

0319. Development of an *In Vitro* Model for Tenacious Denture Stain

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Introduction

Aside from denture malodor, denture stain is one of the most prominent and outwardly visible concerns of the denture wearer. However, the literature lacks published *in vitro* stain models for dentures. In the development of denture cleansing products, a standard method for staining is necessary for accurate comparison of cleaning efficacy. Furthermore, development of a tenacious and robust stain model is paramount to differentiating among cleaning methods, particularly when the mechanical action of brushing is involved.

Objective

This work focuses on developing a tenacious stain on denture acrylic that will withstand the mechanical action of brushing while allowing for differentiation of cleaning efficacy.

Methods

Surface abrasion

White, opaque, acrylic slides (Allied Plastics #7328) were abraded using various means and media. Four means of abrasion were investigated, including:

- Sandblasting via glass beads
- Sandblasting via coal grit
- Sanding via belt sander
- Power sanding with Scotch-Brite pads.

Unabraded, glossy slides served as the control.

Plaque growth

Slides were treated with a hot detergent bath for 1 hour to disinfect the slides. The slides were rinsed well under tap water and allowed to dry. A bacterial broth was prepared and autoclaved for 15 minutes at 121°C, 15 psi. After cooling to room temperature, the broth was inoculated with human saliva. This mixture was poured over the prepared slides, abraded side up.

After incubation at 37°C overnight (at least 18 hours), the slides were carefully removed from the media and dipped in deionized water to remove traces of broth. Slides were allowed to dry at room temperature.

Stain composition

A food-based stain composed of heavily staining ingredients included blueberry pie filling, red wine, coffee, and tea. This mixture was poured over slides with dried plaque growth and the slides were allowed to stain overnight at room temperature.

Extended stain protocol

Most denture wearers admit to soaking their dentures in a cleanser approximately two to three times per week. Therefore, three methodologies were developed to accommodate this behavior. In the first, slides underwent 3 continuous days of uninterrupted plaque growth. In the second, slides underwent three alternating cycles of plaque growth followed by stain. Lastly, plaque was allowed to grow on denture slides for three consecutive cycles of overnight plaque growth with adequate drying time between cycles. After completion of three plaque-growing periods, slides were stained using the above food-based stain.

Cleaning protocol

One set of slides was dipped in water and lightly brushed with an Oral-B soft toothbrush for 20 strokes. The second set of slides was dipped in water, and lightly brushed using Polident Fresh Cleanse for 20 strokes. To examine more realistic brushing conditions, two more sets of slides were cleaned with water or Polident Fresh Cleanse by brushing vigorously for 10 seconds.

Measurement of cleaning efficacy

A Photovolt Reflection Meter (model 577) was equipped with search unit, a tricolor sensing head, and a blue filter. The Photovolt was used to determine the reflectance of the stain before and after cleaning. Measurements were taken at three arbitrary locations across each slide. Measurements of five unstained, unabraded slides were also recorded.

Cleaning efficacy was determined according to the equation below:

$$D = \frac{C - A}{B - A} * 100$$

where:

- D = percent stain removed
- A = reflectance reading of stained acrylic slides (control)
- B = reflectance reading of unstained acrylic slide
- C = reflectance reading of cleaned acrylic slides.

Results

● Surface abrasion

The means of surface abrasion had a significant effect on the appearance of the slides as well as the adhesion of the biofilm. The sandblasted slides produced an evenly abraded surface, similar in appearance to frosted glass. Samples treated with the belt sander showed a linear type of abrasion, with deep and shallow abrasions, whereas the Scotch-Brite slides showed arching lines from the power sander. Several of the Scotch-Brite samples exhibited residual dirt and grime from the abrasion process as well as minor detriment to slide integrity. These variations gave cause to dismiss Scotch-Brite as an appropriate means of abrasion.

● Stain tenacity

Results from cleaning the abraded slides are shown in Figure 1. Abrasion of the denture acrylic slides caused greater tenacity of the plaque and stain onto the material. Light manual brushing with a soft toothbrush was able to remove more than 90% of the stain from an unabraded slide, whereas less than 50% of the stain was removed from a slide abraded by sandblasting with coal grit. Additionally, with more vigorous brushing, the greatest differentiation between cleaning with water or Polident Fresh Cleanse was witnessed on slides sandblasted with coal grit. Therefore, slides treated with coal grit would be most likely to demonstrate differences in cleaning efficacy for various denture care products that incorporate brushing.

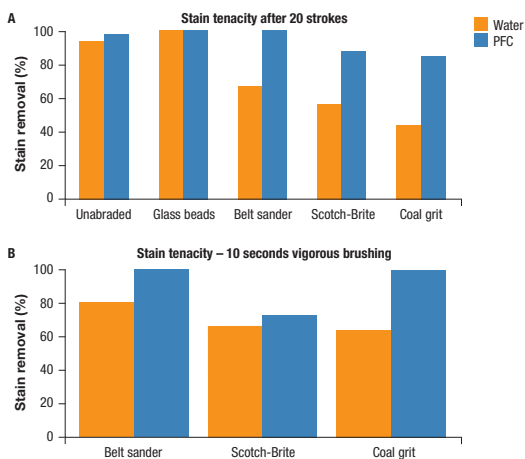


Figure 1. Stain tenacity on abraded slides after 20 strokes (A) and after 10 seconds of vigorous brushing (B). PFC, Polident Fresh Cleanse.

● Extended surface stain

Slides that underwent continuous plaque growth produced very inconsistent biofilms, whereas slides that experienced plaque growth with drying produced very even and robust biofilms. Staining of these slides resulted in a bold stain not easily removed by brushing (Figure 2).

After 20 strokes of light brushing, the stain tenacity between the two methods was not obvious. However, with vigorous brushing, the greater differentiation between stain methods was demonstrated with three overnight plaque growth cycles followed by one overnight stain cycle. This method showed a difference of almost 20% between water and Polident Fresh Cleanse. This method was selected as the most robust and tenacious.

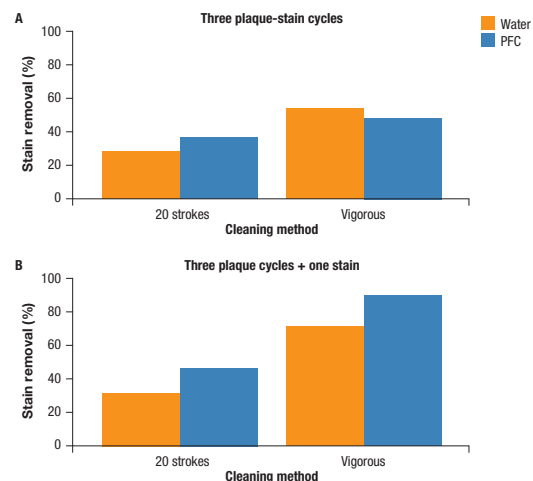


Figure 2. A comparison of stain removal as a function of stain methodology. (A) Three cycles of alternating plaque and stain. (B) Three overnight plaque cycles followed by one overnight stain. PFC, Polident Fresh Cleanse.

Conclusions

- A novel *in vitro* method for staining and cleaning denture material was developed.
- The most tenacious stain was grown on acrylic slides abraded with coal grit, producing a consistently rough surface for improved biofilm adhesion.
- Stain grown on three consecutive layers of overnight plaque growth proved to create the most robust and tenacious stain, allowing for differentiation of cleansers used with brushing.

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