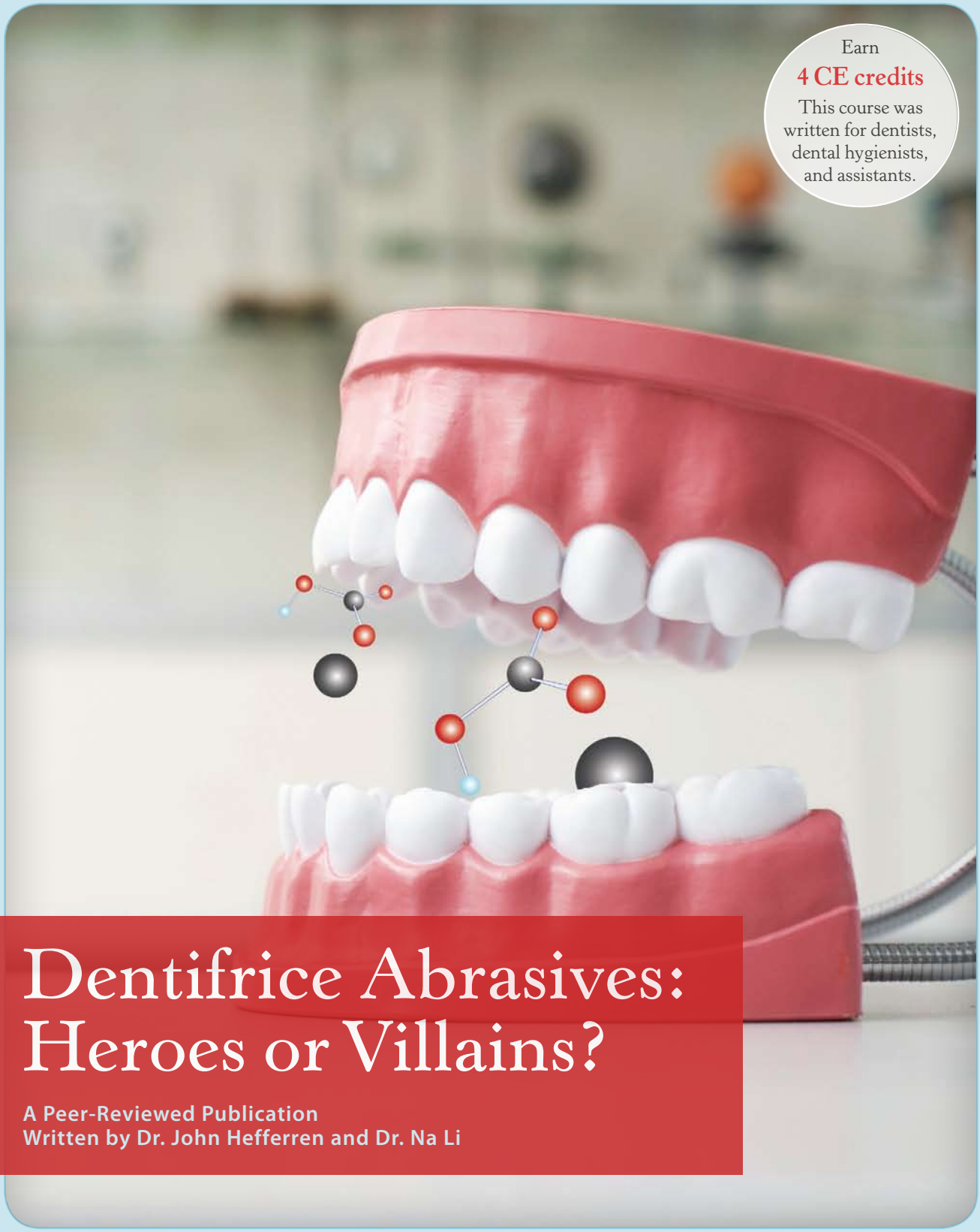


Earn
4 CE credits
This course was written for dentists, dental hygienists, and assistants.

Dentifrice Abrasives: Heroes or Villains?

A Peer-Reviewed Publication
Written by Dr. John Hefferren and Dr. Na Li

ADA CERP® Continuing Education Recognition Program

PennWell is an ADA CERP recognized provider

ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors, nor does it imply acceptance of credit hours by boards of dentistry.

Concerns of complaints about a CE provider may be directed to the provider or to ADA CERP at www.ada.org/goto/cerp.

PennWell® dental CE digest® ineedCE.com The Academy of Dental Therapeutics and Stomatology™

Go Green, Go Online to take your course

This course has been made possible through an unrestricted educational grant. The cost of this CE course is $59.00 for 4 CE credits.
Cancellation/Refund Policy: Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell in writing.

