

## Abrasive Properties of Three Different Toothpastes

**S. Shahabi**<sup>1, 2, 3</sup>✉, **F. Pesaran**<sup>4</sup>, **MJ. Kharazifard**<sup>5</sup>

<sup>1</sup>Associate Professor, Department of Dental Materials, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Assistant Professor, Dental Research Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Assistant Professor, Laser Research Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>4</sup>Dentist, Private Practice

<sup>5</sup>Statistical Consultant, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

## Abstract:

**Objective:** The main purpose of this study was to develop a simple reproducible system to compare abrasive effects of three different toothpastes.


**Materials and Methods:** A specific mold was used to fabricate 37 samples made of polymethylmethacrylate. The samples were stroked by toothbrushes connected to a V8 Cross Brushing Machine in a solution of fluoridated toothpastes and distilled water. The samples were evaluated initially and also after 48 hours. The data were analyzed by one-way ANOVA test.

**Results:** No significant differences was found among the three types of toothpastes after 25000 strokes ( $P=0.427$ ).

**Conclusion:** All the three toothpastes presented same abrasive properties.

**Key Words:** Toothbrushing; Toothpaste; Oral Hygiene

*Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2008; Vol: 5, No.1)*

 Corresponding author:  
S. Shahabi, Department of Dental Materials, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran  
shahabis@sina.tums.ac.ir

Received: 10 May 2007  
Accepted: 9 October 2007

## INTRODUCTION

Tooth brushing with toothpaste is rather arguably the most common form of oral hygiene practiced by individuals in developed countries. Although numerous claims have been made so far concerning toothpaste, the potential for oral care has significantly expanded in recent years [1]. Toothpastes have been claimed to deliver a range of preventive and therapeutic agents such as fluoride, metal salts and pyrophosphate for calculus inhibition, antimicrobials to reduce plaque growth, and numerous compounds to treat dentine hypersensitivity [2-4] Also, by the incorporation of detergents and abrasives, stain and plaque removal may be improved and short term breath freshening imparted. Indeed many products based on anionic detergents, such as sodium lauryl sulphate, possess considerable antim-

icrobial properties and are known to reduce plaque growth when compared to water. Nevertheless, toothpastes are intricate formulations and a fine balance has to be achieved in order to offer oral health benefits whilst restraining chemical and/or physical damage to the teeth and gums [5-6].

Various methods have been applied in studies concerning abrasive properties of toothpastes. These comprise measuring weight changes of the test object, surface profile measurements, and electron microscopy and radioactivity measurements. As the *in vivo* studies in the field are rather difficult to be subjected to standardizing, the *in vitro* methods are standardized. All *in vitro* methods presently available, and probably those to come, will be criticized because of the numerous variables affecting everyday use products and the influ-

ences of the complex oral environment on the matter that can never be fully stimulated in the laboratory [7,8].

A toothpaste wear study must also utilize slurry of the toothpaste, water and artificial saliva to properly simulate oral conditions during typical tooth brushing. Without toothpaste, manual toothbrushes have exhibited little abrasive power [9].

Dental abrasives are believed to play an important role in the cleaning power of toothpastes. The degree of abrasion shown by an agent is directly subjective to its own properties such as chemical composition, crystal structure, cleavage, friability, hardness, particle shape, surface features and particle size distribution, solubility, concentration and compatibility with other ingredients of the toothpaste [10].

Therefore, an acrylic model was intended to determine and compare the abrasive properties of the toothpastes and is meant to more likely relate to the effects on dentine and plastic restorative materials. The model allows chemical and mechanical effects to be separated [11].

Also a V8 Cross brushing machine was used in our study. A cross brushing machine is the apparatus has eight positions for holding specimens. A toothbrush is positioned to pass reciprocally over the mounted samples with a chosen tension on the brush while immersed in dentifrice slurry. The distance traversed by the brush should be no longer than the brush head, so that the specimen doesn't lose contact with the brush. It is important to have some means

for agitation of the slurry while the brushing is under process. A suitable method to accomplish this is attaching rubber mixing vanes just below the brush head. As the brushing takes place, these vanes will prevent the abrasive from setting down to the bottom of the slurry container.

