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Evaluation of the Efficacy of Commercially Available Nano-Hydroxyapatite Paste as a Desensitizing Agent

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ABSTRACT

Aim: To evaluate the efficacy of commercially available nano-hydroxyapaptite paste as a desensitizing agent.

Materials & Methods: The study included 30 subjects complaining of dentinal hypersensitivity. After prophylactic scaling & root planing, patients were instructed to brush with the given commercially available nano-hydroxyapatite paste twice a day. A numeric rating scale was used to measure the parameter of pain related to the stimuli at the baseline and after the application of gel at the intervals of 24 hours, 1 month, 3 months and 6 months.

Results: There was remarkable decrease in the dentinal hypersensitivity at the end of 6 months. Intragroup comparisons at various time intervals were significant ($p<0.0001$). The mean pain score at the end of 6 months was 3.00 +/- 0.468 from 7.93 +/- 0.248 at the baseline.

Conclusion: Hence, commercially available nano-hydroxyapatite paste is effective in reducing dentinal hypersensitivity.

Keywords: Dentine, Dentine hypersensitivity, Dentin desensitizing agents, Hydroxyapatite.

INTRODUCTION

Dentinal hypersensitivity is a very common problem encountered clinically. It is characterized by short, sharp pain arising from exposed dentin in response to stimuli typically thermal, evaporative, tactile and osmotic or chemical which cannot be ascribed as any other form of dental defect or pathology[1]. The age range varies from 20 to 50 years[2] and the peak incidence is between 30 to 40 years[3, 4].

The primary cause of dentinal hypersensitivity could be attributed to loss of enamel on the tooth crown and gingival recession exposing the tooth root. Enamel loss could be due to overconsumption of acidic food and tooth grinding caused by stress and parafunctional behaviors. Gingival recession may occur as a result of aggressive and incorrect tooth brushing, as well as periodontal diseases[5]. Dentinal hypersensitivity has also been reported after external tooth bleaching[6].

The exact mechanism of dentinal hypersensitivity is not very clear but several theories have been proposed to explain the phenomenon: 1.) Direct Innervation Theory which states that nerve fibers present within the dentinal tubules induce impulses when they are injured, hence causing dentinal hypersensitivity[7]. 2.) Odontoblast Deformation Theory/Transducer mechanism suggests that dentinal hypersensitivity

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is caused due to damaged odontoblasts or their processes when external stimuli are applied to the exposed dentin. They conduct impulses to the nerves in predentin and underlying pulp from where they proceed to central nervous system where these impulses are relayed as pain[7]; but these theories are not well accepted succumbing to their own limitations. The most accepted theory amongst the proposed is the theory given by Branstorm. 3.)"Hydrodynamic Theory" which states that when dentinal tubules are exposed to the oral environment, fluid within the dentinal tubules may flow in either inward or outward direction depending on the pressure differences in the surrounding tissue[8]. These intratubular fluid shifts, in turn activate mechanoreceptors in intratubular nerves or in the superficial pulp and are perceived as pain by the patient.

This condition could be managed by a wide variety of procedures, agents and formulations applied locally, either "in office" or "at home"[9]. Two basic desensitization techniques are used as means for the treatment: desensitization by occluding the dentinal tubules by formation of smear layer on the exposed area[10]. This can be achieved by using agents like calcium hydroxide, hydroxyapatite, silver nitrate, strontium chloride, by means of using hard tissue LASERS or fluoride iontophoresis[11,12]. The second technique is by blocking the pulpal sensory nerves with agents like silver nitrate available in various forms. Desensitizing toothpastes are the most widely used at home treatments. With the advancement in nano-technology, nano particles of hydroxyapatite are incorporated in dentifrices which occlude the dentinal tubules by its smaller particle size and its biomimetic property.

MATERIALS & METHODS

The study was conducted from October 2013 to March 2014 in the Department Of Periodontics at Karnavati School of Dentistry, Uvarsad. The study protocol was approved by the Ethical Committee of the instituition with number KSD-283.

