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CLEANING PROCEDURES FOR SMALL DENTAL INSTRUMENTS PRIOR TO STERILIZATION

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Abstract

Observations were made in an institutional setting on the quality of cleaning of dental burs. Assessments were made by scanning electron microscopy of surface contamination and change to the surface quality of burs before and after use, and as a result of different cleaning procedures.

The most significant finding was the corrosive action on carbon steel burs of a phosphoric acid based cleaning solution in routine use at the time. We show by comparison the effectiveness and non-corrosive nature of an alternative detergent based on sulfamic acid, and propose a suitable cleaning routine.

Two other findings are presented: new burs as unpackaged are unacceptable for use without first being subjected to a cleaning process (we recommend a suitable procedure); and there is a need for distilled water rather than tap water rinsing after detergent use.

It is an important part of an institution's responsibility to monitor cleaning, sterilizing and supply services; the scanning electron microscope is a valuable adjunct in this aspect of quality assurance.

KEY WORDS: Dental Instruments, Burs, Effect of Use, Decontamination, Sterilization, Cleaning Solutions, Ultrasonics.

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Introduction

At the Westmead Hospital Dental Clinical School, a central sterilizing unit services the everyday needs of 180 clinical chair positions and 4 operating rooms. At the time of commencement of this study, all non-fixed instrumentation was processed through this central sterilizing unit after each use and prior to re-distribution. The protocols for cleaning and sterilization introduced by the unit manager (PM) were based on many years of operating room experience in major hospitals.

As the Dental School is a relatively new facility, it seemed reasonable to assess the effectiveness of the cleaning procedures employed; especially as the sterilizing and packaging phases following decontamination are routinely assessed for their effectiveness through standardized, hospital-wide, infection control procedures.

The problem of dealing with or assessing bur corrosion is not new. McLundie (1974) examined, amongst other things, the effect of immersion of tungsten carbide burs in various chemical solutions. The study found that prolonged immersion produced signs of attack for all six solutions studied.

It is known that during autoclaving of carbon steel instruments, iron reacts with oxygen and water to produce ferrous hydroxide with the $Fe(OH)_2$ appearing as a blackish-green rust on the instrument surface. In an attempt to deal with this, several dip-applied corrosion inhibitors have been studied including 2% sodium nitrite for non-wrapped instruments (Bertollotti and Hurst, 1978). Walsh (1979) tried various different wrap cloths in an attempt to reduce this autoclave-induced corrosion. This contributory component of bur corrosion is not a consideration in our institution as burs are wrapped in foil and hot air sterilized for 1 h.

Ultrasonication has been shown to improve greatly both the removal of dentine filings from endodontic instruments (Lester and Boyde, 1977) and the efficacy of glutaraldehyde in destroying bacterial spores on small dental instruments (Warfield and Bryington, 1982). Harkness and Davies (1983) tested a number of proprietary solutions with and without ultrasonication for relative efficiency in removing abraded tooth particles from diamond burs. The conclusions reached were that: i) ultrasonication is a rapid, effective and convenient method of rendering diamond burs absolutely clean; and ii) surface active agents appear to be the most effective cleaning solutions.

Rather than a discrete, self-contained study, this paper is part of a series of observations made over a period of time in a large institutional setting in an ongoing attempt to assess and to improve the quality of the cleaning of small dental instruments, more particularly dental burs. The assessments were made solely by scanning electron microscopy (SEM) of surface contamination and of progressive change to the quality of the surface of the burs. Bacteriological testing was not a part of this study which focusses on the degree of visible surface contamination before and after use of certain burs and the effect on the bur surface of certain cleaning solutions. The aim was to find, with certain procedures, the cleanest surface on the basis that an instrument must be cleaned in order to be sterilized. The pragmatic significance of the highest degree of cleanliness at these levels of magnification is arguable to some; nevertheless, that level was consciously accepted as the parameter for this study.

Materials and Methods

The assessment of burs at various stages of presentation and use and after various cleaning procedures was undertaken in the following sequence (see also Table 1): 1. burs as presented from their packaging (either single or multiple in plastic containers); 2. effect of cleaning of a used bur with a commercial phosphoric acid (PA) based detergent ("Dilac": Diversey Pty. Ltd., Seven Hills, N.S.W.); 3. effect of various concentrations of the PA detergent for cleaning procedures; 4. effect of a commercial sulfamic acid (SA) based detergent ("Dentac": Whitely Chemicals, Chippendale, N.S.W.); 5. effect of varying the washing and drying procedures after detergent use; and, 6. effect of the final washing agent and storage time. Every experimental sequence and its evaluation was repeated a minimum of three times.

