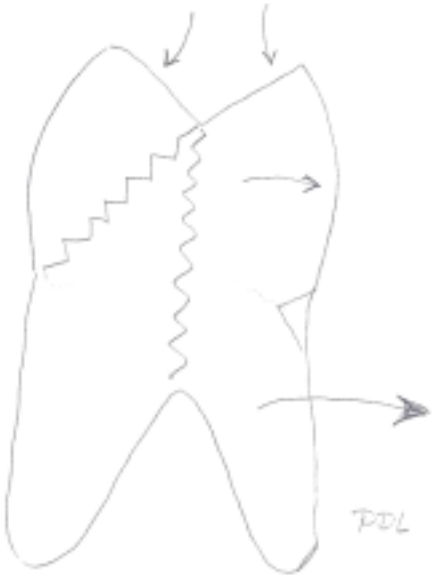

Figure 2.

Figure 3. Gingival Cleft may be associated with abnormal occlusion

Figure 4. Abfraction: In this heavy bruxer, the notched-shaped lesions are located sub-gingivally. The tissue must be displaced to access the lesions, indicating the toothbrush abrasion is not the primary cause of the defect

Figure 5. Abfraction lesions in the subgingival area measured 2–3 mm in horizontal depth, and had a chisel shaped form

Figure 6. Chemical Erosion after Abrasion: Once this bruxer has removed the protective covering of enamel, the exposed dentin may be dissolved by saliva or drinks with a pH lower than 6.8 but higher than 5.5 (where the enamel is affected). Restorative care would be to etch, prime and bond the dentin to the enamel without altering the occlusion to retard the wear of the tooth

Table 2 List of potential agents, restorative materials or procedures for use in the management of dentine hypersensitivity

Reversible	Non-reversible
Desensitising toothpastes	Glass ionomer cements
Fluoride gels, rinses, and varnishes	Resins, filled or unfilled
Oxalates of ferric, aluminium and potassium	Periodontal flaps or grafts
Protein precipitants	Pulp extirpation and root canal filling

1–10 scale, where 1 = mild, and 10 = intolerable) and any changes – an increase, decrease or no change – in intensity of the pain
- The trigger or stimulus which initiates the sensitivity
- The frequency and duration of each episode
- Other related events, such as recent restorative or periodontal and hygiene treatments, change in diet or oral hygiene aids or regimen, or home bleaching.

A thorough clinical examination should follow the interview, and include an objective evaluation of the following factors:
- Does tactile examination with a dental explorer elicit pain, and can the pain be localised to one area or one tooth?
- Is the area or tooth sensitive to gentle flow of air from the air-water syringe?
- Is the tooth sensitive to percussion?
- Is there sensitivity to biting pressure or upon release?
- What is the duration of pain after stimuli?
- Does radiographic examination reveal caries or periapical pathology?
- Is dentine exposed (gingival recession, loss of attachment, loss of enamel, or abfraction)
- Is there evidence of cracked cusps, fractured or leaking restorations, or occlusal interference and hyperfunction, or bruxism?

Once the cause is determined, treatment options can be considered. Options can be non-reversible or reversible (*Table 2*) or a combination of both depending upon severity and extent of the condition.

Figure 7. Tooth Mobility:Evaluation of fremitus (tooth mobility) can be done by placing the forefinger lightly on the buccal of pairs of the teeth and asking the patient to "grind around". Differences of mobility can be noted during movements.

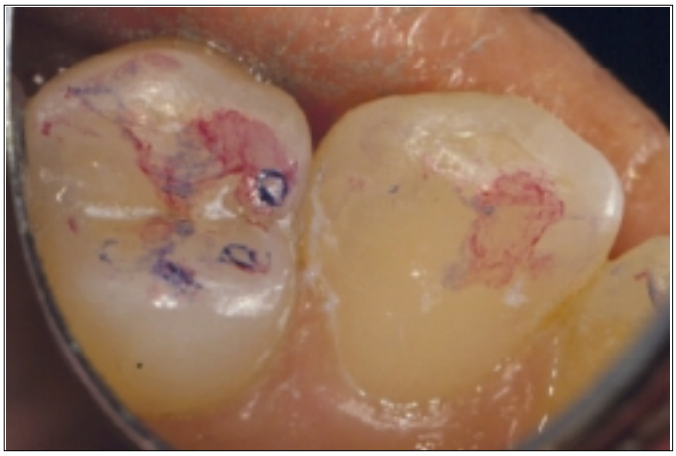

Figure 8. Tooth mobility: In the previous patient exhibiting fremitus, the occlusion was heavier on the first premolar than on the canine, and the premolar moved during excursive movements. Red articulating marks indicate functional guidance (and should be removed), blue indicates maximum intercuspation