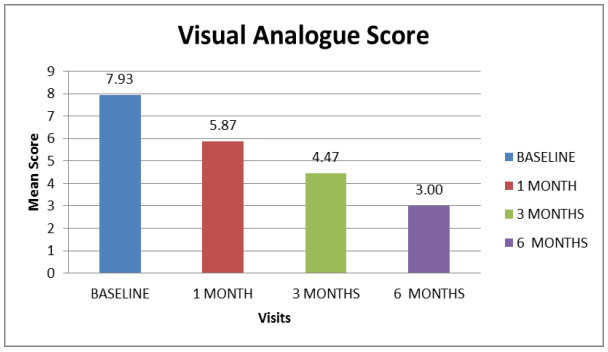
The sample consisted of 30 patients of both the sexes (20 male and 10 female) who reported to the out-patient department with the chief complaint of dentinal hypersensitivity. Participants in the study had good general & oral health. After prophylactic scaling and root planing patients having plaque score and gingival index score ≤1 were included. A special proforma format was designed so as to have a methodical and systematic recording of all the observations and information.

These patients were given commercially available nano hydroxyapatite paste (Aclaim). Each patient was then asked to come for the follow up after 1, 3, 6 months. At each follow up, patient was subjected to:

1. Air Spray Test- This was the first test done for the tooth sensitivity by controlled air pressure using a standard dental syringe at 4 to 65 psi at an ambient temperature directed perpendicularly and at a distance of 1 to 3cm from the exposed dentin surface. The adjacent teeth are isolated with the help of cotton rolls or pad of the gloved finger.

2. Ice Cold Water Test- This test included application of 10 ml ice cold water to the exposed dentin surface while again the adjacent teeth are isolated with the help of cotton rolls or pad of the gloved finger.

3. Visual Analogue Scale (based on the severity ascending from 0 to 10) A 10 cm scale was prepared, where each centimeter stood for the marking (where 0 =no pain and 10 =severe pain).



Graph 1: Visual Analogue Score.

RESULTS

At the baseline, there was no difference from the current state. As the period of follow up progressed, statistically significant results were seen which showed stronger efficacy at the end of 6 months. The significance was proved by running paired two t test (Table 1 & Figure 1).

Table 1: Intergroup comparison of Visual Analogue Score.

		Mean	Std. Deviation	P Value	Results
	Visual Analogue Score BASELINE	7.93	0.961	<0.0001	S
	Visual Analogue Score 1 MONTH	5.87	1.506		
	Visual Analogue Score BASELINE	7.93	0.961	<0.0001	S
	Visual Analogue Score 3 MONTHS	4.47	2.100		
	Visual Analogue Score BASELINE	7.93	0.961	<0.0001	S
	Visual Analogue Score 6 MONTHS	3.00	1.813		
	Visual Analogue Score 1 MONTH	5.87	1.506	<0.0001	S
	Visual Analogue Score 3 MONTHS	4.47	2.100		
	Visual Analogue Score 1 MONTH	5.87	1.506	<0.0001	S
	Visual Analogue Score 6 MONTHS	3.00	1.813		
	Visual Analogue Score 3 MONTHS	4.47	2.100	<0.0001	S
	Visual Analogue Score 6 MONTHS	3.00	1.813		

Table 2: Mean value of VAS at different time intervals.

Baseline	7.93
1 Month	5.87
3 Months	4.47
6 Months	3.00

Table 3: Mean percentage value of hypersensitivity tests.

Test	Mean % of teeth affected amongst 30 patients			
	Baseline	1st month	2nd month	3rd month
Air Spray	92.35%	87.5%	65.4%	39.3%
Cold Test	95.6%	79.6%	53.2%	28%

DISCUSSION

Dentin itself is a vital tissue, consisting of dentinal tubules, and is sensitive because of extensions of odontoblasts and formation of dentine–pulp complex[13]. DH develops in two phases: lesion localization and lesion initiation. For DH to occur, the lesion localization has to be initiated[14]. Dentine hypersensitivity (DH) is a common dental complaint which may have a profound effect on an individual's quality of life; however DH tends to be an underestimated condition due to underreporting by its sufferers and also the difficulty in diagnosing it[15].