In this study, abrasive properties of 2 Iranian toothpastes namely Darugar II and Paveh were compared with an imported one called Colgate applying a tooth brushing machine and weight loss method.

## MATERIALS AND METHODS

Three different toothpastes were used in this study (Table 1): Colgate (Colgate-Palmolive Company, USA), Darugar II (KAF, Iran) and Paveh (Tolipers, Iran). Thirty-seven polymethylmethacrylate samples were made using a polycarbonate mould. The mould consisted of 5 blocks 3 mm in diameter, 30 mm thick, and 40 mm in height.

The samples were kept in a closed plate in silicagel and weighed by digital Sartorius AG DCottengen with the accuracy of 0.0001 g. The blocks were randomly driven into the three toothpaste groups (Iranian toothpaste groups n=13, Imported toothpaste group n=11). The samples were then brushed in a toothpaste and solution by V8 cross brushing machine.

The brushes were Butler 411, Gum medium. The samples were placed in the holes of the same moulds kept in the glass plates, then placed in the bath of the brushing machine in

**Table 1.** Components of the toothpastes.

Toothpaste	Components
<b>Colgate</b>	Dicalcium phosphate dehydrate, Deionized water, Sorbitol, Glycerin, PEG600, Sodium lauryl phosphate, Cellulose, sodium monophosphate, Tetrasodium pyrophosphate, Sodium saccharin, Sodium fluoride
<b>Darugar II</b>	Dicalcium phosphate, Sodium methyl parabone, Silica, sodium monofluoro phosphate, Methyl parabone, Sodium enlauryl sarkozinate, Sodium lauryl phosphate, CMC, Sorbitol, Propylen glycole, Glycerin, Sodium saccharin, Deionized water
<b>Paveh</b>	Sodium carboxy methyl cellulose, Glycerin, Sorbitol, Sodium saccharin, sodium monofluoro phosphate, Citric acid, Aerosyl, Sodium lauryl phosphate, Deionized water, Dicalcium phosphate

numerical order and covered with 100 ml of toothpaste slurry. The slurry consisted of 25 g of toothpaste and 100 ml of distilled water. The tests were performed under 200 g force and 25000 strokes. The specimens were then removed from the bath, rinsed, wiped dry, and kept for 48 hours in silica plate and then weighed.

The data were analyzed by one-way ANOVA test using SPSS 11.5 Software. The confidence level was set at 0.95.

## RESULTS

Weight loss in each group was recorded (Table 2). The mean amount of weight loss was 0.800 mg (SD=0.289) for Paveh, 0.791 mg (SD=0.646) for Colgate and 0.585 mg (SD=0.426) for Darugar. There was no significant difference between the three toothpastes ( $P=0.427$ ).

## DISCUSSION

We found no significant difference between the abrasive properties of the three toothpastes involved in the study and also, no significant weight loss difference was noticed in any of the three groups.

Opinion tends to advocate that soft tissue damage and gingival recession are caused by toothbrush, whereas hard tissue loss is mainly a function of toothpaste abrasives. However, toothpaste abrasives are considered to have minimal effects on enamel with the activity being largely directed towards dentine [12]. Other agents operating *in vivo*, particularly dietary acid, may significantly enhance the action of toothpaste abrasives on dentine and enamel [13].

Historically, a large number of researches have been dedicated to dentin wear associated with abrasives added to toothpastes. Therefore, an acrylic model was intended to determine and compare the abrasive properties of the toothpastes and is meant to more likely relate to the effects on dentine and plastic restorative materials. Also, the results must largely relate to mechanical actions of the products regardless of any chemical erosive action of other ingredients. Acrylic is chemically inert to such ingredients [14].

Another advantage in our study was the use of a V8 Cross brushing machine. This machine can move forward and backward like brushes do.

