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Mini Review

Dentin Hypersensitivity and Recent Developments in Treatment Options: A Mini Review

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Abstract

Dentin hypersensitivity is becoming increasingly prevalent. It is mainly caused by an osmotic, tactile, chemical, thermal or evaporative stimulus which causes the movement of dental fluid within the tubules, either outwards or inwards. A sharp pain may be induced, and may hamper the daily activities of patients. The etiology of the sensitive teeth should be considered before treatment planning; following this, current options for treatment methods and related desensitizers should be tried. If desensitizers cannot relieve the pain, then restorative materials may be used to seal the dentine. Root canal therapy should be the last choice of treatment. It should be noted that sufferers may have an acidic diet or parafunctional habits which exacerbate the lesions. Therefore, patients should be encouraged to use oral hygiene products carefully, and preventive management should not be ignored. Various forms of desensitizers (toothpastes, gels, mouthwash, etc.) have certain advantages, and it is often best to use a combination of different desensitizers with treatment methods such as lasers and iontophoresis. In this mini-review, treatment options described in recent studies are discussed, and the latest products used in sensitivity prevention are compared in detail, in order to facilitate the management of these painful lesions.

INTRODUCTION

Dentin hypersensitivity has recently become increasingly widespread. For the majority of patients, a sharp pain appears, lasting for a short period and occurring at intervals. This generally occurs when drinking cold water, eating icy food or breathing in frosty weather. In severe cases, the pain last for hours and hampers daily activities. Since the pain spectrum is wide, it is essential to address this condition and to apply the optimum treatment.

Dentin hypersensitivity is often defined as the pain arising from a chemical, tactile, thermal, osmotic or evaporative stimulus whereby the dentin surface is exposed to the oral environment [1,2]. There are many reasons for dentin involvement in the oral cavity, such as attrition, abrasion and erosion, cervical caries, gingival recession and excessive brushing [3]. Many theories of the etiology of hypersensitivity have been proposed over the years; however, the most recent and most generally accepted of these is the hydrodynamic theory [4]. This theory involves the flow of the dentinal fluids found in the dentinal tubules to either the pulpal or enamelodentinal junction in response to the stimulus. The flow creates a pressure change in each direction and triggers the sensory nerves located either in the dentinal tubules (A-nerves) or within the pulpal body (C-nerves) [3-6]. The response of the sensory nerves depends on the type and duration of the stimulus. For example, a cold stimulus extends the flow of the dentinal fluid to the outer edge of the pulpal body, and creates a sharper and stronger pain than that of a heat stimulus. Heat pressure extends the tubules and induces fluid flow towards the pulp [7]. This causes a slower and duller response [3]. The more severe response from a cold stimulus has been confirmed by many researchers to involve the rapid outward movement of the dentinal fluids [4,8,9].Irrespective of whether exposed to the oral environment, the dentin tubules are opened to the pulpal nerves, and this initiates hypersensitivity. A high proportion of people have exposed dentin surfaces; however, only a relatively small number of patients suffer from this pain [10].

Dentin hypersensitivity is usually encountered among people aged between 20 and 50 [11,12]. The older population rarely encounters hypersensitivity problems; this can be ascribed to the reparative properties of dentine, fibrosis within the pulp and sclerosis of the tubules [10,13].The prevalence of these cases is reported as a wide spectrum; numerous clinical studies evaluated by trained dentists have shown a range of prevalence of between 3%and 57% [10]. A variation of results has been reported due to differences in clinical settings [14].

TREATMENT OPTIONS -I

Preventive Management

The most important procedure for overcoming sufferers' existing pain is to eliminate the etiological factors. There are numerous treatment options for hypersensitivity, and the majority of them have been found to heal this condition [3]. It is therefore essential to use the most appropriate treatment option for the specific underlying cause. Before pain and severe lesions develop, there are several preventive strategies available for consideration by dentists. A reduction in the risk of etiological factors is the main goal of preventive management. These procedures (Figure 1) focus on to prevent the exposure of the opened tubules to the oral environment and basically aim to prevent the formation of the cervical lesions. Cervical area of teeth is the most vulnerable part that existing enamel and cementum can be worn and ruptured during normal chewing forces. Thus, underneath dentin could be exposed to etiologic factors of hypersensitivity. Preventive management has the importance of noticing the sensitive areas and having precautions before.

TREATMENT OPTIONS –II

Recent Developments

There are many treatment options for eliminating the pain. Several previous studies [15-17] have evaluated the efficiency of the most common methods used. Among the numerous treatment options, the most frequently used are nerve desensitization, covering or plugging of the tubules or a combination of both [10]. The most recently developed materials used in experiments are discussed below; a combination of these methods is generally recommended. In order to relieve the pain, restorative treatments may be applied, and root canal therapy is a last resort (Figure 2).