The commercial phosphoric acid (PA) based solution is a medium foaming acidic detergent containing w/w phosphoric acid 33.6%; acetic acid 1.75%; and surfactant 2.0%. The solution is widely used in the Dairy Industry for the removal of milkstone build-up on milk-processing equipment of which stainless steel is a major component.

The commercial sulfamic acid (SA) based solution is a newly developed detergent containing w/w sulfamic acid (amidosulphonic acid - $H_2N.SO_3.H$) 16.5% and non-ionic surfactant 4%. Sulfamic acid in solution slowly hydrolyzes forming ammonium bisulphate (Merck, 1940; Sax, 1979); it is regarded as a "soft" or "slow" acid.

Burs as presented from their packaging (see No Cleaning - 1, Table 1).

Unused burs were examined directly in the SEM from their packaging without any preparation, cleaning or coating. The burs were chosen to represent a cross-section of the range in use at the time throughout the Dental School: (i) Ash

Table 1: Abbreviated listing of methods

No Cleaning

1. unused burs from packaging

Cleaning

PA Detergent

2. unused bur + Procedure 1*, then: same bur after use + Procedure 2#
3. unused burs + Procedure 1* + Procedure 2# with different combinations of PA concentration and ultrasonicator time.

SA Detergent

4. unused burs + Procedure 1* + Procedure 2#
5. unused burs + Procedure 1* + Procedure 2# with variable tap water and distilled water washing and ethanol rinsing after the distilled water.
6. unused burs + Procedure 1* + Procedure 2# with variation to compare tap water to distilled water wash with time.

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*Procedure 1

a) ultrasonicate 4 mins 70% ethanol; b) hot air dry.

#Procedure 2

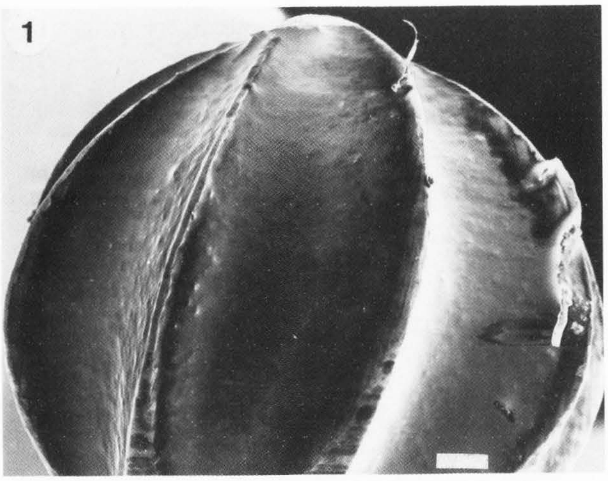
a) place in 50/50 dilution of detergent and tap water; b) ultrasonicate 4 mins; c) wash in water; d) rinse in 70% ethanol; e) hot air dry.

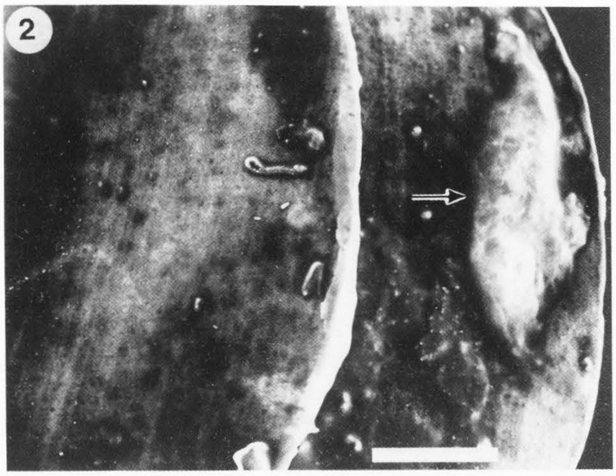
("Ash": Dentsply Ltd., Weybridge, Surrey, England) round, size 3, HP - carbon steel (Rd.P.C.3 1/ 012[3]); (ii) Ash flat fissure, size 8, HP - carbon steel (F.F.X.C.8 36/ 023[563]); (iii) Komet ("Komet": Gebr. Brassler GMBH & Co., Lenco, W. Germany) carbide tapering fissure, HP - tungsten carbide (H33/ 016); (iv) Star ("Star": Syntex Dental Products, Inc., Valley Forge, PA) WM2- XF, FG - diamond (Item 0654- 062182); (v) Ash plug finishing, pear, size 1, RA - carbon steel (identified by manufacturer as Fig 47[230]).

