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Comparative Evaluation of Commercially Available of Three Desensitizing Toothpaste On Dentinal Tubule Occlusion- An In-vitro SEM Study

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ABSTRACT

Dentinal hypersensitivity is a common complaint among patients. The acute, non-spontaneous, short or long lasting nature of pain requires a therapeutic mode which would bring about a significant immediate and lasting relief from dentine hypersensitivity. This study compared the efficacy of three commercially available in occluding dentinal tubules using Scanning electron microscopy. A total of 20 dentin blocks were obtained from the roots of the single rooted teeth and randomly divided into three groups comprising of three test groups. The dentinal occlusion are evaluated using scanning electron microscopy (SEM). All groups showed an increase in the percentage of tubular occlusion at However pro-argin group showed a significantly greater percentage of tubular occlusion as compared to the other groups after seven days. All the experimental agents were effective in occluding dentinal tubules as compared to the control group. The percentage (%) of occluded tubules was found to be highest for pro-argin as compared to the other groups over a period of 7 days. However further long term studies more studies are required to come to a conclusion.

Keywords: Hypersensitivity, Dentinal tubules

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INTRODUCTION

Dentine hypersensitivity is a short sharp pain in response to thermal, evaporative, tactile, osmotic or chemical stimuli which may not be ascribed to any other form of dental defect or pathology. Dentine hypersensitivity (DH) remains an oral health problem in adults on a global scale. A number of approaches exist to reduce or potentially eliminate hypersensitivity, and these approaches fall into two classes: those that physically occlude the tubules, which comprise the majority of treatment modalities; and those that block neural transmission at the pulpal tissues, chemically depolarizing the nerve synapse with potassium-based therapy. The prevalence of hypersensitivity widely varies (from 8% to 57%).

It has been stated in the literature that DH develops in two phases: lesion localization and lesion initiation. Lesion localization occurs by loss of protective covering over the dentin, thereby exposing it to external environment. It includes loss of enamel via attrition, abrasion, erosion or abfraction. Another cause for lesion localization is gingival recession which can be due to toothbrush abrasion, pocket reduction surgery, tooth preparation for crown, excessive flossing or secondary to periodontal diseases. As stated earlier, not all exposed dentine is sensitive. For DH to occur, the lesion localization has to be initiated. It occurs after the protective covering of smear layer is removed, leading to exposure and opening of dentinal tubules.

Three major mechanisms of dentinal sensitivity have been proposed in the literature:

- Direct innervation theory
- Odontoblast receptor
- Fluid movement/hydrodynamic theory

According to direct innervation theory, nerve endings penetrate dentine and extend to the dentino-enamel junction. Direct mechanical stimulation of these nerves will initiate an action potential. Odontoblast receptor theory states that odontoblasts acts as receptors by themselves and relay the signal to a nerve terminal. Brannstrom (1964) has proposed that dentinal pain is due to hydrodynamic mechanism, i.e., fluid force. Scanning electron microscopic (SEM) analysis of “hypersensitive” dentin shows the presence of widely open dentinal tubules. The presence of wide tubules in hypersensitive dentin is consistent with the hydrodynamic theory. This theory is based on the presence and movement of fluid inside the dentinal tubules. This centrifugal fluid movement, in turn, activates the nerve endings at the end of dentinal tubules or at the pulp–dentine complex. This is similar to the activation of nerve fibers surrounding the hair by touching or applying pressure to the hair. The response of pulpal nerves, mainly Aδ intradentinal afferent

fibers, depends upon the pressure applied, i.e., intensity of stimuli. It has been noted that stimuli which tend to move the fluid away from the pulp–dentine complex produce more pain.

The treatment of dentinal hypersensitivity has as goal pain remission, often by topic application of desensitizing agents, anti-inflammatory agents, agents that block the neuronal response, root coverage procedures through periodontal plastic surgery and, most currently, high and low input laser irradiation.

Although there are different therapies for the treatment of dentin hypersensitivity, the main challenge is to find a substance or treatment that effectively eliminates the pain and does not relapse, which unfortunately is still not available. So, it is fundamental to have comparative studies of different treatments and products, considering their dentinal tubules physical obliteration efficiency and the associated dentin permeability reduction.