Dentifrice abrasive properties depend on particle size, shape and hardness of the abrasives as well as other factors such as the frequency of brushing and hardness of the bristles. Since the latter factors remained constant among all the dentifrices, only physical properties of the toothpaste would explain the disparity of the results obtained. Indeed, the average particle diameter of the abrasive determines the abrasion rate. On the other hand, chemically identical abrasives can also have different cleaning/abrasion rates depending on the total dentifrice composition. This fact may explain why dentifrices using the same type of abrasives differ in accordance to their cleaning power potential. The abrasive properties of toothpaste must be determined on the basis of its complete composition and not only limited to its abrasive agents [15].

Acrylic blocks and dentin specimens have been used in various studies [16-22]. Momoi et al [15] used Z100 dental composite in a con-

**Table 2.** Mean, Standard Deviation(SD) and Standard Errorr (SE) of weight loss\* in mg.

Type of toothpaste	N	Mean	SD	SE	Minimum	Maximum
Paveh	13	0.800	0.289	0.080	0.3	1.3
Colgate	11	0.791	0.646	0.195	0.0	2.2
Darugar II	13	0.585	0.426	0.118	0.0	1.5

\* The difference between weight of samples before and after experiment.

trol group to compare the wear occurring in glass ionomer. In the study of Harrington et al [23], PTEE (poly tetrafloro ethylene) was used. In our study, a force of 200 g was applied to the head of the brushes by the brushing machine. This is the mean force used in previous studies as well. The minimum force was used in tests conducted by West et al [17] (170 g) and the maximum was applied by Tanoue et al [24] (300 g).

Buttler 411-Gum medium brushes were used as they have a more reasonable price compared to other foreign standard brushes. This type of brush has a handle connected to its head facilitating its connection to the machine its settlement on the samples. The number of strokes in this study was set to be 25000 approximately equivalent to the number of strokes applied on a tooth in 2.5 years of cleaning. Harrington used 60000 strokes for assess the wear, weighing the samples before, after, and every 20000 strokes [23]. De Boer used 10000 strokes weighing the samples after 1000, 2000, 5000, and 10000 strokes [18]. The reason for us applying a less number of strokes in this study, compared to Harrington, was the use of surface profilometer. This device works with great precision in 2 and 3 dimensional modes in micrometer. Therefore, no more strokes than 20000 seemed required.

Because of the noticeable effect of abrasives on enamel wear, abrasive properties can play a role in judging toothpastes; the properties we found not to be significantly different in two Iranian toothpastes and one imported one.

## CONCLUSION

In conclusion, this model appears to provide a simple *in vitro* method to compare abrasive properties of toothpastes and using it, all the three toothpastes presented same abrasive properties.

## ACKNOWLEDGMENT

The authors would like to thank Mr. Souri for

his contributions. This research was supported by Dental Research Center of Tehran University of Medical Sciences, Health services grant no. 2821.

## REFERENCES

- 1-Addy M, Dowell P. Dentine hypersensitivity--a review. Clinical and in vitro evaluation of treatment agents. J Clin Periodontol 1983 Jul;10(4): 351-63.
- 2-Hooper SM, Newcombe RG, Faller R, Eversole S, Addy M, West NX. The protective effects of toothpaste against erosion by orange juice: studies in situ and in vitro J Dent. 2007 Jun;35(6):476-81.
- 3-Philpotts CJ, Weader E, Joiner A. The measurement in vitro of enamel and dentine wear by toothpastes of different abrasivity. Int Dent J. 2005;55(3 Suppl 1):183-7.
- 4-Addy M, Dowell P. Dentine hypersensitivity--a review. Clinical and in vitro evaluation of treatment agents. J Clin Periodontol 1983 Jul;10(4): 351-63.
- 5-Moran J, Addy M, Newcombe R. The antibacterial effect of toothpastes on the salivary flora. J Clin Periodontol 1988 Mar;15(3):193-9.
- 6-Addy M, Willis L, Moran J. Effect of toothpaste rinses compared with chlorhexidine on plaque formation during a 4-day period. J Clin Periodontol 1983 Jan;10(1):89-99.
- 7-Rees DA, Davis WB: An in vivo method of assessing dentine and enamel loss. J Dent Res 1975;54.
- 8-Lobene RR. Effect of dentifrices on tooth stains with controlled brushing. J Am Dent Assoc 1968 Oct;77(4):849-55.
- 9-Dyer D, Addy M, Newcombe RG. Studies in vitro of abrasion by different manual toothbrush heads and a standard toothpaste. J Clin Periodontol 2000 Feb;27(2):99-103.
- 10-Torrado A, Valiente M, Muñoz CA. Cleaning power and abrasivity of a new toothpaste based on ion-exchange resins. Am J Dent 2004 Apr;17(2): 80-4.
- 11-Heath JR, Davenport JC, Jones PA. The abrasion of acrylic resin by cleaning pastes. J Oral Re-