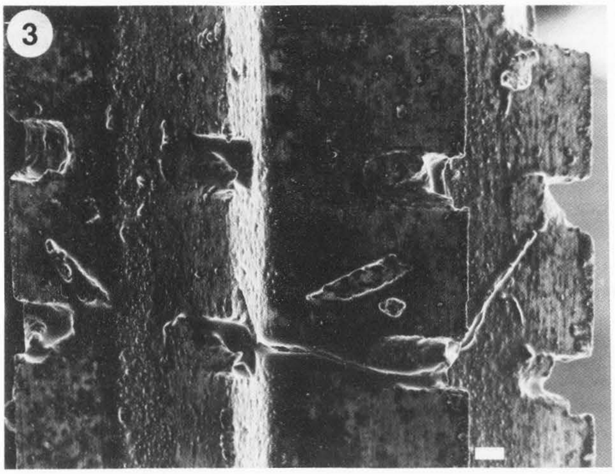
Effect of PA detergent and bur use (see Cleaning - 2, Table 1)

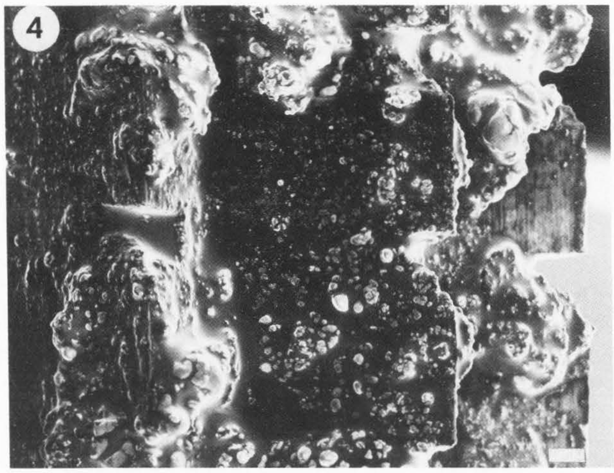
An Ash plug finishing bur - (v) above - was examined before use as unpackaged; after initial cleaning; after use in the normal way for preparation for polishing of the carved surface of an amalgam restoration in an extracted tooth; and then again after subsequent cleaning in PA detergent.

The cleaning procedure, in standard use at that time, was in two parts: before and after initial distribution.









Figs. 1 to 7 are of unused burs examined by SEM direct from their packaging, uncleaned and uncoated.

Fig. 1. An unused carbon steel round bur (i) covered with a film of grease and oil with several non-metallic filaments attached. Bar = 100 μm.

Fig. 2. Higher magnification of a similar bur (i) to Fig. 1 showing bubble formation in the film coating (at arrow). Bar = 100 μm.

Fig. 3. An unused flat fissure carbon steel bur (ii) showing film over surface and attached thread. Bar = 100 μm.

Fig. 4. Higher magnification of a similar bur (ii) to Fig. 3 showing accumulated particulate matter embedded in the film coating. Bar = 100 μm.

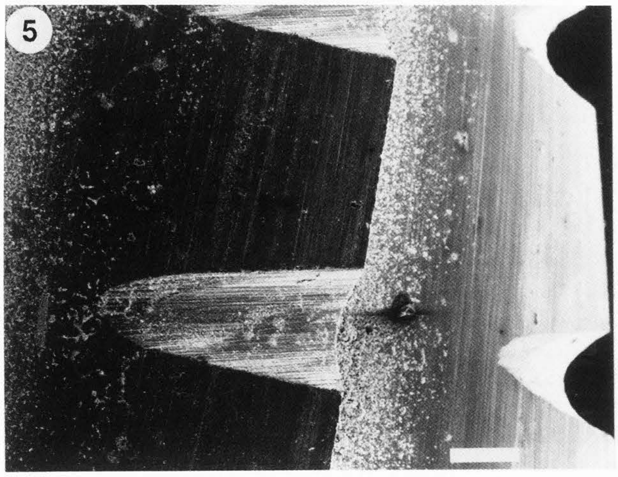
Before distribution (Procedure 1, Table 1): a) bur ultrasonicated for 4 mins in 70% ethanol; and b) hot air dried.
After distribution and use - (Procedure 2, Table 1): a) bur placed in a 50/50 dilution of (PA) detergent and tap water; b) ultrasonic cleaning for 4 mins; c) generous rinsing in tap water; d) generous rinsing in 70% ethanol; and, e) hot air dried.