Treatment options

In the case of abscessed teeth, cracked teeth or dental caries, removing the cause can involve: endodontic therapy, oral surgery (extraction, root resection or apical surgery), or replacing the restoration and broken cusp.

When a restoration is indicated, preventing sensitivity can take the form of base placement (such as Vitrabond for thermal sensitivity) or sealing dentine tubules with a prime and bond system (as found with any composite bonding system). Sensitivity can be reduced by cleansing the cavity preparation with a chlorhexidine solution to reduce bacterial insult, sealing tubules with a HEMA and glutaraldehyde material (e.g. Gluma) or selecting materi-

als that have no history of inducing this condition (e.g. composite resin instead of amalgam).

Techniques for cementation of crowns, which preclude over-drying of the tooth where glass ionomer cements are employed, may be helpful in avoiding sensitivity. Depending on the cement used, dentine tubules can be sealed under crowns with prime and bond, HEMA/gluteraldehyde or simple copal varnish. If occlusal trauma is suspected (*Figure 7*), adjusting the occlusion (*Figure 8*) or inserting a splint may be beneficial. Cervical lesions from abrasion or abfraction may require restorations for thermal protection, as opposed to application of a desensitising material alone. Some sensitivity associated with new composite restorations is due to placement techniques and bulk cure of high polymerisation-shrinkage materials.

The 'C-factor', or ratio of bound surfaces to unbound surfaces, can help determine the potential for sensitivity and suggest a possible change in placement techniques to minimise the effects of polymerisation shrinkage. A Class I or Class V cavity preparation has the high-est C factor (5) and the greatest chance for post-operative sensitivity but is also often used through aesthetic necessity to treat existing sensitivity. Techniques that can minimise the chance of exchanging one type of sensitivity for another then include avoiding bulk filling, placement of a stress breaker liner such as Optibond II or Vitrabond, and soft-start curing lights[12]. Abfraction lesions may require adjustment of the occlusion (usually elimination of the function contacts other than those in maximum inter-cuspation), followed by placement of a microfilled composite, which offers some flexibility with the tooth movement. A higher failure rate has been reported in Class V composite bonding of non-carious cervical lesions when the composite is placed in an untreated abfraction lesion, emphasising the need to modify the occlusion and reduce the abfraction forces (*Figures 9–11*).

Figure 9. Blue is maximum intercuspation; red is function. The premolar has heavy function rather than anterior guidance. There is evidence of parafuctional habits on all the teeth

Figure 10. Heavy function on the premolar (*Figure 9*) has produced a non-carious abfraction lesion. The patient complained of sensitivity, so a composite restoration was placed. It debonded (failed) in a few weeks. Proper treatment would be to adjust the occlusion on the first premolar (and the molar), then replace the restoration

Figure 11. Observation of the patient in function shows contact on the first premolar but not on the second premolar. Splint therapy may be indicated for parafunctional habits

Root surfaces that have been exposed from erosion and/or abrasion, (sometimes described as toothbrush trauma) can often be

recovered by periodontal flap or graft surgery, but only in cases where resins have not been applied previously to the root surface. Consideration must be given to the future need for muco-gingival grafting to the application of any restorative material as an uncontaminated dentine surface is necessary for re-attachment.

Sensitivity management

The challenge for sensitivity management is greatest when the sensitive tooth does not have or require a restoration. Then, the number of teeth involved and the location and frequency of the sensitivity dictate the best type treatment.