- habil 1983 Mar;10(2):159-175.
- 12-Davis WB, Winter PJ. Measurement in vitro of enamel abrasion by dentifrice. *J Dent Res* 1976 Nov-Dec;55(6):970-5.
- 13-Davis WB, Winter PJ. The effect of abrasion on enamel and dentine after exposure to dietary acid. *Bri Dent J* 1980; 148(11): 253-7.
- 14-Radmalm G. Dentine abrasivity. The use of laser light determination of the abrasive properties of different silicas, an in vitro study. *Swed Dent J* 1986;10(6):243-50.
- 15-Momoi Y, Hirosaki K, Kohno A, McCabe JF. In vitro toothbrush-dentifrice abrasion of resin-modified glass ionomers. *Dent Mater* 1997 Mar;13(2):82-8.
- 16-Dyer D, MacDonald E, Newcombe RG, Scratcher C, Ley F, Addy M. Abrasion and stain removal by different manual toothbrushes and brush actions: studies in vitro. *J Clin Periodontol* 2001 Feb;28(2):121-7.
- 17-West N, Addy M, Hughes J. Dentine hypersensitivity: the effects of brushing desensitizing toothpastes, their solid and liquid phases, and detergents on dentine and acrylic: studies in vitro. *J Oral Rehabil* 1998 Dec;25(12):885-95.
- 18-De Boer P, Duinkerke AS, Arends J. Influence of tooth paste particle size and tooth brush stiffness on dentine abrasion in vitro. *Caries Res* 1985; 19(3):232-9.
- 19-Parry J, Rees GD, Smith AJ. Toothpaste abrasivity assessment on dentin and the effects of specimen preparation. IADR/AADR/CADR 80th General Session; 2002 March 6-9; Abstract No. 4051.
- 20-Moore C, Addy M. Wear of dentine in vitro by toothpaste abrasives and detergents alone and combined. *J Clin Periodontol* 2005 Dec;32(12): 1242-6.
- 21-De Menezes M, Turssi CP, Hara AT, Messias DC, Serra MC. Abrasion of eroded root dentine brushed with different toothpastes. *Clin Oral Investig* 2004 Sep;8(3):151-5.
- 22-Svinnseth PN, Gjerdet NR, Lie T. Abrasivity of toothpastes. An in vitro study of toothpastes marketed in Norway. *Acta Odontol Scand* 1987 Jun;45(3):195-202.
- 23-Harrington E, Jones PA, Fisher SE, Wilson HJ. Toothbrush-dentifrice abrasion. A suggested standard method. *Br Dent J* 1982 Aug 17;153(4):135-8.
- 24-Tanoue N, Matsumura H, Atsuta M. Wear and surface roughness of current prosthetic composites after toothbrush/dentifrice abrasion. *J Prosthet Dent* 2000 Jul;84(1):93-7.
- 25-Haselden CA, Hobkirk JA, Pearson GJ, Davies EH. A comparison between the wear resistance of three types of denture resin to three different dentifrices. *J Oral Rehabil* 1998 May;25(5):335-9.