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A Literature Review: Dentin Hypersensitivity and Its Treatments

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ABSTRACT

The aim of this review study is to increase information about dentin hypersensitivity, its etiology and treatments. For data collection we used PUBMED to find relevant articles. Then using the obtained articles and relevant text books, we attempted to sort this information according to etiology, prevalence and available treatment options.

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Introduction

Dental Hypersensitivity (DH) is one of the most common problems encountered in the clinical works. Unlike dental caries and periodontal diseases, DH is one of the most painful chronic dental problems with the minimum therapeutic success.(1)

Clinical Features

DH is an acute and sharp pain that is caused by the exposed dentin and occurred in response to different stimuli such as thermal changes, occlusal forces, acidic diet, brushing and evaporative stimuli that cannot be justified with other dental defects or pathologies. (2)

Two concepts are defined in dentistry for pain: "pulp pain" and "dentin pain".(3) A dull ache that its position is hardly clear and remains over irritation time is "pulp pain" which is caused by the activity of C fibers and if it continues, it confirms pulpitis.4,5 The acute specific pain which is disconnected after the cessation of stimulation is dental pain and is created by nerve fiber A-δ and can be seen in different diseases as DH(4,5).

In physiological conditions, when dentin-pulp complex is protected by enamel and cementum, provocations such as cold, heat, sweet, acidic foods, brushing and touch do not cause dentin pain(6). Factors associated with exposure of dentin are attrition, abrasion, erosion, abfraction and cementum loss in the cervical area which occur following periodontal disease or the loss of organic material in dental hard tissue after whitening the teeth(7).

Etiology

Several theories have been proposed for the mechanism of DH including direct stimulation theory, odontoblastic transmission mechanism, and gate control theory and in hydrodynamics theory that the former theory has more been accepted (8).

Theories of dental pain are as follows:

Direct stimulation theory claims that nerves exist in the dentine. The possibility of a neural pathway of the central nervous system to the junction of enamel - dentin has been considered in this theory. In the past, it was thought that dental sensitivity is caused by sensory nerves in the dentinal tubules (9). However, in studies with electron microscopy, the nervous fibers have only been seen in the innermost dentinal tubules in the dentin round the pulp and the hypothesis that Nerve Endings exist at the junction of enamel - dentin has not been proven (10).

Odontoblastic transmission mechanism states that, most of the pulp nerve endings are in close proximity with odontoblasts. It may be possible that the sensory fibers can detect and respond to fluctuations flow in odontoblasts (10).

Hydrodynamic theory describes that external osmotic, chemical, mechanical or thermal simulations lead to fluid flow in dentinal tubules. These movements of fluid lead to the activation of nociceptors in the internal dentine and the environmental pulp and thus producing action potential and feeling pain (9,10).

Gate control theory declare that, some materials may be released throughout dentin and directly act on pulpal nerve. Activation of pulp nerves is sometimes associated with the chemical composition of a solution instead of its osmotic pressure. The documents confirming this theory are obtained based on animal experiments (9).

Diagnosis

A simple clinical procedure for diagnosing DH includes evaporative or air blast methods or the use of exploratory probe on the exposed dentin, in a mesiodistal direction that evaluates all the teeth in one direction in the area where the patient complains of pain (11). The severity or the pain degree can be determined by the classification criteria (e.g., mild, moderate or severe) using Visual Analog Scale (VAS). Another common method is Schiff scale (12). Pain intensity in DH ranges from strong with severe pain to mild with moderate intensity, which might explain why all patients with DH do not go to the dentist (3,5,13). In patients with DH, dental plaque accumulation,

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the risk of caries, gingivitis and subsequent periodontal problems increase because it is very difficult to maintain normal health (14).

Prevalence and epidemiology

The prevalence of distribution and manifestations of this disease has been differently reported in other studies that it was due to a difference in the communities, habits, diet and methods of investigation (15). In general, DH ranges from 4%-74% (1,16,17,18,19). DH is slightly more common in women than men. Whereas people of any age may experience DH, most patients aged 20-50 years are involved with the age peak between 30-40 years old 17. According to different types of the involved teeth, canines and premolars of both the arches are the most affected teeth. The most commonly affected area is the buccal cervical area (20).

Although the DH is a common disorder and is one of the most excruciating dental diseases, the proposed treatments are not sufficient and successful (21). This can lead to physical or psychological problems for the patients. Therefore, it can have a negative effect on the quality of people's life, especially the impact on the choice of diet regimen, optimal oral hygiene and aesthetic aspects (22).

Suggesting Clinical treatments

Like other diseases, correct diagnosis of DH assists in successful treatment. The best diagnosis for the DH is obtained by proper history. All teeth of the painful area should be examined. Elimination of etiologic factors is the most important ways of treating DH. The accepted etiologic factor for DH is the hydrodynamic theory which is described by Brannstrom (23). According to this theory, there are two main ways for treating DH (24):

1- Blocking exposed dentinal tubules to prevent the movement of fluids

2- Limiting the excitatory neurotransmission

The first mechanism applies its effect with the intentional use of the majority of desensitizing agents that are currently available on the markets, such as fluoride varnishes, oxalate gels, dentin bonding and laser treatments etc. The second mechanism is based on the use of potassium nitrate, etc. In addition, root coverage by surgery may be an option for treatment of cervical root exposure (25,26).