Educational Objectives

Upon completion of this course, the clinician will be able to do the following:

1. Know the different types of dentifrice abrasives
2. Understand the efficacy of the different types of dentifrice abrasives
3. Understand the safety of the different types of dentifrice abrasives

Abstract

This learning module presents information about the benefits of dentifrice abrasives. It covers the three major types of dentifrice abrasives: phosphates, carbonates, and silicas. It details the efficacy of each type of material and provides data about the safety of each type of material. Sodium bicarbonate has been found to be the least abrasive of the materials in common use while providing effective cleaning because it uses both mechanical and chemical methods in the cleaning process.

Role of Dentifrice Abrasives

Dentifrice abrasives offer patients benefits for both oral health and personal appearance. They help prevent gum disease by removing plaque that accumulates through normal eating and drinking, and they remove stains from the teeth, allowing people to smile with confidence.

Are toothpaste abrasives really necessary?

The need for abrasives as well as toothpaste has been debated over the years. People vary considerably in their propensity to form and accumulate dental stain and surface debris—as well as in their desire for white teeth. It has been long recognized that brushing with just a wet brush has little influence on stain removal within the typical one to three minutes of twice daily brushing. Depending to some extent upon toothbrush bristle texture and the individual's oral tissues, longer brushing times merely irritate the gingival tissues without achieving the desired tooth surface cleansing.

Kitchin and Robinson made famous the statement, "One should use only as much abrasion as necessary to clean one's teeth."[1] They might have qualified it by adding, "consistent with the commitment of the individual to having clean, white teeth."[2] Robinson was a firm believer that the dentist should help with the dentifrice choice and tailor the dentifrice to the patient's needs.[3]

Types of Dentifrice Abrasives

The three major categories of dentifrice abrasives are phosphates, carbonates, and silicas.

- **Phosphates** are used as part of toothpaste formulas because they help the product to leave the teeth looking white and feeling clean.
  - **Dicalcium phosphate dihydrate (DCPD)** The Lever toothpaste ad campaign of the 1940s made this material famous with the slogan, "Makes the yellow go away."
  - **Calcium pyrophosphate (CalPyro)** CalPyro is used in a toothpaste with stannous fluoride. The calcium pyrophosphate used was heat treated to reduce the soluble calcium ion availability and thus increase the fluoride ion availability.
- **Carbonates** have been used for nearly 100 years to make a variety of products and environments fresh-smelling, in addition to their abrasive properties.
  - **Sodium bicarbonate** is also known as baking soda. Its chemical action was used in the 1920s to clean silver. In the 1940s, its absorbency was used to deodorize refrigerators. In the 1970s, the uses of sodium bicarbonate expanded to washing clothes and deodorizing carpets. For the last two decades, it has been used as a dentifrice abrasive and an oral deodorizer. Sodium fluoride, which provides soluble fluoride, is compatible with sodium bicarbonate.
  - **Calcium carbonate** is more familiarly known as chalk. It is a naturally occurring substance found in locales all over the world, making it one of the most economical mechanical abrasives available. Calcium carbonate is available as mined salt or chemically modified as precipitated chalk. The precipitated chalk is much less abrasive than the mined salt product. The calcium ion limits soluble fluoride in toothpaste to seven ppm; thus sodium monofluorophosphate is used with calcium containing abrasive such as calcium carbonate.
- **Silicas** are one of many products in the hydrated silica family, available in many particle sizes and characteristics. Some silicas mechanically clean the teeth, while other silicas can thicken the toothpaste. In toothpaste, silicas are chemically inert. They absorb fewer flavors and functional additives. As a result, they are chemically compatible with such additives as soluble fluorides.

Are Toothpaste Abrasives Safe?

The tooth and its relevant characteristics

There was concern expressed and documented in laboratory extracted tooth brushing studies as early as 1907, when Miller reported the wasting away of tooth tissue that resulted from erosion, abrasion, chemical abrasion, and denudation.[4] Such studies were in contrast to the intact tooth and supportive bone structure of historic materials from both animals and humans.

Teeth are composed of enamel and dentin. Intact dental enamel is hard and resistant to wear, although over a number of years, wear may occur.[5,6] Enamel wear is generally

of less concern than dentin wear or abrasion. Dentin has about a quarter of the hardness of enamel and thus is much more sensitive to wear than the harder enamel.

Human enamel receives no blood supply, hence it is biologically dead. However, enamel does participate in chemical reactions with acids and chelating agents. This chemical reactivity is of some concern when dietary habits and food choices turn toward acidic foods that are consumed over a long period of time, such as drinking 16 ounces of a soft drink with a straw.[7]

The physical and chemical characteristics of dentifrice abrasives

Intact, sound enamel is mechanically resistant to the abrasives of all three major abrasive toothpaste materials. Phosphates and chalk are mechanical tooth cleansers and generally biologically inert. However, the polyvalent calcium ion can react with other toothpaste ingredients, as well as with chemically reactive sites on the tooth surface, such as etched areas.