Among the reversible treatment options are materials that interfere with the transmission of the pain stimulus at the level of the A-delta fibres around the odontoblast (potassium salts), or exert a blocking effect on the open dentine tubules (strontium, oxalates or fluoride agents). Some protein precipitants may act in a dual capacity.

A number of topical agents have been used to reduce tooth sensitivity. The most common for professional application are fluorides. Fluoride may decrease sensitivity peripherally by occluding the dentine tubules through crystallisation and reducing the fluid flow to the pulp[13]. Patients may use a prescription toothpaste with higher concentrations of fluoride (5,000ppm), or the dentist may apply a topical fluoride either as a gel in a tray to treat many teeth, or as a varnish to treat specific, accessible areas of a single tooth.

Another group of materials is the oxalate salts, include potassium oxalate and ferric oxalate. These materials, which are generally applied in a rubbing or burnishing motion, act by occluding the tubules and reducing tubule fluid flow in either direction. Other agents applied by the dental professional are the dentin-bonding derivatives or agents and the HEMA/gluteraldehyde products, which either occlude the tubules or precipitate the protein in the tubule.

Figure 12. Non-scalloped, no reservoir tray used for bleaching

Desensitising toothpastes

The most common, professionally endorsed, self-applied approach to treating sensitive teeth is the use of desensitising toothpastes[14], which contain potassium salts (nitrate or chloride). Potassium ions pass easily through the enamel and dentine to the pulp in a matter of minutes[15,16]. Potassium is believed to act by interfering with the transmission of the stimuli by depolarising the nerve surrounding the odontoblast process. Most potassium-based desensitising toothpastes also contain fluoride for cavity protection, and some offer an array of flavours and the whitening, tartar-control, and baking soda benefits found in most regular toothpastes (e.g. the Sensodyne® range, GlaxoSmithKline, Crest Sensitivity Protection, Proctor & Gamble, or Colgate Sensitive®, Colgate Palmolive). Strontium salts (chloride and acetate), that are thought to act by blocking the open dentine tubule, can also still be found in desensitising toothpastes (Sensodyne® Original, GlaxoSmithKline).

In clinical trials, the desensitising effect of anti-sensitivity toothpaste generally takes about two weeks of application twice per day to show reductions in sensitivity, and greater effect develops with continued use[17]. The patient should be advised in accordance with the manufacturer's instructions, typically to be applied by brushing twice daily as part of the regular oral hygiene regimen. Recommending desensitising toothpaste that is similar in properties to the patient's regular paste will enhance compliance and increase effectiveness.

However, desensitising toothpastes have been applied in a variety of formats. In 1995, Jerome published a case study describing a technique for treating tooth sensitivity in post-periodontal surgery patients[18]. Instead of having the patient brush with a dentifrice containing potassium nitrate, he placed the desensitising toothpaste in a custom-made soft tray (*Figure 12*). By increasing medicament-tooth contact time, the tray delivery system increased the efficacy of the potassium nitrate dentifrice. In 2001, Haywood *et al* published a paper describing the use of 5 per cent potassium nitrate in bleaching trays to reduce the sensitivity that is triggered during bleaching[19]. They determined that 10–30 minutes of wear time generally alleviates sensitivity.

The current recommendation in the USA is to use a desensitising toothpaste containing 5 per cent potassium nitrate and fluoride, but without sodium lauryl sulphate (SLS) if available. SLS is the ingredient primarily responsible for the foaming action. One possible side

effect of using a large volume of toothpaste may be occasional tissue irritation, possibly from the one of the toothpaste ingredients. If irritation occurs, the patient should try a different flavour and composition. If the gingival problem persists, the dental professional can switch the patient to a professionally supplied potassium nitrate and fluoride products specifically designed for at-home, tray delivery application. The cost of these products is considerably more than toothpaste, and the patient must visit the dentist for re-supply. Therefore, if the patient can use toothpaste without untoward problems, then the patient has a lifetime approach to controlling sensitivity. The patient should be advised to experiment with a variety of toothpastes before committing to the professionally supplied materials.