MATERIALS AND METHOD

Experimental design:

Twenty dentine blocks were prepared and divided into three groups as 1) arginine containing toothpaste. 2) calcium sodium phosphosilicate containing toothpaste 3) ayurvedic toothpaste. The specimens is treated with acid etchant which is washed and dried off carefully to remove debris in tooth surface for proper visualization and accurate values. A pea size amount of toothpaste will be manually rubbed onto the exposed window of dentin using tweezer and cotton. The topography of each group after treatment was determined by scanning electron micrograph.

Specimen preparation:

Dentin disks were prepared from caries-free human premolars extracted in department of oral surgery at Oxford Dental College and Hospital for periodontal reasons from healthy adults. To prepare the disks from the middle part of dentin, removed the enamel with a high-speed hand piece under water cooling, and then longitudinally sectioned them with a low-speed diamond saw under water cooling.

The dentin disks were brought to a state simulating hypersensitivity by being etched with 37% acid etchant for two min (Greenhill and Pashley, 1981), after which they were rinsed with distilled water and used immediately for the experiments.

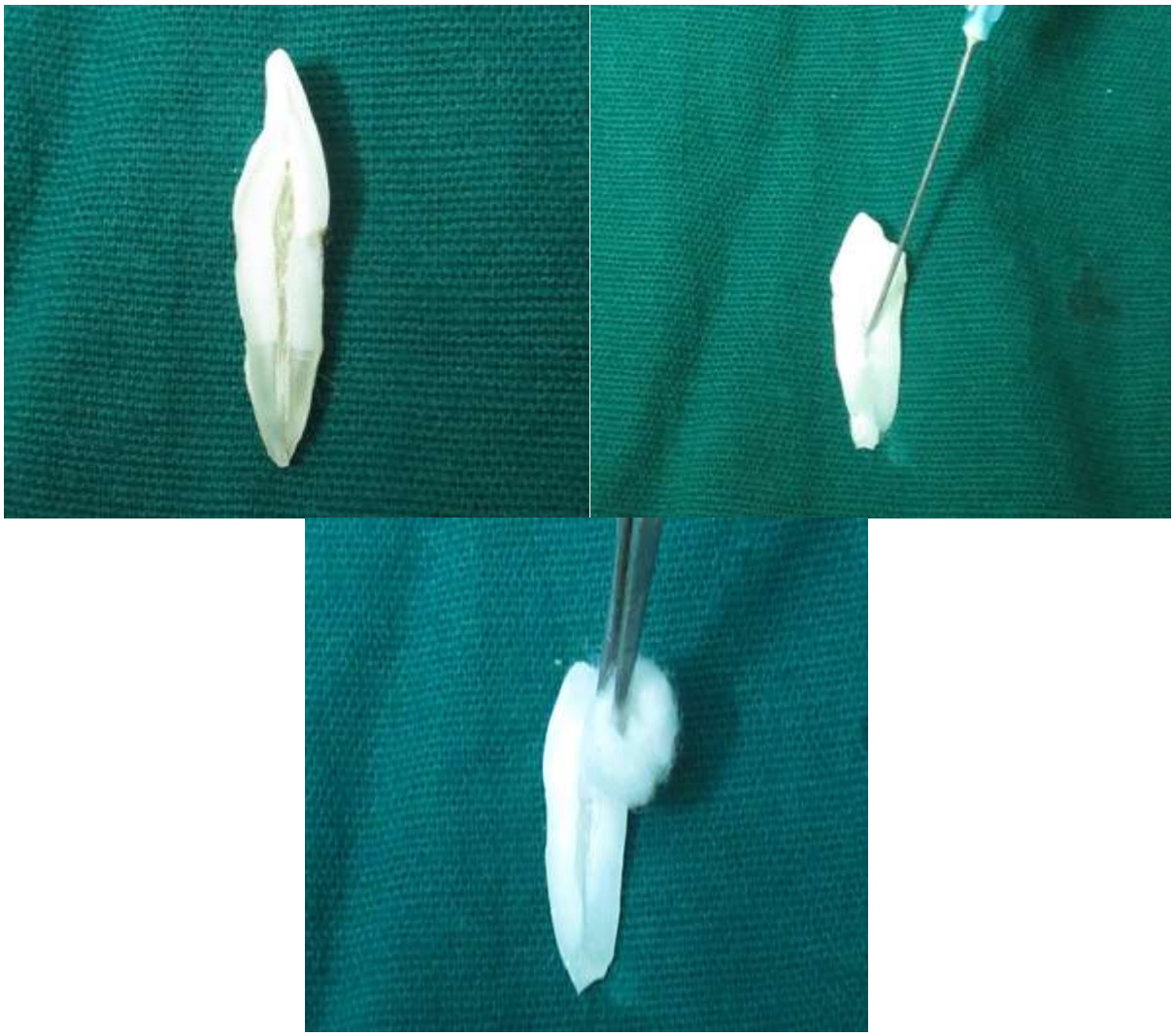


Figure 3: Showing the application of acid etchant and manual rubbing of the toothpaste with cotton and tweezer