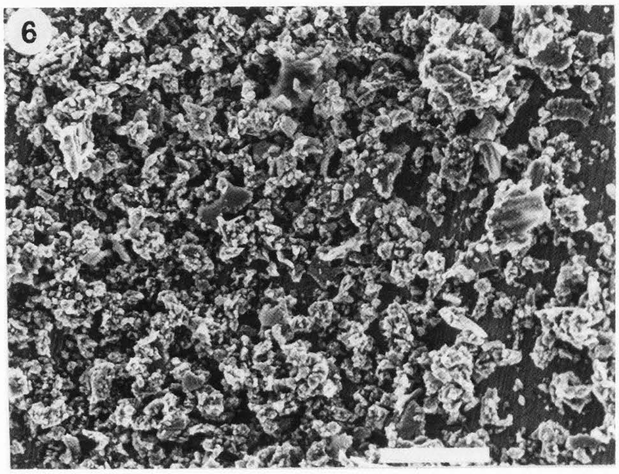
Effect of varying the concentration of, and time of exposure to PA detergent (see Cleaning - 3, Table 1)

Unused Ash round 3 burs - (i) above - were exposed for comparative purposes to the following four sequences after initial cleaning (Procedure 2): a) a 1/ 20 dilution of PA detergent and tap water; ultrasonication for 1 h to provide an extreme degree of exposure; rinsing in tap water; rinsing in 70% ethanol and hot air drying; b) a 1/ 40 dilution of PA detergent and tap water; ultrasonication for 4 mins; rinsing in tap water; rinsing in 70% ethanol and hot air drying; c) a 1/ 20 dilution of PA detergent and tap water; no ultrasonication - soaking only; rinsing in tap water; rinsing in 70% ethanol and hot air drying; and d) a 1/400 dilution of PA detergent and tap water; 4 mins ultrasonication; rinsing in tap water; rinsing in 70% ethanol and hot air drying.

Effect of SA detergent (see Cleaning - 4, Table 1)

The following procedure was an attempt to compare the effects of the PA detergent (above) with the SA detergent. Unused Ash round 3 burs - (i) above - were exposed to a 70% ethanol solution, ultrasonicated for 4 minutes, and hot air dried; and b) after this initial cleaning,





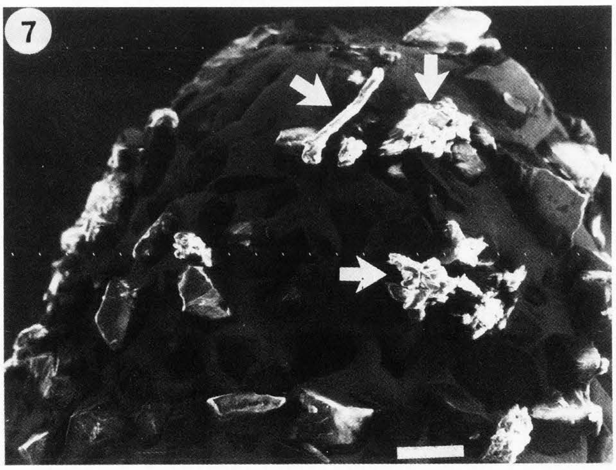


Fig. 5. An unused tungsten carbide fissure bur (iii) with fine debris accumulated along the longitudinal flutes. Bar = 100 µm.

Fig. 6. Higher magnification of the same bur (iii) as in Fig. 5 showing the crystalline debris along the flute. Bar = 10 µm.

Fig. 7. An unused diamond bur (iv) showing non-conductive fibrous debris (at arrows) between the diamond particles (the print is purposefully at a low contrast level to compensate). Bar = 100 µm.

exposed to a 1/ 20 dilution of SA detergent, ultrasonicated for 4 minutes, rinsed in tap water, rinsed in 70% ethanol and hot air dried.

Effect of varying the washing and drying procedures after detergent use (see Cleaning - 5, Table 1)

Unused Ash round 3 burs - (i) above - were initially cleaned (Procedure 1) and then variously washed in distilled water and tap water after ultrasonication in the SA detergent. An assessment was made of the effect of rinsing subsequently in 70% ethanol prior to hot air drying. To do this, burs were, after 4 mins ultrasonication in a 1/ 20 dilution of the SA detergent in tap water: a) washed in tap water and hot air dried; b) washed in distilled water and hot air dried; and c) washed in distilled water; rinsed in 70% ethanol and hot air dried.

Effect of storage time on variously washed burs (see Cleaning - 6, Table 1)

In order to assess the effect of time of storage on decontaminated burs, unused Ash round 3 burs - (i) above - were, after initial cleaning, ultrasonicated for 4 mins in a 1/20 dilution of the SA detergent and then: a) washed in tap water and hot air dried; and b) washed in distilled water and hot air dried. Both sets were put aside for 18 days under cover in normal storage conditions before being examined.

All burs in this study were examined uncoated in a JEOL 840 SEM at 15 kV. Stereo-pair images were recorded at 5^{o} or 10^{o} tilt, where appropriate.