Dentinal hypersensitivity occurs after the protective covering of smear layer is removed, leading to exposure and opening of dentinal tubules. There are two basic modes to treat dentinal hypersensitivity: in office desensitizing therapy and home care methods. Theoretically, the in-office desensitizing therapy should provide an immediate relief from the symptoms. The in-office desensitizing agents can be classified as the materials which undergo a setting reaction (glass ionomer cement, composites) and which do not undergo a setting reaction (varnishes, oxalates).

Desensitizing toothpaste is the first line treatment of dentinal hypersensitivity[16]. Grossman listed the requirements for an ideal dentine desensitizing agent as: rapidly acting with long-term effects, non-irritant to pulp, painless and easy to apply and should not stain the tooth[16]. Traditionally, the therapy for management of DH was primarily aimed at occluding the dentinal tubules or making coagulates inside the tubules.

Products available for self-application are potassium nitrate, strontium chloride, fluorides, etc. These desensitizing products are effective in reducing dentin hypersensitivity but do not biomimic the natural enamel and dentin apatite in composition, structure and morphology. The condition reappears because of tooth brush abrasion, the presence of acid challenges in the mouth or degradation of the coating material. Therefore there was need for a material that would

mimic the apatite crystals and overcome the shortcomings of conventional products.

Recently, nanotechnology has been involved in variety of fields including dentistry. Nanotechnology is the design, fabrication, characterization and utilization of materials which are less than one hundred nanometer in atleast one dimension. Nanotechnology based nano hydroxyapatite dramatically increases the surface area and surface roughness that leads to superior physiochemical properties. Hydroxyapatite nanoparticles can self-assemble to form enamel like structures in aqueous solution.

Under optimum physiological conditions, demineralization and remineralisation are balanced in the oral cavity, so that no net loss of mineral from the teeth occurs. But conditions such as excess plaque, inadequate salivary flow and frequent intake of acidic food or carbohydrates can upset the balance, driving the equation overwhelmingly in the direction of demineralization that leads to enamel dissolution in microns ultimately resulting in dentinal hypersensitivity.

Nano hydroxyapatite can act immediately as an alternate substance and not only alleviate the pain but also cure the sensitivity of teeth. Since the chemical composition is similar to the main structure of tooth enamel, it forms a protective new layer made of tooth enamel having the thickness of 1 to 2 micrometer and covers the open pores of tubules and eliminates the sensitivity. Nano hydroxyapatite exhibits better attachment onto enamel than the large ones and the amorphous one. A layer of hydroxyapatite nanoparticles can inhibit the future mineral loss from the enamel surface significantly. Since the new nano layer is insensitive, underlying enamel surface is well protected under the acidic condition[17]. Hence attributing to its various advantages like: smaller particle size, biocompatibility, bioactivity, resistance to solubility & acid attack; nano hydroxyapatite is used in toothpaste for remineralization of enamel also[18,19]. It also has an application as an anti-cariogenic material[20].

With their high area to volume ratio, excellent bioactivity and biocompatibility nano sized hydroxyapatite particles are expected to be excellent materials in the treatment of dentinal hypersensitivity[21,22].

CONCLUSION

A variety of desensitizing agents have been used in the field of dentistry to treat hypersensitivity. This study proves the efficacy of nano hydroxyapatite paste in treating dentinal hypersensitivity. This improved efficiency of the material is due to its biomimetic property which not only alleviates hypersensitivity of the teeth but also cures it.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Holland GR, Narhi MN, Addy M, Gangarosa L, Orchardson R. Guidelines for the design and conduct of clinical trials on dentine hypersensitivity. J Clin Periodontol. 1997;24(11):808–13.

2. Flynn J, Galloway R, Orchardson R. The incidence of 'hypersensitive' teeth in the west of Scotland. J Dent. 1985;13(3):230–6.