The silica family of ingredients is largely physically and chemically nonreactive with other toothpaste ingredients, so that the divalent calcium ion available from calcium phosphates and calcium carbonates can react with anions like fluoride to limit the solubility of fluorides such as sodium fluoride. These calcium-containing abrasive systems usually have sodium monofluorophosphate (MFP) as a source of fluoride for the targeted 1,000 ppm fluoride for topical caries protection in toothpaste. The monofluorophosphate ion is hydrolyzed in the mouth to release fluoride, thus avoiding the reaction with calcium within the toothpaste that limits fluoride availability.

Because silica is largely nonreactive with other toothpaste ingredients, it has been the most frequently used toothpaste abrasive in recent years.

Safety

Ingredients used as dentifrice abrasives are generally considered safe. If there is a concern, the focus is usually on the degree of tooth surface abrasion and in particular on dentin, since dentin is much softer than enamel.

Efficacy

Sodium bicarbonate has always been something of an exception to most dentifrice abrasives. In addition to its mechanical cleansing, the chemical interactions of sodium bicarbonate change the oral microflora, exercising additional beneficial effects on plaque and other tooth surface accumulations, such as stains.

Zambon and his group at the University of Rochester studied 100 adults who used toothpaste with 52% and 65% sodium bicarbonate for six months and then for another three months after the participants stopped using the paste.[8]

Compared to their prestudy baseline values, the participants had a 50% reduction in dental plaque, a 70% reduction in gingival inflammation, and a 60% reduction in dental stain. Microbiological assays showed no adverse shift in the oral microflora; rather, the microbial analysis showed a promotion of health-associated oral microorganisms.

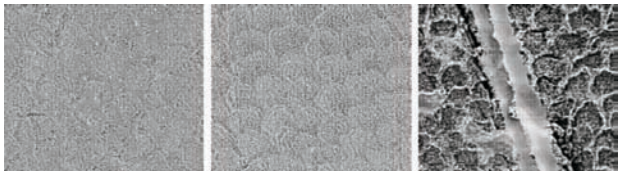
Can life choices alter tooth surfaces?

The heightened recognition of an increase in dental erosion has made some dental investigators ask, "Will chemical erosion be the next challenge to dental care?"

When erosion was combined with attrition, abrasion, and other forms of tooth surface wear, 80% of the primary incisors of children and 40% of occlusal surfaces of adults 50 years or older had discrete symptoms of clinical wear.[9,10] Increased consumption of acidic beverages and foods over extended periods of time has led to studies of chemically eroded enamel. Acid-eroded enamel has been shown to have increased sensitivity to mechanical abrasion and selective clinical wear at sites of wear from all sources.[11]

Some investigators have gone so far as to suggest that tooth brushing should be separated in time from eating and thus the traditional time to brush one's teeth. This perspective adds a new dimension to concern about the extent of mechanical cleaning of teeth with a toothbrush and toothpaste.

Figure 1. Scanning electron micrographic photos (magnification 2,000×) of sound human enamel surfaces acid-etched for 15, 35, and 75 seconds



Acid etching of enamel produces a mechanically friable and chemically reactive surface. The profilometer stylus tracking the surface profile is barely visible in the 15- and 35-second etched surface, but the 75-second etch in Figure 1 shows how friable the severely etched surface becomes.

Who values stain-free anterior teeth?

The answer is clear: almost everyone. An easy smile is an important part of conveying happiness, well-being, and friendliness. When children with cystic fibrosis were treated with tetracycline, one common side effect was severely discolored teeth. The children tried to talk with their mouths closed to hide them. Restorations to mask the discoloration of the anterior teeth made both children and parents happier and often improved general health.

The Dentifrice Function Program of the American Dental Association did a number of pilot studies with different populations to get a better understanding of the

necessity of mechanical abrasives in toothpaste formulations. The volunteer populations that were recruited included dental hygiene students, dental office staff, and the research staff of oral care product companies, as well as additional adult oral care study participants who joined the studies to earn a little extra money.[12,13,14,15]

A nonabrasive toothpaste was formulated with the usual detergent, binder, and flavor toothpaste ingredients, but with no abrasive added to the toothpaste. Subjects were asked to use the special toothpaste for six weeks.

Results: These pilot studies demonstrated vividly the necessity of including an abrasive system in toothpaste formulations, confirming the earlier commercial failure of a liquid, nonabrasive, detergent-based dentifrice.