The specimens were randomly divided into 3 groups, with 3 applications of different desensitizing treatments and a control group (without any application of toothpaste). Five specimens of each group were used for visual analysis in scanning electron microscopy (SEM).

Four groups:

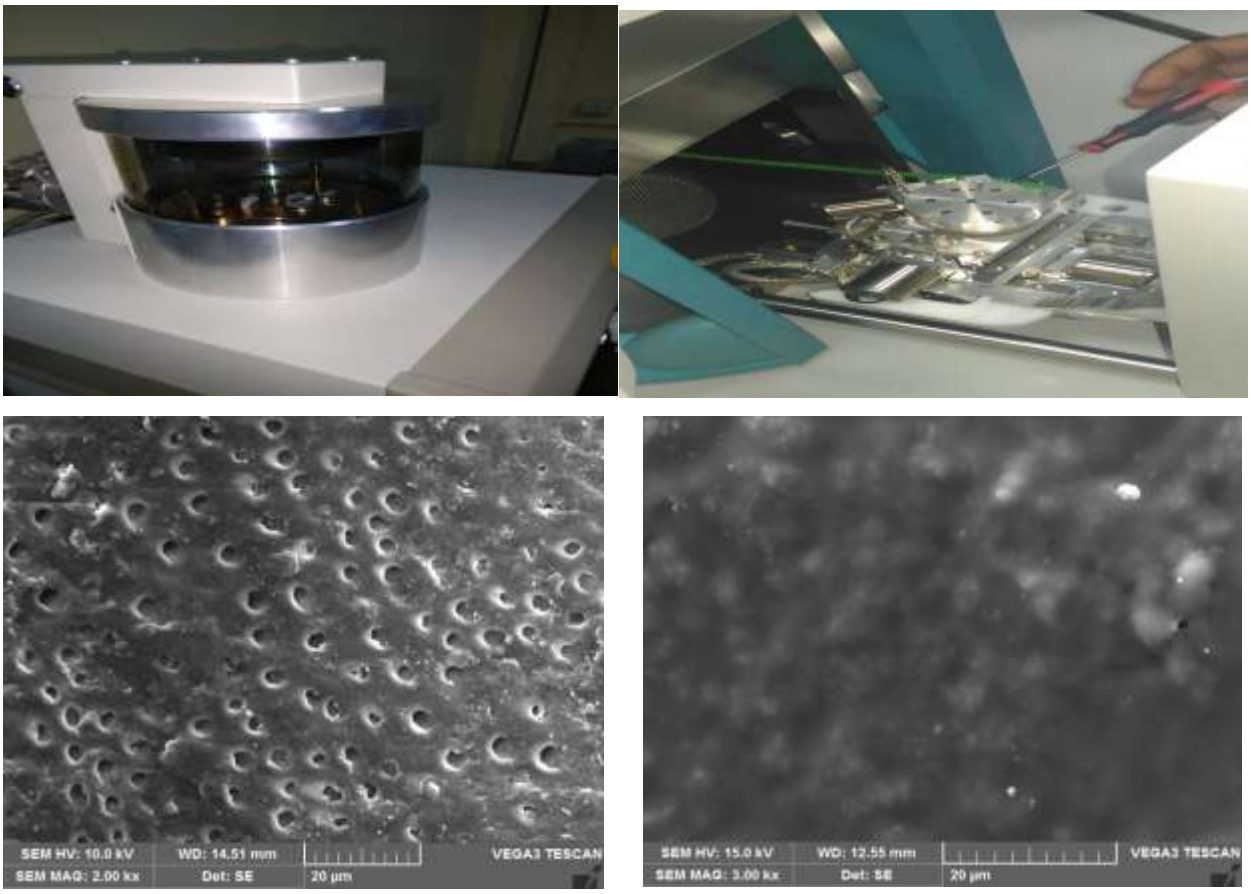
Group 1: Pro-argin

Group 2: Calcium sodium phosphosilicate

Group 3: Commercially available over the counter ayurvedic toothpaste

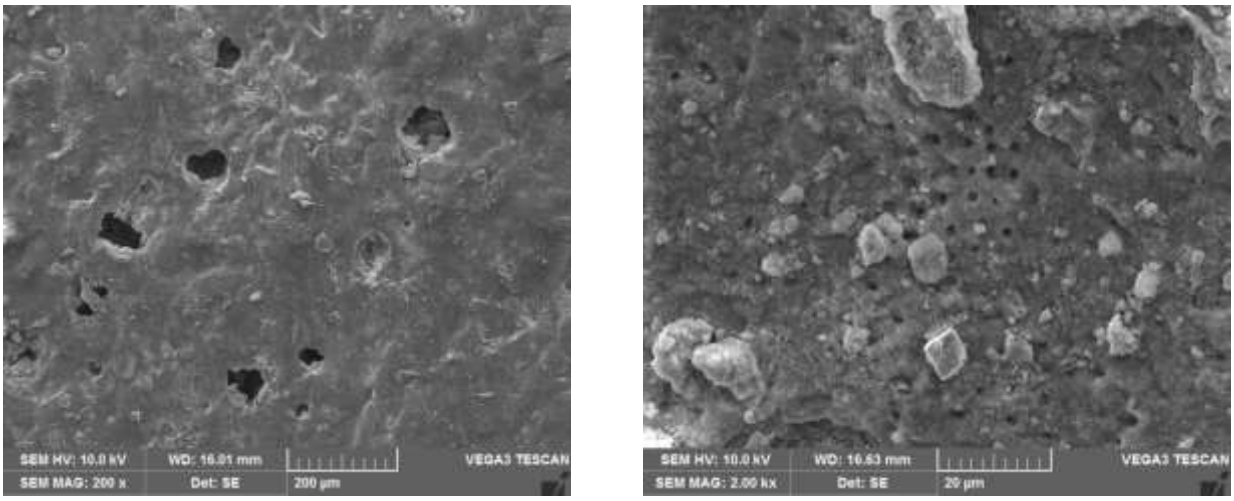
Scanning electron microscopy:

The extent of tubule occlusion was assessed using a scanning electron microscope. The specimens were sputter coated to aid conductivity. Photomicrographs of representative dentin surface areas were taken at 10 lakhs magnifications with resolution of 3nm.



a) b)

Figure 1 a) SEM section showing open dentinal tubules prior to treatment and b) SEM section showing occlusion of dentinal tubules after treatment with Pro-argin group



c) d)

Figure 2 c) showing the dentinal occluding surfaces in calcium sodium phosphosilicate group and d) showing the dentinal occluding surfaces in ayurvedic group

Results:

The highest occluding effect of dentinal tubules was obtained for pro-argin paste group when compared to ayurvedic and calcium sodium phosphosilicate containing toothpaste. The clinical effectiveness of these materials will depend in part on the dissolution resistance or solubility level of precipitates. Further research is required to provide evidence of the durability of occlusion of these desensitizing agents under simulated clinical conditions and functional studies to assess their ability to reduce fluid flow (hydraulic conductance) through dentin.

DISCUSSION:

Dentin hypersensitivity has been the subject of many studies that have evaluated different strategies and products for its treatment and consists in a suitable substitute of the human dentin considering the permeability and SEM analysis. Among the tested products in this study, it is worth mentioning the different action mechanisms. In the present study, a significant reduction in dentin permeability could be observed after 3 applications of these products.

Pastes and toothpastes containing desensitizing agents has also been widely researched and produced. The arginine and calcium carbonate work together in order to accelerate the dentinal tubules natural obliteration mechanisms by "dentin-like" mineral deposits containing calcium phosphate within dentinal tubules. In the present study, a significant reduction of dentin permeability was observed after three applications of both products, but in photomicrographs a great number of opened dentinal tubules could still be observed in ayurvedic and calcium sodium phosphosilicate group.

Ayurveda is the ancient holistic art and science of India that utilizes natural herbs, roots, and minerals to promote optimum well-being and harmony of the individual in balance with nature and the environment. But, the use of ayurvedic toothpaste in case of dentinal hypersensitivity proven to be less effective and some of the patients have a unrealistic myth towards ayurvedic products and promotions. Future studies should provide the fact that the ayurvedic toothpaste formulations and usage in patients will it be effective or it will create a permanent solution for sensitive problems.