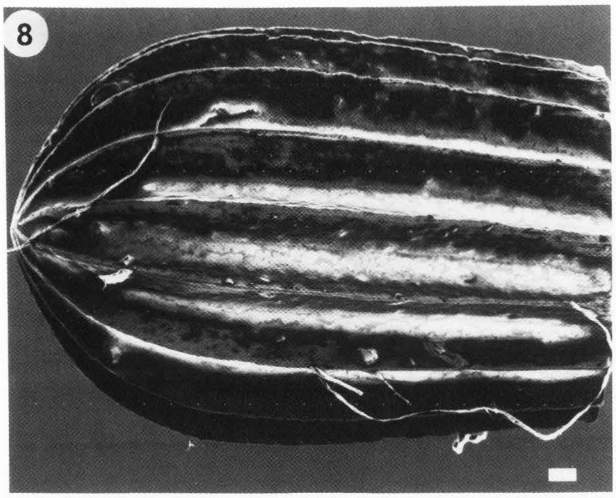
Results

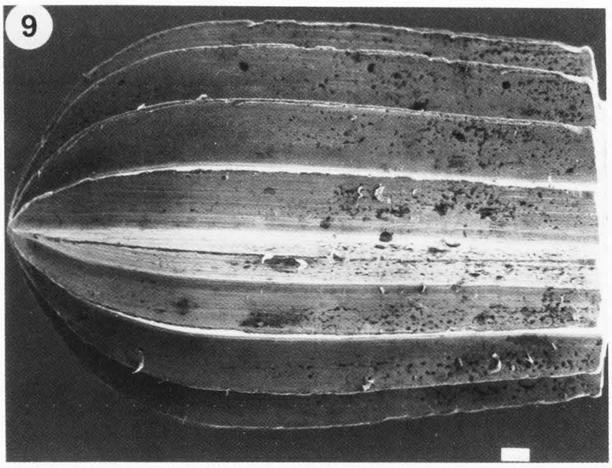
The illustrations accompanying the text are representative of the many images obtained for each of the burs and stages assessed.

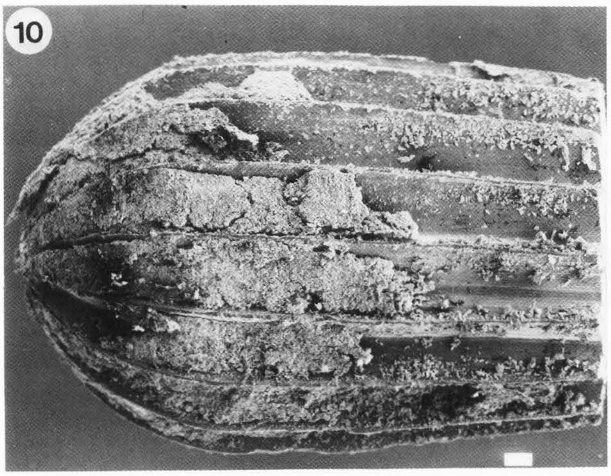
Burs as presented from their packaging (see No Cleaning - 1, Table 1)

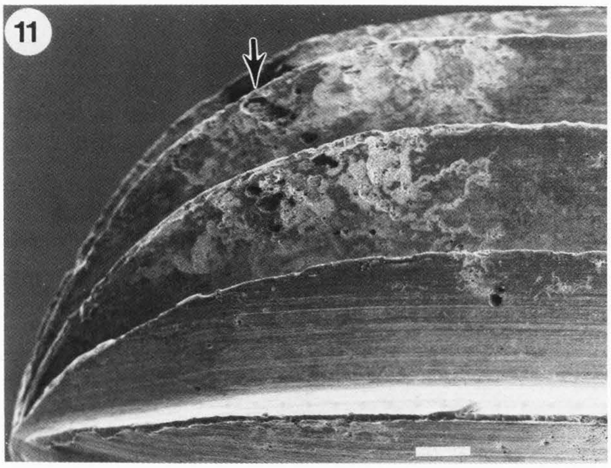
All the different burs - (i) to (v) - examined direct from their packaging showed some kind of surface contamination. The most affected were carbon steel burs (i), (ii) and (v); these appeared coated by a film of grease or oil which obscured the grain structure of the metal (Figs. 1, 2). In addition, strands of what appeared to be non-metallic material (? plastic or cotton fibre) were attached to the bur surface (Figs. 1, 3). Heavy contamination by relatively gross particulate matter was common on the large fissure burs (ii) examined (Fig. 4). Bur (iii) whilst of higher quality manufacture, of tungsten carbide and cleaner overall, nevertheless commonly displayed fine particulate debris accumulated along the longitudinal flutes (Figs. 5, 6). The debris typical of the surface of the unused diamond burs was of a more fibrous kind (Fig. 7).