In this study, the individual response to the stained teeth varied, but most subjects without a firm commitment to the research study withdrew early from the study, thus casting their votes for mechanically cleansing toothpaste. The female participants, who were more sensitive to the importance of a smile, typically used the nonabrasive toothpaste for two weeks and then exercised their option to withdraw without penalty from the study. The researchers showed their commitment and continued for the full six weeks of the study. Participants who joined for a little extra money gave mixed responses to the nonabrasive toothpaste depending upon personal situations.[16]

Some participants reported that they brushed their teeth longer at each brushing in an effort to get the desired dental stain removal-whiteness of their anterior teeth.[15]

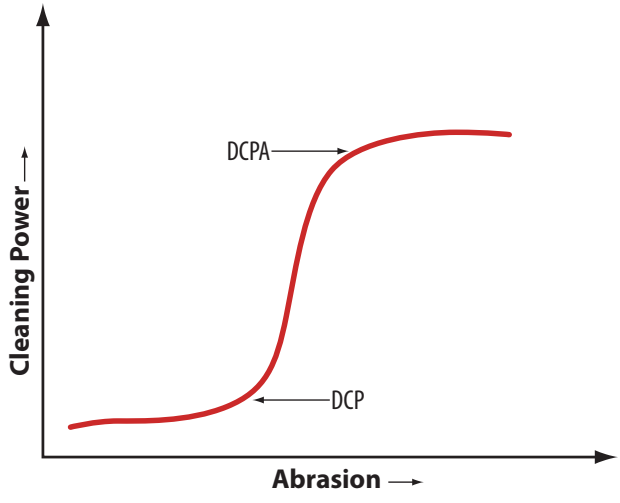
Relation of abrasion to cleaning power

The Dentifrice Function Program conducted a collaborative clinical study of dental stain at the Bloomington campus of Indiana University.[17] Custom-formulated, low-abrasivity tricalcium phosphate toothpaste was used to facilitate stain accumulation and to help with study participant selection. The ability to produce dental stain must be the first participant requirement for a dental stain study.

The participants who did accumulate adequate stain for study participation were stratified into two groups. One half of these individuals were given a dental prophylaxis. The two participant segments, one with clean teeth and one with stain accumulation, were then each stratified into three groups based upon the baseline stain accumulated when brushing with tricalcium phosphate. Each of the six groups (three with clean teeth and three with dental stain) was given one of three study toothpastes, i.e., low, medium, and high abrasivity. The pastes were formulated with graded mixtures of the lower-abrasivity dicalcium phosphate dihydrate and the higher-abrasivity anhydrous dicalcium phosphate. The anterior teeth of participants in the six groups were graded at baseline, two, four, and eight weeks to assess the stain uptake on the initially clean teeth at the start of the study and stain removal from the stained teeth to demonstrate the dental dynamics and equilibrium achieved with toothpaste differing in dentin abrasivity.

This study demonstrated for the abrasive systems with mixtures of dicalcium phosphate dihydrate and anhydrous dicalcium phosphate that mechanical abrasion was related to clinical cleaning power. In addition, dicalcium phosphate dihydrate was at the lower limit of abrasion that was acceptable for routine cleansing and dentin abrasivity greater than dicalcium phosphate anhydrous was not beneficial. This study and related studies led to the recognition that the abrasivity of anhydrous dicalcium phosphate was at the upper limit of useful abrasivity on dentin, the dental surface more sensitive than enamel to abrasion.

Figure 2. Cleaning power as a function of dentin abrasivity



Wülknitz reported the ratio of dentin abrasion to cleaning power for the toothpastes sold primarily in Europe to emphasize the importance of achieving the maximum cleaning with the minimum amount of abrasion.[18] Wülknitz used the ADA Radioactive Dentin Abrasion Method that is now included in the ISO 11609 Toothpaste Specification and the Indiana Cleaning Power Method to report the ratio of abrasion to cleaning power of about 0.7.[19,20,21] This correlation coefficient across a wide range of dentifrices used in Europe at that time indicated that mechanical abrasion was the major contributor to cleaning power, but there are exceptions to this conclusion.

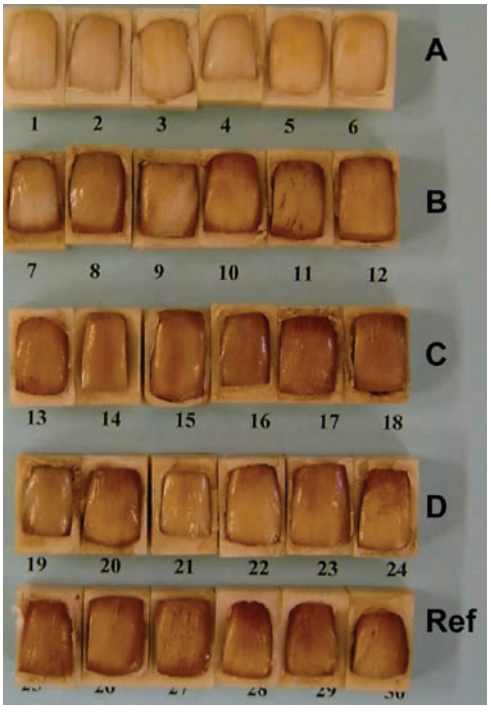
Cleaning power methods

The Indiana Cleaning Power Method is primarily sensitive to mechanical cleaning, but the method actually reports a combination of mechanical and chemical cleaning occurring during the 1,000 tooth brushing strokes used with this laboratory method.[21] A cyclic, nonbrushing model provided a measure of chemical cleaning with no

