

**1409** *In Situ* Fluoride Uptake by Sound and Partially Demineralized Enamel D ZERO J FU\* D LEXOMBCON J D B FEATHERSTONE<sup>1</sup> (Eastman Dental Center Rochester New York USA UC San Francisco California USA)

The aim of this study was to determine fluoride (F) uptake by sound and partially demineralized enamel after treatment with different concentrations of F dentifrice using an *in situ* model. Twenty healthy consenting adults participated in the study. Two gauze covered flattened bovine enamel blocks, one sound and one partially demineralized, were placed on each side of the subject's mandibular partial denture in the buccal flange area (total of 4 blocks). Test dentifrices containing either 0.250, 500 or 1100 ppm F (as NaF) were applied by brushing twice per day for 14 days. At the end of the test period the enamel blocks were evaluated for total F uptake using the microdrill biopsy technique (Sakkab *et al.* 1984). Enamel powder samples were analyzed for F content using the Taves (1968) microdiffusion method. The enamel blocks were subsequently evaluated for alkali-soluble F by exposure to 1M KOH for 24 h (Caslavka *et al.* 1975) and then again evaluated using the microdrill biopsy technique for remaining fluoride. The mean (SD) total F uptake values ( $\mu\text{g}/\text{cm}^2$ ) after the 0.250, 500 and 1100 ppm F dentifrice treatments were 2.69(0.70), 5.10(2.55), 7.41(3.49) and 10.71(4.91) respectively for partially demineralized enamel and 1.78(0.49), 3.25(1.19), 3.88(1.59) and 3.65(1.10) respectively for sound enamel. F uptake was significantly greater for partially demineralized enamel than for sound enamel ( $p < 0.01$ ). The majority of the F uptake after F dentifrice treatment (greater than 80%) was associated with the non-alkali-soluble fraction for both sound and partially demineralized enamel. There was a dose response relation for F uptake by partially demineralized enamel while F uptake by sound enamel appears to plateau after treatment with 250 ppm F dentifrice. This study was supported by NIH/NIDR Grant DE 08577.

**1410** *In Vitro* Fluoride Uptake from Chinese and Indian Dentifrices A. ITTHAGARUN\* S. H. Y. WEI (Department of Children's Dentistry and Orthodontics, The University of Hong Kong, Hong Kong)

The effectiveness of F dentifrices in reducing dental caries is well documented. However, not all F dentifrices are equally effective. The objective of this study was to compare fluoride uptake from Chinese and Indian dentifrices which hold the biggest share of the dentifrice market in these vast countries. A non-fluoride dentifrice was included as control. Dentifrices were analyzed for fluoride concentrations and were randomly divided into 2 groups. Four round adhesive discs (area = 4.9 mm<sup>2</sup>), were placed on each tooth (10 teeth/group) giving 4 windows for treatment with 1 control and 3 F dentifrices. Windows were treated with selected dentifrice supernatants for 1 hour. F uptake was analyzed by acid etch biopsy technique (Wei *et al.* *J Dent Res* 60:1297, 1981). F conc in the 1st layer of enamel (2.90  $\mu\text{m}$ ) in ppm/ $\mu\text{g}$   $\pm$  SEM were as follows: For Group 1: Control 2692  $\pm$  225, First\* 3245  $\pm$  188, Maxam Tartar Control\* 3904  $\pm$  282, Colgate MFP\* 5314  $\pm$  499. For Group 2: the values were: Control 2380  $\pm$  93, Vicco\* 2374  $\pm$  69, Tianqi\* 2766  $\pm$  192, Maxam DFP\* 3052  $\pm$  164. Colgate MFP\* and Maxam DFP\* showed statistically higher F uptake from control ( $p < 0.001$ ,  $p < 0.01$ , respectively, ANOVA and t-Test). Significant differences were also seen amongst the dentifrices such as First\* and Colgate MFP\* and Vicco Vajradenti and Maxam DFP ( $p < 0.01$ ). This study suggests that, when compared to 'multinational dentifrices', the Chinese and Indian dentifrices manufactured locally failed to show the F uptake efficacy even though they claimed to contain varying levels of F.

**1411** Fluoride Retention in Whole Saliva After the Application of Fluoride Dentifrices W-T YANG\*, Y-J DONG and Y-B WANG (Tri-Service General Hospital, Taipei, Taiwan, ROC)