Effect of PA detergent and bur use (see Cleaning - 2, Table 1)









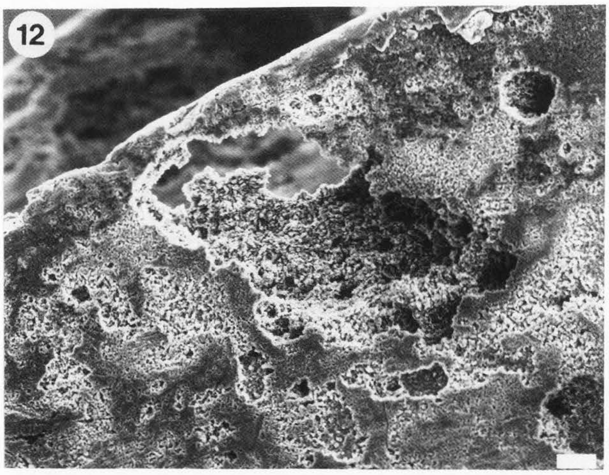


Fig. 12. Higher magnification of the area arrowed in Fig. 11. The metal of the cutting edge of this particular flute has been eroded through completely. Bar = 10 μm.

Figs. 8-12 are of the same plug finishing bur (v) followed through from its being unpackaged to initial cleaning, first use and subsequent cleaning.

Fig. 8. Bur (v) as unpackaged. Note the film over the surface and the usual adherent thread-like material. Bar = 100 μm.

Fig. 9. Same bur after initial cleaning in 70% ethanol with ultrasonication for 4 min. Note the loss of the film, the relatively poor quality of metal finish and the small particles still adherent to the bur surface. Bar = 100 μm.

Fig. 10. Same bur after use in the initial preparation of the surface of a carved amalgam for polishing. Macerated amalgam clogs the flutes of the bur. Bar = 100 μm.