mechanical cleaning.[22] With calcium pyrophosphate as a reference, the abrasion-to-cleaning-power ratio of sodium bicarbonate was 10 times more effective than that of calcium pyrophosphate.

Using laboratory methods designed to measure the clinical functionality of toothpaste abrasive systems, dentin abrasivity and mechanical cleaning power, the chemical cleaning power of seven grades of sodium bicarbonate, were measured.[23]

Figure 3. Bovine teeth were acid-etched in tea stain prior to brushing with tested toothpastes and calcium pyrophosphate reference. Teeth in rows A to D were brushed with test pastes with a wide variety of abrasive systems. The teeth in row D were brushed with calcium pyrophosphate reference material.



Abrasion was measured with sodium bicarbonate in water and glycerine to simulate use in toothpaste and to determine the effect of water solubility on the measurement of abrasion. The cleaning power of these grades of sodium bicarbonate differing in particle size was measured using a modified Indiana Cleaning Power Method that includes 1,000 brushing strokes with a soft-bristle manual toothbrush.[21] A cyclic, nonbrushing laboratory method was used to measure chemical cleaning power of sodium bicarbonate. In this model, sodium bicarbonate demonstrated similar antistain activity to such agents as polyphosphates that clean by chelation.[22]

Conclusions from these studies were as follows:

- Sodium bicarbonate in various crystalline sizes has a very low dentin abrasivity. Mean abrasivity of seven grades of sodium bicarbonate particles was one ninth that of the abrasivity reference, calcium pyrophosphate.
- The mean ratio of abrasion to cleaning power (abrasion cleaning power) for the seven grades of sodium bicarbonate was 10.2, compared to 1.7 for calcium pyrophosphate.

There is little question based on these laboratory methods that sodium bicarbonate cleans teeth with much less abrasion than the ISO calcium pyrophosphate abrasivity reference material.

The very low dentin abrasion of sodium bicarbonate of 30 to 40, compared to the more typical 70 to 110 of toothpastes, has led to speculation on the mechanism of action occurring with sodium bicarbonate cleaning the tooth surface. The alkalinity of sodium bicarbonate and its interference with plaque adhesion are usually first-mentioned theories to explain its stain- and plaque-removal actions. Crystal size, shape, and hardness are usually used to explain correlations between crystal characteristics and abrasion achieved, but the good water solubility of sodium bicarbonate probably minimizes differences between crystal fractions. There was minimal difference in the abrasion and cleaning power of various grades of sodium bicarbonate in both abrasion and cleaning power, further suggesting that chemical cleaning is a major dental cleaning mechanism for sodium bicarbonate.

If one examines various cleaning uses of sodium bicarbonate over the years from silver table settings to refrigerators, it is difficult not to agree that sodium bicarbonate works by a combination of chemical and physical means and that mechanical abrasion is not the sole contributor to its action on silver or dental enamel.[23]

Newbrun summarized the utility of sodium bicarbonate in dentifrices as compatible with fluoride, bactericidal against most periodontal pathogens, and safe, as well as lower in abrasivity and cost. Thus he concluded that sodium bicarbonate was the consummate dentifrice ingredient.[24]

Summary and conclusions

- Dentifrices with the three major categories of abrasives are likely to be safe from a dentin and enamel abrasivity perspective and functional in their ability to clean teeth.
- Sodium bicarbonate is the least abrasive of the calcium phosphate, calcium carbonate, and silica abrasive systems in general use in today's dentifrices.
- The cleaning function of sodium bicarbonate is achieved by a combination of mechanical and chemical cleaning; thus sodium bicarbonate cleans with less abrasion.
- Trends in dietary patterns and personal life choices suggest that chemical erosion may alter the practice of dentistry and affect simple traditional methods such as brushing one's teeth after eating.