Finding DH treatment according to numerous techniques and therapeutic alternatives is difficult. Several methods and materials were used to reduce DH ranging from a variety of home remedies including over-the-counter (OTC) products such as toothpastes, tray application foams, desensitizing mouthwashes, to in-office treatments including varnish productions, liners, restorative materials, dental adhesive iontophoresis products and more recently, laser (27).

Home remedies are easy and reasonable and are used to treat a high number of teeth. In contrast, in-office treatments are expensive and complicated and limited to a small number of teeth (28).

At-home treatment

At-home products are often applicable to patient's treatment with mild to moderate DH such as toothpastes, mouthwashes, chewing gums and low level laser (LLL) emitting toothbrush.(27)

Among at-home products, hypoallergenic toothpaste has been raised as the main home remedy for DH which is highly available and affordable. It is easy-to-use and not an invasive method and a good therapeutic way because brushing is almost a universal habit among people (29). The toothpastes containing potassium nitrate have proven their effectiveness in relieving symptoms of DH (30,31). Potassium is a primary ingredient for hypoallergenic toothpastes that destroys message transmission by nerve endings. Potassium salts such as potassium nitrate, potassium chloride, potassium citrate act by publishing along the dentinal tubules and depolarizing nerve cells. Accordingly, the cells are external unresponsive to external stimuli. The effect of Potassium Nitrate is cumulative and the patient should use toothpaste for several weeks to reduce pain (32). A review study by kanapka con-

cludes that potassium nitrate reduces the DH within 8 to 12 weeks(33).

The second group is anti-sensitivity toothpastes that act by blocking dentinal tubules in order to block the hydrodynamic mechanism. Deposition is a thin lining or "artificial smear layer" on the exposed dentinal tubules that can lead to closing the dentinal tubules (32). Some studies show that remineralizing toothpastes contain sodium fluorides and calcium phosphates that are able to reduce the DH (34,35). Recently, some toothpastes and tooth powders contain arginine and their effectiveness has been proven by several clinical studies. These materials include 8% arginine, calcium carbonate, and 1450PPM fluoride and act in an alkaline environment which leads to the more calcium deposits and salivary phosphate on the surface and within the dentinal tubules. Consequently, calcium carbonate is absorbed by arginine and makes up positively charged molecules (36).

The best toothpastes are the types containing potassium nitrate (5%) that lack sodium lauryl sulfate (SLS), SLS are cleaner part of foaming constituents. SLS is associated with removing the smear layer and increasing the incidence of oral aphthous ulcers (37). Recently, some researches on using minerals of non-organic components of tooth structure (such as calcium and phosphate) have attracted a lot of attention and (38,39,40,41,42,43) are inspiring for use of hydroxyapatite to block the dentinal tubules (44). Different types of hydroxyapatite were tested in vivo and in vitro and were found effective in blocking dentinal tubules. Nano-hydroxyapatite components were added into toothpastes and newer products available on the market were produced (45).

Parkinson et al conducted a study to verify the efficiency of fluoride-stannous (0.40-0.45%) fluoride containing toothpaste compared with the toothpaste containing 1,000 ppm fluoride in reducing the pain of DH and observed that the toothpaste containing stannous fluoride reduces pain better than the control fluoride (46).

NOVAMIN technology was created in 1990 by a modification from bioactive glasses which are useful in bone regeneration and bone repair. NOVAMIN also reacts with dentin and is changed by the abrasive particles to obtain particles that are small enough to access dentinal tubules. Each microscopic NOVAMIN particle is used as a delivery system for the ionized bioactive particles. When the particles are exposed to fluids (saliva or tap water), they immediately react and release inorganic ions of calcium that reinforce the natural remineralization process. As the particle's reaction and deposition of complex Ca and Po4 continue, these layers are crystallized to hydroxyapatite that are chemically and structurally similar to biological apatite. Combination of the remaining NOVAMIN particles and the newly formed hydroxyapatite layer leads to the physical closure of the dentinal tubules which reduce DH. In-vitro analysis shows the significant closure of tubules with NOVAMIN compositions (47,48).

Mouthwashes containing potassium nitrate and fluoride decrease DH and few studies have been done on the chewing gums containing potassium chloride. The results of such studies are not reliable (5,49).

The fluoride available in mouthwashes is effective in reducing DH through blocking dentinal tubules. From the disadvantages of home methods, having plenty of time to relieve the symptoms can be mentioned that reduces symptoms within 2-4 weeks (50).

Recently the Low-Level Laser Therapy (LLLT) has been as a new therapeutic method to control DH and desirable results have been achieved (51). The studies carried out on comparing the effects of this type of toothbrush with ordinary anti-allergy toothbrushes shows better results of using these toothbrushes in reducing DH (27,51).

After the ineffectiveness of at-home treatments, in- office treatments are recommended.