The treatment options usually known as desensitizers may be classified in terms of their chemical formulae and physical mechanisms [4]. Potassium nitrate is currently the most preferred material. Dentifrices containing potassium nitrate are common, easy to use and accessible oral health care products. The mechanism of potassium salts (nitrate or chloride) relies on the relatively small size of the ions, which act quickly enough to move into the dentinal tubules and reach the pulp in just minutes [4,18]. Potassium oxalate is another potassium salt which is able to initiate a reaction with the calcium ions within teeth. Calcium oxalate crystals are able to plug the dentinal tubules, while the remaining potassium ions can depolarize the nerve membranes, blocking the stimulus [11,19]. Although these nerve-blocking properties are the reason for using potassium in many desensitizing methods, clinical studies have reported conflicting results. When used as a topical agent and concentrated between 1% and 15%, potassium nitrate has been shown to remove the sensitivity successfully [20,21]. However, in one study [22], the blocking capacity of potassium nitrate was evaluated as being inadequate even within sound teeth. Moreover, Poulsen et al.[23], found that there was insufficient evidence for the ability of dentifrice containing potassium nitrate to diminish sensitivity when compared to placebo dentifrices. In other studies, alternative chemical formulas have shown promising results [4,24]. One of these studies found that a solution of 10% strontium chloride, 2% sodium fluoride and 40% formalin decreased hypersensitivity, while 5% potassium nitrate did not [4]. Other formulations shown to reduce hypersensitivity are magnesium sulfate iontophoresis, sodium monofluorophosphate toothpastes, silver nitrate agents [4], strontium chloride varnish [25],aluminum lactate rinses [26] and Guanethidine [27].The authors believe that new formulations in different physical forms (such as rinses, solutions and chewing gums) would be more beneficial than the current methods used.

Fluorides are also used in hypersensitivity problems. The preventive mechanism of fluoride may arise from occlusion of the tubules or blocking of the transmission of stimuli [28]. According to the results of studies [10,29], fluoride varnishes applied by dentists have the most successful results of these fluoride treatment methods. This can be attributed to the increased retentiveness of the varnished surfaces compared with other forms of fluoride treatment. If toothpastes are involved in treatment modalities, not only fluoride but also bioactive glass or chemicals such as strontium should be added to the toothpaste. Bioactive glass is mainly composed of silica and is utilized in hypersensitivity problems to provide Ca^{+2} and PO_4^- ions to the tooth surface to block the tubules [30-32]. Pradeep et al. [24],

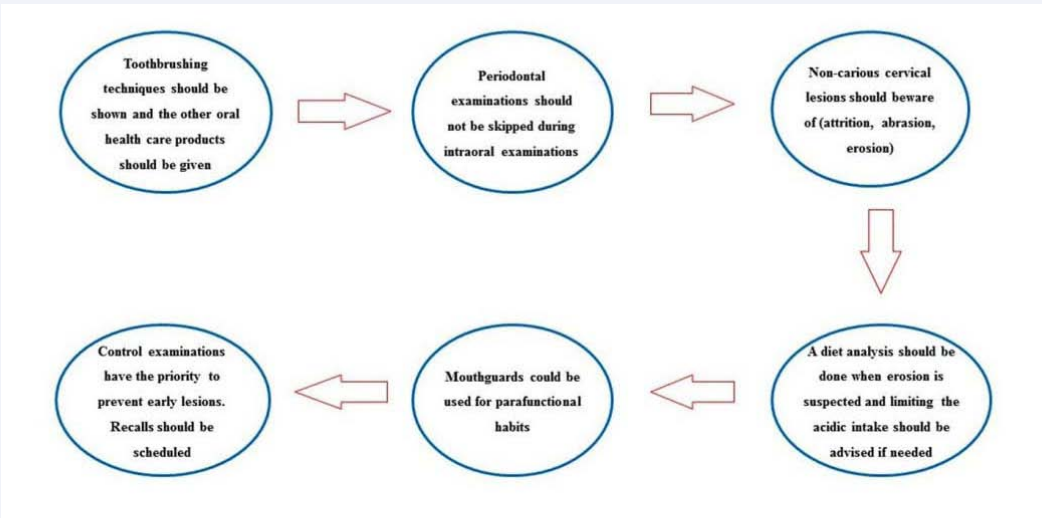

Figure 1 Preventive procedures for dentine hypersensitivity.