References

1 Kitchin PC, Robinson HBG. How abrasive need a dentifrice be? J Dent Res. 27: 501–506, 1948.
2 Hefferren J. How abrasive should toothpaste be? Pharmacy Times. 50–52, 1974.
3 Robinson HBG. Individualizing dentifrices: The dentist's responsibility. JADA 79: 633–636, 1969.
4 Miller WD. Experiments and observations on the wasting of tooth tissue variously described as erosion, abrasion, chemical abrasion, denudation, etc. Dent Cosmos. 49: 1–23, 109–124, 225–247, 1907.
5 Donachie MA, Walls AW. Assessment of tooth wear in an aging population. J Dent 23: 157–164, 1995.
6 Pontefract HA. Erosive toothwear in the elderly population. Gerodontology 19: 5–16, 2002.
7 Lussi A, Jaeggi T, Zero D. The role of diet in the aetiology of dental erosion. Caries Res. 38 (Suppl 1) 34–44, 2004.
8 Zambon JJ, Mather ML, Gonzales Y. A microbiological and clinical study of the safety and efficacy of baking soda dentifrices. Compend. 18:(Suppl. No. 21) 539–544, 1998.
9 Millward A, Shaw L, Smith AJ, et al. The distribution and severity of tooth wear and the relationship between erosion and dietary constituents in a group of children. Int J Paediatr Dent. 4: 151–157, 1994.
10 Lussi A, Schaffner M, Hotz P, et al. Dental erosion in a population of Swiss adults. Community Dent Oral Epidemiol. 19: 286–290, 1991.
11 Hunter ML, Addy M, Pickles MJ, et al. The role of toothpastes and toothbrushes in the aetiology of tooth wear. Int Dent J. 52: 399–405, 2002.
12 Lobene R, Hefferren J, and Dentifrice Function Committee. Clinical response of non-abrasive dentifrice use in dental hygienists. J Dent Res.75:88 (1996).
13 Schiff T, Hefferren J, Dentifrice Function Committee. Clinical response of nonabrasive dentifrice use in adult males. J Dent Res. 75:87 (1996).
14 Cooley WE, Sturzenberger P, Hefferren J, Dentifrice Function Committee. Clinical response of non-abrasive dentifrice use in adults. J Dent Res. 75:87 (1996).
15 Cancro L, Charles C, Hefferren J, Dentifrice Function Committee. Nonabrasive and moderate abrasivity dentifrice use in adult females. J Dent Res. 75:87 (1996).
16 Hefferren J, Dentifrice Function Committee. Clinical studies to determine clinical response to nonabrasive dentifrice use. J Dent Res.: 75:45 (1996).
17 American Dental Association Health Foundation Research Institute: Clinical methods for determining dentifrice cleaning ability. JADA 109: 759–762, 1984.
18 Wülknitz P. Cleaning power and abrasivity of European toothpastes. Adv Dent Res. 11: 576–579, 1997.
19 Hefferren J. A laboratory method for assessment of dentifrice abrasivity. J Dent Res. 55:563–573, 1976.
20 International Standards Organization ISO 11609, 1995 Dentistry—toothpaste—requirements, test methods and marking.
21 Stookey GK, Burkhard TA, Schemehorn BR. In vitro removal of stain with dentifrices. J Dent Res. 61: 1236–1239, 1982.
22 Smith J, Ersen E, Coffman L, Berg ML, Hefferren J. Cyclic laboratory model to measure the chemical cleaning powder of seven grades of sodium bicarbonate. J Dent Res. 82:A #384, 2003.
23 Berg ML, Ersen E, Smith J, Coffman L, Hefferren J. Clinical functionality of seven grades of sodium bicarbonate in the same toothpaste formulation. J Dent Res. 82:A #386, 2003.
24 Newbrun E. The use of sodium bicarbonate in oral hygiene products and practice. Compend Contin Educ Dent. (Suppl. No. 21) 52–57, 1997.

Author Profile

John J. Hefferren

Dr. Hefferren graduated from Loyola University, Chicago in 1950 with a BS in chemistry with mathematics and physics minors. He continued his studies at the University of Wisconsin, Madison, achieving an MS and Ph.D. in pharmaceutical chemistry with minors in organic and biochemistry. From 1954 to 1959, he was with the American Medical Association, Chicago, after which he joined the American Dental Association, Chicago, where he remained until 1986. Dr. Hefferren taught at Northwestern University, Chicago from 1956 to 1986 as a professor of oral biology. Since 1986, he has been a research professor at the University of Kansas, Lawrence.

Currently, Dr. Hefferren remains a research professor as well as president of Odontex, Inc., Lawrence, KS Research Consultants. His research interests include oral care agent assessment methods; site-specific, controlled release drug delivery systems for intraoral/systemic functionality; and oral and systemic aspects of nutraceuticals and custom foods.

Na Li, Ph.D.

Dr. Li is an Associate Professor in the Analytical Chemistry, College of Chemistry, Peking University, Beijing, China. Her focus has been spectroscopy with emphasis on fluorescence and phosphorescence. Her work with me has been on developing and verifying laboratory models to predict the clinical functionality of oral care agents. Our collaboration has been on developing and characterizing enamel surface changes resulting from exposure to acids. Exposure causes increased surface fragility and porosis from one perspective, but this situation sets up the opportunity to restore the surface in perhaps a more functional manner to combat the rigors of the daily reactive oral milieu.