A recent clinical study has indicated that calcium sodium phosphosilicate (CSPS) results in a greater reduction in sensitivity compared with potassium nitrate (**Pradeep et al 2010).** CSPS is a bioactive glass and, when exposed to body fluids, it reacts and deposits hydroxycarbonate apatite (HCA), a mineral chemically similar to that in enamel and dentin (**Andersson et al 1991).** Early *in vitro* studies have demonstrated that CSPS forms a mineralized layer and occludes exposed dentin surfaces (**Litkowshi et al 1997).** In addition, the layer formed by CSPS has been demonstrated to exhibit a greater reduction in permeability when challenged with citric acid compared with a

control (**Burwell et al 2010 and Wang et al 2010**). Recent clinical trials have also shown the efficiency of CSPS in reducing dentin sensitivity (**Millenman et al 2012 and Pradeep et al 2012**). Over the past 10 years, CSPS has been included in the formulations of over 15 products, and these products are sold in over 20 countries (**Greenspan et al 2010**). NovaMin® (which is technically described as inorganic, amorphous CSPS), is the branded ingredient found in numerous professional and over-the-counter dental products designed to relieve tooth sensitivity. In the present study CSPS shown less dentinal tubule occlusion when compared with pro-argin group.

Occlusion of dentinal tubules is one approach currently used in the treatment of dentine hypersensitivity. As a consequence any reduction in the radius of the tubule opening would be expected to reduce dentine permeability and as such should be effective in treating dentine hypersensitivity. This study evaluated the occlusion of dentinal tubules by three desensitizing agents. More or less all the desensitizing agents occluded the dentinal tubules. But arginine paste were most effective when compared with other toothpaste. Hence it can be used effectively to treat the patients with hypersensitivity. It is also unclear whether permeability must be completely stopped before sensitivity can be treated, considering this, it is important to say that some substances may also have a desensitizing effect observed only "in vivo". ven with the limitations of this study it has been concluded that none of the treatments may be considered 100% effective in treating dentinal hypersensitivity since a partial reduction of the permeability was observed.

CONCLUSION:

Severity of dentinal hypersensitivity can be episodic. Hence establishing a concrete diagnosis becomes imperative in the attempts to identify and isolate an effective therapeutic agents for the elimination of dentinal hypersensitivity. In the current study all the experimental agents demonstrated an efficacy in occluding dentinal tubules as compared to the control group. The percentage (%) of occluded tubules was found to be highest for pro-argin group as compared to the other group over a period of 7 days. However further long term investigations are needed to critically warrant the usage of these agents.

REFERENCES:

1. Rizzante FA, Maenosono RM, Duarte MA, Furuse AY, Palma-Dibb RG, Ishikiriama SK. In Vitro evaluation of dentin hydraulic conductance after 980 nm diode laser irradiation. J Periodontol. 2016 Feb 26.
2. Miglani S, Aggarwal V, Ahuja B. Dentin hypersensitivity: Recent trends in management. J Cons Dent: JCD. 2010 Oct;13(4):218.