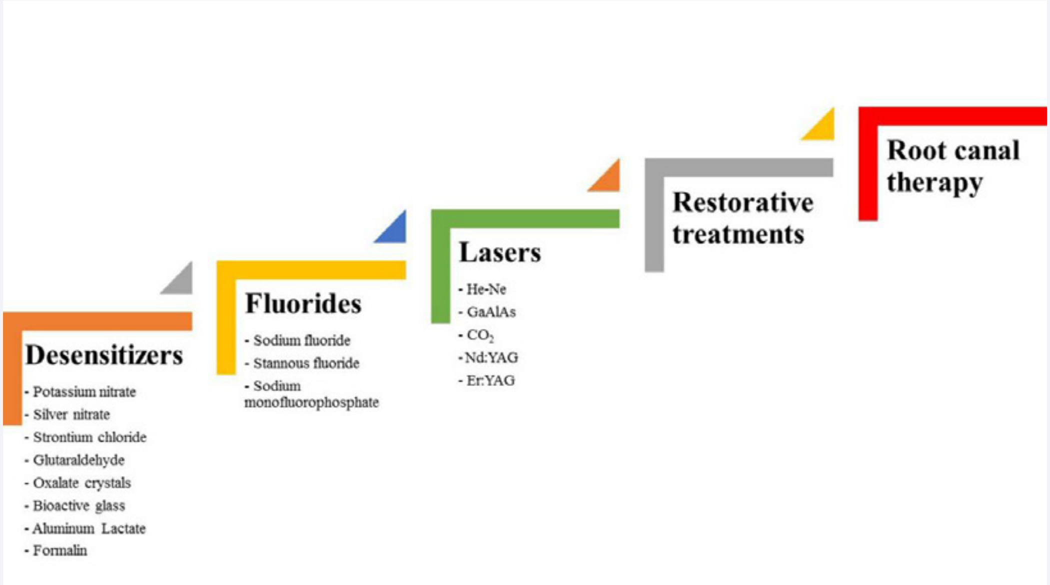

Figure 2 Treatment options for dentine hypersensitivity.

showed that a 5% concentrated bioactive glass toothpaste known as calcium-sodium-phosphosilicate had superior results over a toothpaste containing 5% potassium nitrate in reducing hypersensitivity in 110 patients over 6 weeks. Strontium salts have recently been used in toothpastes and have shown promising results. The exact mechanism is not yet known [33], although microscopic evaluations have shown that these salts undergo direct adhesion to the organic content of the dentin such as the odontoblastic processes [10]. Several in vitro studies have proven the efficiency of strontium-containing toothpastes in occluding dentinal tubules [34,35], although some studies have reported no clinical efficiency from strontium [14,36]. Moreover, strontium acetate is currently recommended rather than strontium chloride, due to its improved characteristics such as stronger linkage with fluoride and potassium nitrate [37,38].

Various biomolecules are incorporated into newly-designed toothpastes in order to overcome hypersensitivity problems [39]. Investigation is not limited to strontium toothpastes; the well-known arginine toothpastes have also been subjected to numerous studies [40-42]. Regarded as a breakthrough invention in nanotechnology [40], arginine has a simple mechanism involving the creation of precipitates on the dentine surface [39]. Arginine is an amino acid generally found in human saliva and works in parallel with calcium carbonate and phosphate to form precipitates [14]. This is the basis for the interaction between arginine technology and calcium-, phosphate- and glycoprotein-containing toothpastes (Colgate Sensitive Pro-Relief, Colgate-Palmolive Company, NY, USA). Studies have described the superior results of these toothpastes in reducing dentine hypersensitivity as compared with potassium nitrate or fluorides [41, 43-45], and electron spectroscopy images have shown a high proportion of calcium, oxygen and phosphate ions, indicating remineralization [40]. Based on the satisfactory results of these studies, various forms of arginine have been released. In addition to these toothpastes, in-office pastes and mouthwash also now use arginine. An 8% arginine in-office paste has been shown to reduce hypersensitivity more effectively than a fluoride-based prophylaxis paste after 4 weeks [46]. Moreover, a 0.8% arginine mouthwash reduced the tactile sensitivity of patients more significantly than those using potassium nitrate mouthwashes [47]. These rinses are thought to reduce the dentinal fluid flow, thus resulting in less dentine hypersensitivity [46]. Patients with a highly acidic diet often find that toothpastes and mouthwashes are ineffective, however. With the added challenge of acidity, the occluded dentinal tubules are re-exposed to the oral flora. Recently, an acid-resistant occluding material has been used in mouthwashes with good results [48]. In hydraulic conductance tests, a mouthwash containing 1.4% potassium oxalate (Listerine Advanced Defense Sensitive; Johnson&Johnson, NJ, USA) reduced dentine permeability by 100% [49]. Another study compared the potential sensitivity elimination rates of Listerine Advanced Defense Sensitive mouthwash and Colgate Sensitive Pro-Relief toothpaste and mouthwash and showed that the toothpaste had increased the mineral/matrix ratio to the greatest extent by adding extra calcium and phosphate. However, Listerine mouthwash occluded the dentinal tubules to the largest extent, even after the acidic challenge [50]. If patients are uncomfortable with the tactile effect of toothbrushes and even sensitive toothpastes, these very effective mouthwashes may be recommended.