Dr. Na Li received her BS in chemistry at Peking University. She received her MS and Ph.D. in analytical chemistry from the College of Chemistry when she focused on spectroscopy. She was a postdoctoral student in Bioanalytical Chemistry, Department of Pharmaceutical Chemistry, University of Kansas, Lawrence.

Disclaimer

The authorsof this course have no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course.

Reader Feedback

We encourage your comments on this or any PennWell course. For your convenience, an online feedback form is available at www.ineedce.com.

Questions

1. Which of the following statements is not true?
   a. Dentifrice abrasives offer patients benefits for both oral health and personal appearance.
   b. Dentifrice abrasives help prevent gum disease by removing some of the plaque that accumulates through normal eating and drinking.
   c. The main purpose of dentifrice abrasives is to aid in the prevention of xerostomia.
   d. Dentifrice abrasives remove stains from the teeth, allowing people to smile with confindence.

2. Which material is not a dentifrice abrasive?
   a. Resilon
   b. Phosphates
   c. Carbonates
   d. Silicas

3. What is the main purpose of phosphates?
   a. Halitosis therapy
   b. To leave the teeth looking white and feeling clean
   c. Prevention of gum recession
   d. None of the above

4. Heat-treating calcium pyrophosphate has what net effect on fluoride ion availability?
   a. Increases it
   b. Decreases it
   c. No effect

5. The calcium ions in calcium pyrophosphate limit the amount of soluble fluoride in toothpaste to?
   a. 8 parts per million
   b. 7 parts per million
   c. 6 parts per million
   d. 5 parts per million

6. According to the article, sodium bicarbonate has been used as a dentifrice abrasive since:
   a. The 1920s
   b. The 1940s
   c. The 1960s
   d. The 1980s

7. According to the article, precipitated chalk is more abrasive than mined salt.
   a. True
   b. False

8. What is calcium carbonate more commonly known as?
   a. Sand
   b. Cellulose
   c. EDTA
   d. Chalk

9. Which of the following is NOT true of sodium fluoride?
   a. It is compatible with silicas.
   b. It provides soluble fluoride.
   c. It is also known as CalPyro.
   d. It is compatible with sodium bicarbonate.

10. In calcium carbonate, like calcium phosphates, the calcium ion limits soluble fluoride in toothpaste to 7 ppm.
    a. True
    b. False

11. Silicas are only available in one particle size.
    a. True
    b. False

12. Besides mechanically cleaning the teeth, what else do silicas do?
    a. Act as a thinner in toothpaste
    b. Preserve the color of the toothpaste
    c. Act as a thickening agent
    d. None of the above

13. What are the two main components of teeth?
    a. Enamel
    b. Dentin
    c. Both a and b
    d. None of the above

14. Which is harder, enamel or dentin?
    a. Dentin
    b. Enamel

15. Dentin has about one fourth the hardness of enamel.
    a. True
    b. False

16. Which of the following statements is true?
    a. Human dentin receives no blood supply.
    b. Human enamel receives a blood supply.
    c. Human enamel receives no blood supply.
    d. None of the above.

17. Intact, sound enamel is mechanically resistant to which abrasives?
    a. Phospates
    b. Carbonates
    c. Silicas
    d. All of the above

18. Phosphates and chalks are mechanical tooth cleansers and generally biologically inert.
    a. True
    b. False

19. Can the divalent calcium ion available from calcium phosphates and calcium carbonates react with anions like fluoride to limit solubility?
    a. Yes
    b. No

20. According to the article, the monofluorophosphate ion is _____ in the mouth to release fluoride.
    a. Ionized
    b. Hydrolyzed
    c. Accumulated
    d. Covalent

21. Why has silica been the most frequently used toothpaste abrasive in recent years?
    a. It chemically reacts aggressively with other toothpaste ingredients.
    b. It comes in a variety of colors.
    c. It is largely physically or chemically nonreactive with other toothpaste ingredients.
    d. None of the above.