3. Pashley DH, Livingston MJ, Reeder OW, Horner J. Effects of the degree of tubule occlusion on the permeability of human dentine in vitro. Arch Oral Biol. 1978 Jan 1;23(12):11271133-31.
4. Pashley DH. Dentin permeability, dentin sensitivity, and treatment through tubule occlusion. J Endo. 1986 Jan 1;12(10):465-74.
5. Mahale S, Badade P, Panjwani A, Vaidya P. Dentinal tubule occlusion by desensitizing dentifrices: SEM study. IOSR J Dent Med Sci. 2015;14(10):21-4.
6. Ishihata H, Kanehira M, Finger WJ, Takahashi H, Tomita M, Sasaki K. Effect of two desensitizing agents on dentin permeability in vitro. J Appl Oral Sci. 2017 Feb;25(1):34-41.
7. Pereira JC, Segala AD, Gillam DG. Effect of desensitizing agents on the hydraulic conductance of human dentin subjected to different surface pre-treatments-an in vitro study. Dent Mat. 2005 Feb 28;21(2):129-38.
8. Kolker JL, Vargas MA, Armstrong SR, Dawson DV. Effect of desensitizing agents on dentin permeability and dentin tubule occlusion. J Adhesive Dent. 2002 Sep 1;4:211-22.
9. Piola Rizzante FA, Massunari Maenosono R, Guenka Palma R, Hungaro Duarte MA, Kiyoshi Ishikiriama S. Evaluation of dentinal permeability reduction provided by different desensitizing treatments. RSBO Revista Sul-Brasileira de Odontologia. 2014;11(3).
10. Dhillon P, Govila V, Verma S. Evaluation Of Various Desensitizing Agents In Reducing Dentin Hypersensitivity Using Scanning Electron Microscope: A Comparative In Vitro Study. Ind J Dent Sci. 2014 Dec 1;6(5).
11. Suge T, Ishikawa K, Kawasaki A, Yoshiyama M, Asaoka K, Ebisu S. Duration of dentinal tubule occlusion formed by calcium phosphate precipitation method: in vitro evaluation using synthetic saliva. J Dent Res. 1995 Oct;74(10):1709-14.
12. Lavender SA, Petrou I, Heu R, Stranick MA, Cummins DI, Kilpatrick-Liverman L, Santarpia III RP. Mode of action studies of a new desensitizing dentifrice containing 8.0% arginine, a high cleaning calcium carbonate system and 1450 ppm fluoride. Am J Dent. 2010 May 1;23(Special Issue):14A-9A.
13. Olley RC, Pilecki P, Hughes N, Jeffery P, Austin RS, Moazzez R, Bartlett D. An in situ study investigating dentine tubule occlusion of dentifrices following acid challenge. J Dent. 2012 Jul 31;40(7):585-93.
14. Zhu M, Li J, Chen B, Mei L, Yao L, Tian J, Li H. The effect of calcium sodium phosphosilicate on dentin hypersensitivity: a systematic review and meta-analysis. PloS one. 2015 Nov 6;10(11):e0140176.

15. Pradeep A, Sharma A. Comparison of clinical efficacy of a dentifrice containing calcium sodium phosphosilicate to a dentifrice containing potassium nitrate and to a placebo on dentinal hypersensitivity: a randomized clinical trial. J Periodontol. 2010;81: 1167–1173.
16. Andersson OH, Kangasniemi I. Calcium phosphate formation at the surface of bioactive glass in vitro. J Biomed Mater Res. 1991;25: 1019–1030.
17. Litkowski LJ, Hack GD, Sheaffer HB, Greenspan DC. Occlusion of dentin tubules by 45S5 Bioglass (R). Bioceramics. 1997;10: 411–414
18. Burwell A, Jennings D, Muscle D, Greenspan DC. NovaMin and dentin hypersensitivity—in vitro evidence of efficacy. J Clin Dent. 2010;21: 66–71.
19. Wang Z, Sa Y, Sauro S, Chen H, Xing W, Ma X, et al. Effect of desensitising toothpastes on dentinal tubule occlusion: a dentine permeability measurement and SEM in vitro study. J Dent. 2010;38: 400–410.
20. Milleman JL, Milleman KR, Clark CE, Mongiello KA, Simonton TC, Proskin HM. NUPRO sensodyne prophylaxis paste with NovaMin for the treatment of dentin hypersensitivity: a 4-week clinical study. Am J Dent. 2012;25: 262–268.
21. Pradeep A, Agarwal E, Naik S, Bajaj P, Kalra N. Comparison of efficacy of three commercially available dentifrices [corrected] on dentinal hypersensitivity: a randomized clinical trial. Aust Dent J. 2012;57: 429–434.
22. Greenspan DC. NovaMin and tooth sensitivity-an overview. J Clin Dent. 2010;21: 61–65. pmid:21207915
23. Pandya N, Jain AK, Soni SS. Efficacy of Ayurvedic toothpaste based on Dashan Sanskar Churan. Sachitra Ayurveda. 1995;47(12):907.
24. Pickover CA. The Medical Book: From Witch Doctors to Robot Surgeons: 250 Milestones in the History of Medicine. Sterling Pub.; 2012.
25. Howshigan J, Perera K, Samita S, Rajapakse PS. The effects of an Ayurvedic medicinal toothpaste on clinical, microbiological and oral hygiene parameters in patients with chronic gingivitis: a double-blind, randomized, placebo-controlled, parallel allocation clinical trial. Ceyl Med J. 2016 Jan 4;60(4).