Today, lasers are widely used in many areas of dentistry. Although lasers are not extensively used in hypersensitivity cases, many types of lasers have been used in these treatments since 1985 [17].There are various types of lasers used in the treatment of hypersensitivity including neodymium-yttrium-aluminum-garnet (Nd:YAG), erbium (Er):YAG, carbon dioxide (CO_2), helium-neon (He-Ne) and gallium-aluminum-arsenide (GaAlAs) [17,51]. However, the efficiency of these treatments varies between 5.2% and 100% [17]. The basic mechanism of lasers in the reduction of dentin hypersensitivity is not clear, and it is believed that this depends mainly on the type of laser system and parameters chosen [17,51,52]. The basic mechanism of low-power lasers (He-Ne, GaAlAs)involves the coagulation of the proteinal tissues of dentin, "promoting biomodulatory effects, reducing inflammatory processes and related pain", thus reducing the permeability [51,53]. In addition, medium-power lasers including CO_2, Nd:YAG and Er:YAGlasers increase surface temperature, which can recrystallize the dentin surface and result in the complete sealing and closure of tubules [51,52]. Er:YAG lasers have been only recently been used in the treatment of dentin hypersensitivity, and limited data are available for this treatment [51]. Results reported for the reduction of dentin hypersensitivity range from 38.2% to 47% at 6 months for Er:YAG lasers [51]. Despite strong theoretical evidence, clinical trials have shown conflicting results [54,55]. Due to these inconsistent results, it is advisable to combine laser treatment with ion-based gels or varnishes.

Adhesives are commonly used in *in vitro* and *in vivo* studies which aim to create a hybrid layer over the dentin. With this covering of the dentin surface, the pain stimulus directly affecting the pulp tissue is blocked [56]. Moreover, adhesives denature the protein structures of dentin and consequently reduce dentin permeability [57]. Both self- and total-etch systems are indicated for eliminating hypersensitivity, and all of these approaches have advantages according to in vitro studies [58,59]. However, one study has shown no statistically significant results [60]. In order to evaluate the effectiveness of adhesives, several experiments have been carried out using desensitizing agents. In a combined study, an adhesive agent (Seal&Protect; Dentsply Caulk, PA, USA) showed similar results to those of a glutaraldehyde agent (Gluma Desensitizer; Heraus-Kulzer, Hanau, Germany) and had statistically more effective results in patients with hypersensitivity problems than a GaAlAs laser, an acidulated phosphate fluoride (Nupro Gel;Dentsply Caulk, PA, USA) and a potassium oxalate gel (Oxa-Gel; Art-Dent, Araraquara, SP, Brazil) [61]. In the same study, a fluoride gel showed an intermediate level of sensitivity reduction compared to the adhesive agent. Another study comparing fluoride gel with a total-etch adhesive agent (Single Bond; 3M ESPE, St. Paul, MN, USA) showed no statistically significant results; however, according to SEM evaluation, the adhesive agent had occluded more dentine tubules than the fluoride gel [62]. It is reported in one study that the concentration of desensitizing agents is an important factor in increasing effectiveness. Erdemir et al. [63], found that the inferior results of an oxalate-based desensitizer compared to an oxalic acid desensitizer (Pain-Free;Parkell Inc., Edgewood, NY, USA) and an adhesive agent (Seal&Protect) and that could be attributed to the low concentration of oxalate. Gibson et al. [64], used an adhesive agent in hypersensitivity sufferers and compared this with desensitizing and non-desensitizing toothpastes. After 6 months, the adhesive agent had reduced VAS scores with a statistically significant effect in comparison with toothpastes. It is obvious that adhesive agents have the ability to occlude dentinal tubules and in general, the results of adhesive agents over 3 to 6 months are convincing in comparison with other desensitizing agents. It should be noted that these products are not mainly purposed to prevent sensitivity and, long-term results should be investigated to ensure the reliable performances over hypersensitivity lesions.

CONCLUSION

Dentin hypersensitivity is a common problem within many populations, and preventive management therefore has an essential role. Oral examinations should be carefully carried out, and the risk of sensitivity should not be ignored. Although there are a wide variety of treatment options for dentin hypersensitivity, agents are likely to diminish the pain for only 3 to 6 months [11]. In-office treatments such as dentin sealants, varnishes and lasers should be combined with additional products for home use to overcome the pain. The novel technologies addressed in this article such as sensitive toothpastes containing sodium monofluorophosphate, arginine technology, strontium chloride and potassium oxalate mouthwashes should be advised for patients' daily use. A combination of in-office and at-home products is optimal to achieve successful outcomes in dentin hypersensitivity.

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