Fig. 11. Same bur after second cleaning although first in PA based detergent. The level of cleaning is high (see flutes at bottom of picture) but there is obvious deterioration of the metal surface (at arrow). Bar = 100 μm.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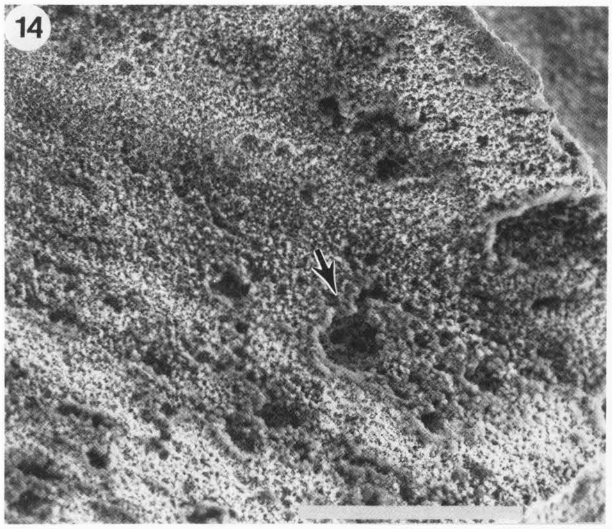
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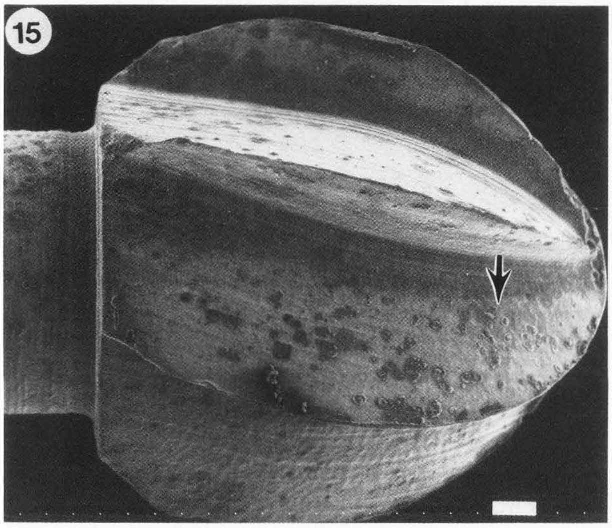
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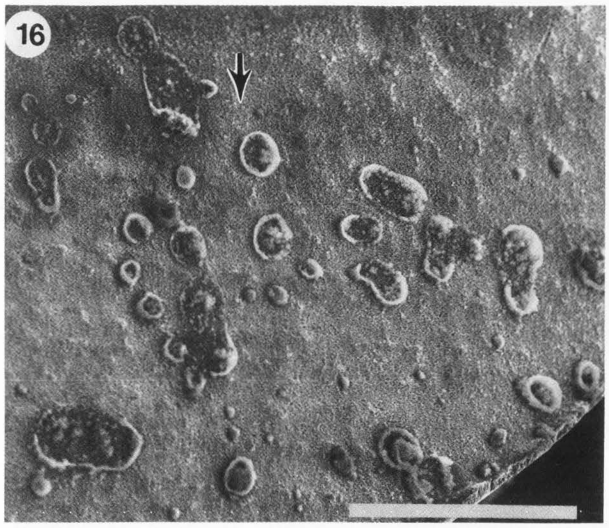
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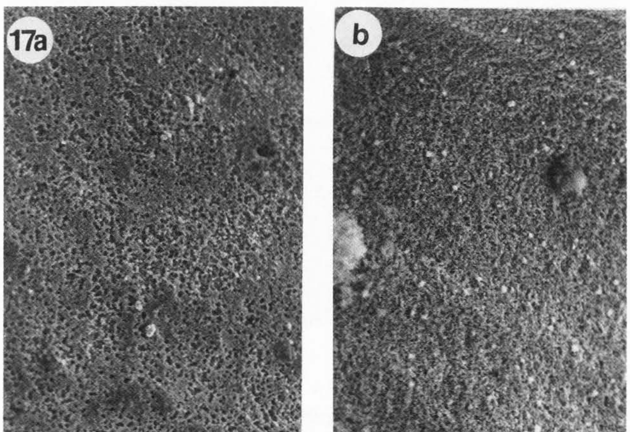
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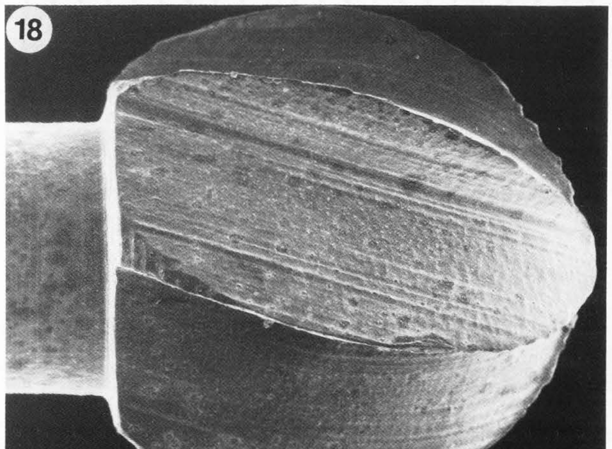
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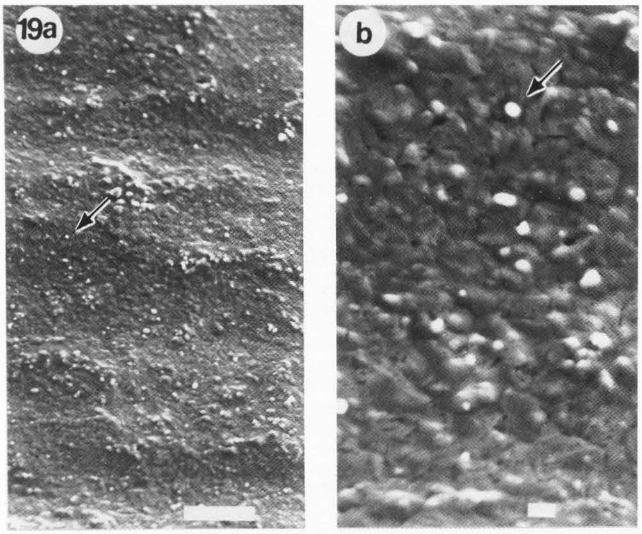
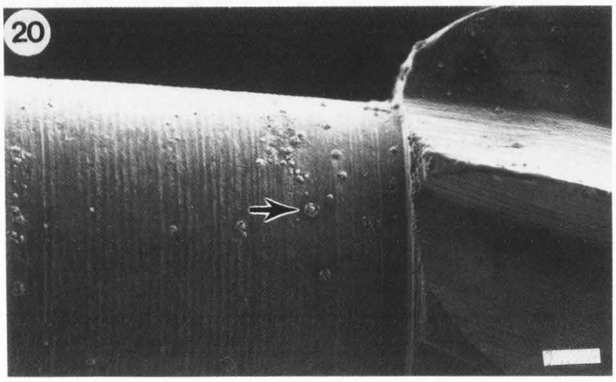
Fig. 8 shows the typical appearance of a bur - (v) - as unpackaged with associated organic film and adherent threads. The organic film and some of the debris are removed after the first cleaning in 70% ethanol (Fig. 9). Fig. 10 shows the degree of accumulation of debris on the flutes after a normal single use in the preparation of a single amalgam restoration for polishing. The level of cleaning resulting from the standard protocol of that time (see Table 1 - Procedure 2) is quite acceptable (Fig. 11), but the apparent damage to the bur in certain locations by way of severe erosion of the flutes (Fig. 12) led us to be concerned about the possible role of the phosphoric acid component of this detergent in the observed deterioration.