Recent evidence has suggested that the cariostatic effects of topical fluoride are related to the presence of low concentration of ionic fluoride in the oral environment. The aim of this study was to evaluate the fluoride concentrations in a 6-hour period after treatment with different fluoride dentifrices. 20 dental students, aged 20-24 years, participated in all aspects of this study. Tested dentifrices included with Mentadent (0.15% w/v NaF), Oral-B (0.225% w/v NaF), Colgate (0.76% w/v MFP), Darlie (0.05% w/v NaF), and placebo dentifrice (PD). Unstimulated whole saliva samples were collected at baseline and 0, 10, 30, 60, 120, 240, and 360 min. A fluoride ion-selective electrode (ORION 96-09, Orion Research, Cambridge, Mass., USA) was used to measure the salivary fluoride concentrations. The results show that fluoride concentrations in whole saliva collected at 10 min were Mentadent (3.09  $\pm$  1.88 ppm), Colgate (3.12  $\pm$  2.31 ppm), Oral-B (3.01  $\pm$  2.07 ppm), Darlie (1.24  $\pm$  1.03 ppm), and PD (0.12  $\pm$  0.05 ppm). There is a strong linear correlation between whole saliva fluoride concentration and dentifrice. After 4 hours, salivary fluoride level were reduced to the baseline. The results suggested that the brushing frequency should be increased in order to maintain sufficient fluoride level in saliva through dentifrice, which may have important implication for enamel remineralization. Supported by a grant NSC-84-B016-524, ROC.

**1412** A Proposed Method for Classifying Toothbrush Efficacy and Safety Potential S. L. YANKELL\*, X. SHI and R. C. EMLING (UPA SDM Phila PA and Int Dent Res Ltd Moorestown NJ)

Recent research on soft bristled toothbrushes demonstrated a direct relationship for laboratory interproximal access (IAE) with clinical plaque removal and for deposit removal (DR) with gingival irritation (ORCA Abs 71:72 1995). The purpose of this laboratory research was to evaluate four commercially available toothbrushes: Aqua Flex New Improved, Crest Complete, Oral B P35 and Reach Advanced Design with varying bristle designs and labeled toothbrush textures (soft or medium). Toothbrush testing was performed for 10 secs 250g brushing pressure horizontal brushing motion simulated posterior teeth and wet pressure sensitive paper (IADR Abs 300:1995). IAE was measured with vernier calipers and DR evaluated on a visual scale of 1-4. The newly developed classification scale (CS) considered IAE increases as beneficial for plaque removal and DR increases as potentially detrimental to gingival tissues. With all toothbrushes tested ANOVA revealed significant ( $p < 0.05$ ) IAE decreases and DR increases with increased toothbrush texture. CS differences between the toothbrushes tested were consistent and significantly different ( $p < 0.05-0.01$ ) when the same textures were compared. A new laboratory method has been developed combining toothbrush efficacy and safety potential to compare toothbrushes with varying bristle designs and similarly labeled textures.

**1413** ASSAY DEVELOPMENT FOR TOOTHBRUSH DAMAGE ON HARD TISSUES C. C. KO\*, M. R. PINTADO, D. TANTBIROJN and W. H. DOUGLAS (Minnesota Dent Res Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, MN 55455)

Toothbrushing can result in hard tissue damage i.e. cervical abrasion. However, there is no generally accepted quantitative assay for the evaluation of damage due to the fact that short damage is difficult to measure. This study was designed as a first step to develop an *in vitro* assay to quantify toothbrushing induced surface loss due to cervical abrasion on bovine incisors. There is mounting clinical evidence that hard tissue loss is induced by the synergy between abrasion and mineral erosion. The demineralization conditions here involved exposure to 6% HEC lactic acid gel with pH value 5.1 for 3 weeks and the toothbrushes used in the assay were coded as R (Reach), CC (Crest Complete), CPr (Colgate Precision), OB (Oral B) and SK (Dr Best Swiffingkopf). The teeth were embedded in PMMA resin and the labial surface of both crown and root were subjected to a demineralization step and then to reciprocal brushing without paste for 40 min. A constant load of 2.5 N pressing force was applied through an Oral Hygiene Replicator at 1 Hz with 12 mm stroke length. A contact profiler was used to record surface profiles which were compared quantitatively before and after toothbrushing by the fitting program AnSur. The maximum loss of the vertical dimension of the brushed surface is reported below. As a correlative technique the toothbrush handle stiffness was included in association with the constant load control. It appears that there is a threshold between a handle stiffness of 1.58 and 1.3 N/mm. This may reflect nonlinear mechanics or loss of resolution of measurement below 10  $\mu\text{m}$ . However, there is a broad correlation between stiffness of 2.54 and 0.55 N/mm in these preliminary results. This may lend support for a demineralization step in the assessment of toothbrush damage which seems justified from a clinical as well as a practical point of view. However, more extensive demineralization may be indicated to test the correlative effects and resolve finer differences. The ongoing research is investigating the effect of pH 4.5 acid to extend the usefulness of the assay including the interactive effects of paste. Supported in part by SmithKline Beecham.