One of the primary motivations for people coming to the dental practice is to have their teeth cleaned, so that their smile will be white. However, some people with sensitive teeth avoid hygiene appointments because of the discomfort the procedure elicits. Such sensitivity can be a pre-existing condition or a result of the cleaning procedure. The tray delivery system may be beneficial to this routine dental hygiene patient with a history of sensitive teeth: applying the desensitising toothpaste in a tray for 10–30 minutes prior to the prophylaxis appointment has been reported to reduce discomfort during and after the procedure. Should discomfort occur after the procedure, the material can be re-applied as needed until it is lessened or gone.

The effect of bleaching

If the patient has previously bleached their teeth with the nightguard vital bleaching technique (see below), then the custom-fitted tray can be used as the carrier for the anti-sensitivity toothpaste. If the patient is not a candidate for bleaching but has a history of chronic sensitivity, then a non-scalloped, no-reservoir designed tray can be fabricated (*Figure 13*). If it is unclear whether this approach will benefit the patient, a less involved technique may be tried that uses a direct thermoplastic tray made directly in the patient's mouth without an alginate impression, stone cast and laboratory exercise[20,21]. While this tray is more rigid, it is a quick means for determining the efficacy of a tray-applied medicament such as toothpaste or fluoride gels[22].

Figure 13. Examples of various tray designs – scalloped, reservoir and non-reservoir

Much has been learned about tooth sensitivity with the advent of at-home bleaching. Nightguard vital bleaching applies a 10 per cent carbamide peroxide material in a custom-fitted tray overnight for 2–6 weeks. Although some claims have been made for nightguard bleaching products that do not induce sensitivity, double-blind clinical studies have shown that sensitivity occurs in 55 per cent to 75 per cent of treatment groups[23–34], with placebo groups experiencing sensitivity in 20 to 30 per cent of subject. One study even reported tooth sensitivity of about 15 per cent in subjects wearing only the bleaching tray. Therefore, it appears that this kind of sensitivity is a multi-factorial event that cannot be totally avoided because it is not exclusively related to the peroxide whitening material.

One option to address this type of sensitivity is to try to predict which patients will become sensitive. However, the only significant predictors determined thus far[35] are a previous history of sensitive teeth and a regimen of more than one application of the bleaching solution per day. Moreover, the 2–6 month treatment time for the complete management of tetracycline-stained teeth has demonstrated just how sporadic the sensitivity is in some patients[36].

Since tooth sensitivity during bleaching is common, yet unpredictable, it must be addressed clinically when it occurs. Often the sensitivity experienced is 'mild', and requires no alteration in the treatment protocol. In cases where it cannot be ignored, the dentist may have to instruct the patient to decrease the frequency (typically, to every other day) and duration of treatments[37]. When this protocol fails, some practitioners advocate the use of topical fluorides in conjunction with the bleaching treatments. Others recommend using a desensitising toothpaste for 2–3 weeks prior to initiating as well as during bleaching. Persons experiencing night time sensitivity may switch to daytime wear and reduce contact

time of the peroxide to 2–4 hours. In severe cases patients may have to stop bleaching for a few weeks or even altogether.

The advent of tray delivered desensitising agents containing potassium has greatly aided the dentist in taking a more active approach to managing sensitivity and affords patients a simple, effective means to control their treatment. The bleaching study demonstrates the efficacy of 10–30 minute applications of the desensitising material, used as needed (one time only, once a week, continuous before each bleaching treatment, or alternated with bleaching treatments).

Conclusion

There are many causes of and treatments for tooth sensitivity. The dentist must explore all possibilities, form a definitive diagnosis or diagnoses, then implement management strategies that address all causes and predisposing factors to reduce or eliminate the sensitivity. Treatments may range from simple topically applied medicaments at home by the patient to restorations, pulp removal or muco-gingival surgery. The severity and extent of the sensitivity will dictate variations in treatment options. Chronic problems with teeth not having restorations or obvious pathology are most disconcerting. The use of a desensitising agent such as 5 per cent potassium nitrate-fluoride gel (toothpaste) applied in the bleaching tray as needed for tooth sensitivity can be effective and gives the patient more control over the condition. This tray delivery technique reduces tooth sensitivity from nightguard bleaching in a majority of patients, which allows most patients (including those undergoing long-term treatment for tetracycline staining) to continue whitening to successful completion.

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