3. Rees JS, Jin LJ, Lam S, Kudanowska I, Vowles R. The prevalence of dentine hypersensitivity in a hospital clinic population in Hong Kong. J Dent. 2003;31(7):453–61.

4. Taani DQ, Awartani F. Prevalence and distribution of dentin hypersensitivity and plaque in a dental hospital population. Quintessence Int. 2001;32(5):372–6.

5. Dababneh RH, Khouri AT, Addy M. Dentine hypersensitivity: An enigma? A review of terminology, epidemiology, mechanisms, etiology and management. Br Dent J. 1999;187(11):606–11.

6. Absi EG, Addy M, Adams D. Dentine hypersensitivity. A study of the patency of dentinal tubules in sensitive and non-sensitive cervical dentine. J Clin Periodontol. 1987;14(5):280–4.

7. Rapp R, Avery JK, Strachan DS. Possible role of the acetylcholinesterase in neural conduction within the dental pulp. In: Finn SB, editor. Biology of the dental pulp organ, Vol. 31. Birmingham: University of Alabama Press; 1968. p 309–31.

8. Brännstrom M, Astrom A. A study on the mechanism of pain elicited from the dentin. J Dent Res. 1964;43:619–25.

9. Orchardson R, Gilliam DG. Managing dentin hypersensitivity. J Am Dent Assoc. 2006;137(7):990–8.

10. Paine ML, Slots J, Rich SK. Fluoride use in periodontal therapy: a review of the literature. J Am Dent Assoc. 1998;129(1):69–77.

11. Kimura Y, Wilder-Smith P, Yonaga K, Matsumoto K. Treatment of dentine hypersensitivity by lasers: a review. J Clin Periodontol. 2000;27(10):715–21.

12. Corona SA, Nascimento TN, Catirse AB, Lizarelli RF, Dinelli W, Palma-Dibb RG. Clinical evaluation of low-level laser therapy and fluoride varnish for treating cervical dentinal hypersensitivity. J Oral Rehabil. 2003;30(12):1183–9.

13. Orchardson R, Cadden SW. An update on the physiology of the dentine-pulp complex. Dent Update. 2001;28(4):200–9.

14. Walters PA. Dentinal hypersensitivity: a review. J Contemp Dent Pract. 2005;6(2):107-17.

15. Bekes K, Hirsch C. What is known about the influence of dentine hypersensitivity on oral health-related quality of life? Clin Oral Investig. 2013;17(suppl 1):S45–S51.

16. Grossman L. A systematic method for the treatment of hypersensitive dentin. J Am Dent Assoc. 1935; 22:592–8.

17. Li Li, Haihua Pan, Jinhui Tao, Xurong Xu, Caiyun Mao, Xinhua Gu and Ruikang Tang. Repair of enamel by using hydroxyapatite nano particle as the building blocks. J Mater Chem. 2008;18:4079-84.

18. Narmatha VJ, Sophia Thakur. An In-Vivo Comparative Study of the Efficacy of Propolis, Nano-Hydroxyapatite and Potassium Nitrate Containing Desensitizing Agents. Research and Review Journal of Dental Sciences 2014; 2(2):113-8.

19. Huang S, Gao S, Cheng L, Yu H. Combined effects of nano-hydroxyapatite and Galla chinensis on remineralisation of initial enamel lesion *in vitro*. J Dent. 2010;38(10):811-9.

20. Huang S, Gao S, Cheng L, Yu H. Remineralization potential of nano-hydroxyapatite on initial enamel lesions: an in vitro study. Caries Res. 2011;45(5):460-8.

21. Browning WD, Cho SD, Deschepper EJ. Effect of a nano-hydroxyapatite paste on bleaching-related tooth sensitivity; they say it's effective in reducing sensitivity. J Esthet Restor Dent. 2012;24(4):268-76.

22. Tschoppe P, Zandima DL, Martus P, Kielbassaa AM. Enamel and dentine remineralization by nano-hydroxyapatite toothpastes. J Dent. 2011;39(6):430–7.

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