22. Ingredients that use dentifrice abrasives are generally considered safe. If there is concern, what is the focus usually directed toward?
    a. The degree of sweetener content
    b. The degree of tooth surface abrasion, in particular on dentin
    c. The degree of whitening achieved
    d. None of the above

23. Increased consumption of acidic beverages and foods over extended periods of time has led to studies that focus on?
    a. Chemically eroded enamel
    b. Veneer preparation techniques
    c. Smoking and its link to oral cancer
    d. None of the above

24. An easy smile is an important part of conveying what?
    a. Happiness
    b. Well-being
    c. Friendliness
    d. All of the above

25. What were the clear results from the Dentifrice Function Program of the American Dental Association?
    a. Abrasives were not needed.
    b. The pilot studies demonstrated vividly the necessity of including an abrasive system in toothpaste formulations.
    c. Both a and b
    d. None of the above

26. As cited in the Indiana Cleaning Power Method, sodium bicarbonate had a ____ fold more effective abrasion-to-cleaning-power ratio than calcium pyrophosphate.
    a. two
    b. four
    c. ten
    d. twenty

27. Does sodium bicarbonate clean teeth with less or more abrasion than calcium pyrophosphate?
    a. More
    b. Less

28. What is the abrasion rating of sodium bicarbonate?
    a. 10–20
    b. 30–40
    c. 35–45
    d. 40–50

29. Does the alkalinity of sodium bicarbonate interfere with the adhesion of plaque?
    a. Yes
    b. No

30. What did Newbrun summarize about the utility of sodium bicarbonate?
    a. It is compatible with fluoride.
    b. It is bactericidal against most periodontal pathogens.
    c. It is safe as well as lower in abrasivity.
    d. All of the above.

ANSWER SHEET

Dentifrice Abrasives: Heroes or Villains?

Name: Title: Specialty:

Address: E-mail:

City: State: ZIP:

Telephone: Home ( ) Office ( )

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Know the different types of dentifrice abrasives
2. Understand the efficacy of the different types of dentifrice abrasives
3. Understand the safety of the different types of dentifrice abrasives

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met? Objective #1: Yes No Objective #2: Yes No Objective #3: Yes No

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0

8. Do you feel that the references were adequate? Yes No

9. Would you participate in a similar program on a different topic? Yes No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

_____

11. Was there any subject matter you found confusing? Please describe.

_____

_____

12. What additional continuing dental education topics would you like to see?

_____

_____

Mail completed answer sheet to

Academy of Dental Therapeutics and Stomatology,
A Division of PennWell Corp.
P.O. Box 116, Chesterland, OH 44026
or fax to: (440) 845-3447

For IMMEDIATE results, go to www.ineedce.com and click on the button "Take Tests Online." Answer sheets can be faxed with credit card payment to (440) 845-3447, (216) 398-7922, or (216) 255-6619.

☐ Payment of $59.00 is enclosed.
(Checks and credit cards are accepted.)

If paying by credit card, please complete the following: ☐ MC ☐ Visa ☐ AmEx ☐ Discover

Acct. Number: _____

Exp. Date: _____

Charges on your statement will show up as PennWell

1.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		16.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		17.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		18.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ		30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

AGD Code 017

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

AUTHOR DISCLAIMER
The authors of this course have no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course.

SPONSOR/PROVIDER
This course was made possible through an unrestricted educational grant. No manufacturer or third party has had any input into the development of course content. All content has been derived from references listed, and or the opinions of clinicians. Please direct all questions pertaining to PennWell or the administration of this course to Machele Galloway, 1421 S. Sheridan Rd., Tulsa, OK 74112 or macheleg@pennwell.com.

COURSE EVALUATION and PARTICIPANT FEEDBACK
We encourage participant feedback pertaining to all courses. Please be sure to complete the survey included with the course. Please e-mail all questions to: macheleg@pennwell.com.

INSTRUCTIONS
All questions should have only one answer. Grading of this examination is done manually. Participants will receive confirmation of passing by receipt of a verification form. Verification forms will be mailed within two weeks after taking an examination.

EDUCATIONAL DISCLAIMER
The opinions of efficacy or perceived value of any products or companies mentioned in this course and expressed herein are those of the author(s) of the course and do not necessarily reflect those of PennWell.

Completing a single continuing education course does not provide enough information to give the participant the feeling that s/he is an expert in the field related to the course topic. It is a combination of many educational courses and clinical experience that allows the participant to develop skills and expertise.

COURSE CREDITS/COST
All participants scoring at least 70% (answering 21 or more questions correctly) on the examination will receive a verification form verifying 4 CE credits. The formal continuing education program of this sponsor is accepted by the AGD for Fellowship/Mastership credit. Please contact PennWell for current term of acceptance. Participants are urged to contact their state dental boards for continuing education requirements. PennWell is a California Provider. The California Provider number is 3274. The cost for courses ranges from $49.00 to $110.00.

Many PennWell self-study courses have been approved by the Dental Assisting National Board, Inc. (DANB) and can be used by dental assistants who are DANB Certified to meet DANB's annual continuing education requirements. To find out if this course or any other PennWell course has been approved by DANB, please contact DANB's Recertification Department at 1-800-FOR-DANB, ext. 445.

RECORD KEEPING
PennWell maintains records of your successful completion of any exam. Please contact our offices for a copy of your continuing education credits report. This report, which will list all credits earned to date, will be generated and mailed to you within five business days of receipt.

CANCELLATION/REFUND POLICY
Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell in writing.