In-office treatments

One of the in-office treatment features is immediate pain relief. The mechanism of action of materials which can be used as in-office treat-

ments such as fluoride therapy, copal varnish, oxalates, dental adhesive, bioglass, laser, arginine components, potassium nitrate and low - level laser, is blocking dentinal tubules or preventing from the transmission of nerve impulses.

Fluoride blocks dentinal tubules by creating soluble components. Besides, the dentin permeability decreases but its effect is short because fluoride is frequently isolated (21,52,53). Sodium fluoride (2%) is used as an in-office treatment (15). Fluorides and Fluoro-Silicates are used in combination with iontophoresis that increase electrical current and ionic diffusion (26). Stannous fluoride has a same effect with sodium fluoride in reducing DH. Fluoride varnish also reduces DH by blocking dentinal tubules which is short-term effect (54).

Copal Varnish reduces DH that has a short period by covering the dentinal tubules (55).

Oxalates acts through blocking dentinal tubules and reducing dentin permeability amounting to over 98% (56,57). Furthermore, potassium oxalate (28%) is used to treat DH. To increase the effect, the tooth surface should be etched. Potassium oxalate can lead to digestive problems. Hence, it should not be used for a long time (58). Suda et al found in a study that oxalic acid hypoallergenic material has dramatically reduced the pain associated with a DH created during dental plaque -removal with ultrasonic devices (59).

Unlike local desensitizing agents, adhesive systems have shown permanent or long-term effects. These materials include varnishes, bonding agents and restorative composite resin (5).

Gluma desensitizing agent leads to coagulation of proteins in the dentinal tubules due to presence of glutaraldehyde (15,60).

Pro- arginine mechanism of action mimics from natural desensitizing process that leads to blockage of open dentinal tubules by creating calcium and phosphate plugs (61).

Bioglass has been produced to stimulate bone-formation. It is used to fill bone defects during the surgical procedures (62). There are reports on the impact of bioglasses in the mineralization and infiltration of the dentinal tubules (63).

Moderate-level lasers such as Nd:YAG, emit infrared light at 1064nm that stimulates the production of secondary dentin and seal open dentin tubules. It also has immediate analgesic effect on nerve cells (65).

Recent studies have shown that natural components found in saliva have desensitizing properties. A topical agent containing 8% arginine was made in bicarbonate buffer with calcium carbonate (61). When placed on exposed dentin, these components create plugs containing arginine, calcium, phosphate and carbonate in the dentinal tubules and reduce DH to restricting the movement of fluid in the tubules. One of the in-office treatments that prevents from neural impulse is Potassium nitrate and LLL (61).

Potassium Nitrate is found as aqueous solution and adhesive gel (15,22,66,67).

LLL like He- Ne that emit visible red light at a wavelength of 630 nm and GaAlAs at a wavelength of 780-830 nm and 900 nm and increase the potential to the activity of nerve cells. Therefore, it limits the transmission of pain stimuli (65). LLL does not change the morphology of dentin tubule (as opposed to moderate level - laser).

Discussion

DH is a chronic disease with the etiologic factors of gingival recession and loss of enamel and both positions lead to exposed dentin (2,66). The intensity and degree of sensitivity depend on many factors and may vary in different individuals (28). DH is a common disease and its prevalence and symptoms have been studied in various countries in the world. There are no precise parameters for measuring DH, and DH reports are not the same among researchers. Millions of people are affected by the DH, and it has affected daily activities of some of them (68). DH prevalence is expected to rise and thus an effective treatment is also needed. Medical and dental sciences have opened new horizons for long life expectancy for people. Older patients survive and keep their teeth at old ages and thereby DH chance increases (69). Despite

many studies and available commercial products, DH treatment still lacks standard protocol. Ideally, studies design should include multiple cases. Otherwise, the results are limited. However, few studies include these situations.

In treating DH, the important point is to pay attention to etiologic factor and removing it as much as possible(56).

In the treatment of DH, treatment often involves the use of agents to block the dentinal tubules. There are several explanations for the failure of these treatments. One of them is technical problems, e.g., difficulty of drying dentine due to continuous release of Gingival Crevicular Fluid (GCF). The next problem is that they provide only a superficial obstruction and are dissolved over time. In addition, their use of these materials does not affect the mechanisms associated with understanding the peripheral and central sense of pain receptors.

The toothpastes containing potassium in clinical studies have reduced the pain. But the studies were conducted. Electrophysiology in dogs has shown that the effect of the local application of potassium salt is weak and can be easily rinsed after washing. Investigating the effect of an agent on DH has numerous problems which include:

Requiring a large number of people with the same extent and duration of pain, the possibility of reducing pain at any time spontaneously, significant placebo effect in studies with this nature.

It should be noted that any treatment selected for DH, requires careful examination of the causes and conditions that have caused these symptoms. Cracked teeth, broken cusps and restorations with leakage also cause pulp pain similar to DH.

Conclusion

This study was a non-systematic review of articles based on the etiology and the available diagnosis and treatments to DH. This study aims at enhancing the information and attitude of dentists about DH and health challenges ahead. After correct diagnosis of DH, existing treatments are selected according to a patient's specific features and the features of the created pain.

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