	R	CC	CPr	OB	SK
Handle Stiffness (N/mm)	2.5371	1.5875	1.3000	0.8235	0.5486
Tuft Length (mm)	8.38-9.45	9.07-11.04	8.53-10.46	10.88	10.91
Vertical Loss ( $\mu\text{m}$ )	20	10	0	0	0

**1414** Automatic optimization of numerical models applied to toothbrush design M. S. QUADLING\*, A. VERSLUIS, W. H. DOUGLAS (Minnesota Dental Research Center for Biomaterials and Biomechanics, University of Minnesota, Minneapolis, USA)

This research aims to develop computational tools for determining an optimal set of material parameters for dental design problems. Results are presented for a toothbrush design problem. A distributed optimization module is being developed to interface with standard finite element solvers such as MARC, and to determine an optimal set of model parameters so that some design criterion is best achieved. Standard search algorithms such as the Nelder-Mead Simplex method are compared to a new robust algorithm which is being developed specifically for this application. This algorithm is based on an entropy minimizing genetic algorithm, and is designed to be able to handle a large set of parameters. For a generic toothbrush design, a finite element model has been built with four distinct segments, namely the head, tufts, neck and handle. For each segment, the elastic moduli and geometry were provided as parameters to the optimization module. The design criterion chosen was to produce an even force distribution on a stationary surface as the tufts of the brush were brought into contact with the surface by moving the handle. An initial elastic modulus of 10% of that of the handle was specified for the tufts. During the optimization process, the elastic moduli of the head and neck were restricted to 20%  $\leq E \leq 200\%$  relative to the handle, the elastic moduli of the tufts to  $E \leq 10\%$  and the thickness of the head to 2 mm  $\leq d \leq 6$  mm. An optimization module successfully converged with convergence ratio  $R=0.999$  and provided optimal sets of parameters for a toothbrush design problem. Preliminary optimization runs of the toothbrush head alone consistently produced a head which was suited at the junction with the neck (by a factor of 50% over the mean stiffness) and otherwise non-rectangular. The ratio of the elastic modulus of the connecting part of the head to that of the neck appears to be the crucial factor.

**1415** Effect of a Device on Toothbrush Integrity P. SCHNEIDER, R. MUSSELMAN\*, N. SARKAR (Departments of Pediatric Dentistry and Biomaterials, Louisiana State University, School of Dentistry, New Orleans, Louisiana)

Recently a device (US Patent #4884311) has been introduced to prevent deterioration of the toothbrush after its repeated use. Its action is based on the viscoelastic properties of the bristles. Drying a wet brush in a forced shape is claimed to maintain the original shape of the bristles.

The purpose of this study was to evaluate the effectiveness of this device in minimizing the deterioration of various commercially available toothbrushes. The bristle deterioration of four brands of toothbrushes with and without the device was characterized. Toothbrushes evaluated were the Oral B 40, Pycopy 12.0 5 row, Butler #330 and the Oral B 20. Ten brushes of each brand were divided into two groups: the control without the device and the experimental with the device. Toothbrushing was simulated in the laboratory using a toothbrushing machine. The experimental conditions were (a) 380 strokes/min, (b) stroke length 41.5 mm with pressure of 450 gm and (d) slurry consisting of 40 gm of toothpaste in 100 gm of water. During brushing bristles slid over a ceramic disc that had a hardness similar to dental enamel. Following 15 minutes of continuous brushing, each toothbrush was removed from the machine and dried using a hair dryer. During drying, the toothbrush bristles in the experimental group were clamped inside the holder. The bristles in the control group were dried unclamped. The cycle was repeated for a total of 91,200 strokes of brushing.

Bristle deterioration was evaluated on the basis of Wear Index (WI) (Glade & Wade, 1986) and Wear Rating (WR) (Rawls 1989). WI is a quantitative measure of the degree of splaying. WR is a qualitative means of ranking brushes in various stages of deterioration. Data on WI and WR showed that toothbrushes in the experimental group had significantly ( $p < 0.05$ ) less deterioration. Improvement in wear resistance was found to be dependent on the brand of toothbrush.

The use of the device retains the nonmatted shape of the bristles and reduces toothbrush deterioration.

**1416** Pressure and Motion Requirements of a Powered Toothbrush S. Ciancio, M. Mather, M. Bessinger\*, P. Bush, R. Schifferle (Center for Dental Studies, SUNY at Buffalo, NY, USA)

Laboratory studies in our Biomaterials Instrument Center suggested that when powered toothbrushes are used, excess pressure may slow down bristle motion and reduce brush effectiveness. Pressure ranges tested were 0 grams, 500 grams. These laboratory findings were evaluated in a clinical study. The objective of this pilot study was to determine the most effective brushing pressure and amount of motion for the Hapika powered toothbrush. Five patients with a plaque index of  $> 1.50$  reported to the clinic. Dental plaque was disclosed and subjects were instructed to brush each quadrant according to the following regimens: 1 = heavy pressure and motion, 2 = heavy pressure and no motion, 3 = light pressure and motion, and 4 = light pressure and no motion. Brushing regimens per quadrant were randomly assigned. Plaque was then scored using the Turesky modification of the Quigley-Hein index. The results of the study showed that the greatest plaque reduction occurred in regimen 3 (56%) compared to 50.7%, 40% and 39.3% in regimens 1, 2 and 4 respectively. The results of this study suggest that this type of powered toothbrush removes plaque best when a light pressure is applied accompanied by motion of the brush. This data also supports a more extensive study of these parameters. Supported in part by a grant from the Minimum Corporation.