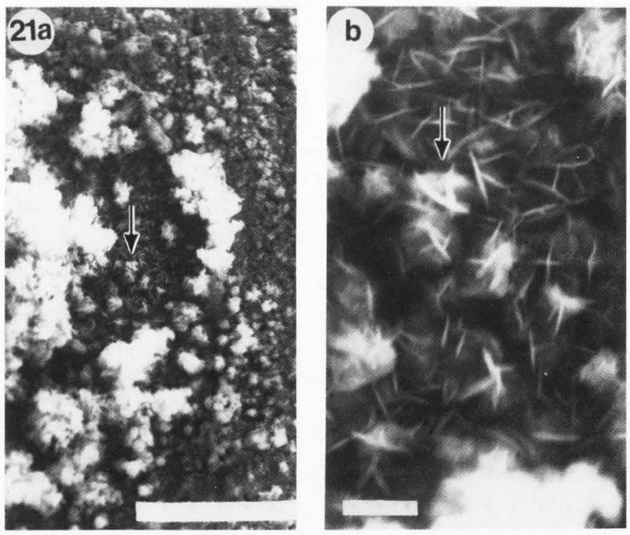


Fig. 13. Unused carbon steel round bur (i) after the extreme of 1 h ultrasonication in the recommended dilution (1/20) of PA based detergent. Although clean, the surface is obviously pitted even at this low magnification. The arrow locates the corrosion pit for Fig. 14. Bar = 100 µm.

Fig. 14. High magnification view of area arrowed in Fig. 13 to show the extensively corroded surface. Bar = 100 µm.

Fig. 15. Unused carbon steel bur (i) after 4 min ultrasonication in a 1/40 dilution of PA based detergent, rinsing in 70% ethanol and hot air drying. The bur is clean and less pitted but has plaque accumulations on its surface. Arrow locates Fig. 16. Bar = 100 µm.

Fig. 16. Higher magnification of Fig. 15 (arrow to same relative location). Surface is pitted at this magnification although obviously much less than for higher concentration and extended ultrasonication time. The colony-like clusters are, we feel, related to the ethanol in tap water rinsing. Bar = 100 µm.

Fig. 17. Higher magnification views of bur surfaces (unused bur (i)) subjected to different concentrations and times of ultrasonication in PA based detergent. 17 (a). normal dilution (1/20) and no ultrasonication. Bar = 10 µm. 17 (b). extreme dilution (1/400) and 4 min ultra-sonication. Bar = 10 µm. Pitting of the bur surface occurred for both regimes although less for the extreme dilution of PA detergent.

Figs. 18 and 19 illustrate the effect of SA detergent on unused burs (i).

Fig. 18. Survey view of bur washed in 1/20 dilution of SA based detergent with ultrasonication for 4 min. The bur is clean, unpitted and there is no precipitate. Bar = 100 µm.

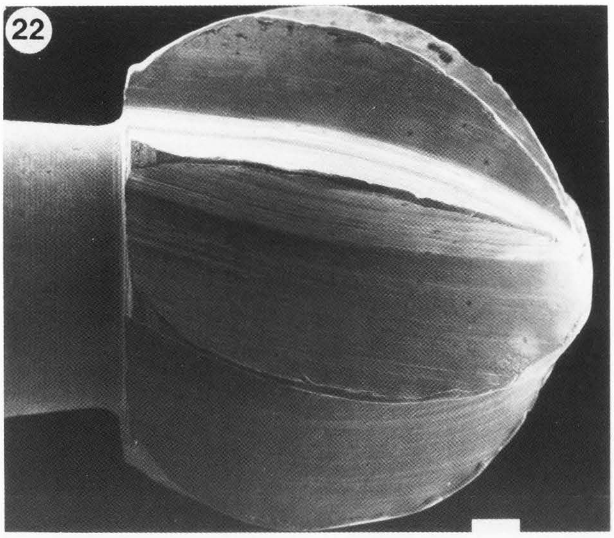
Fig. 19. Progressive higher magnifications of the middle part of the bur shown in Fig. 18. The grain structure is clearly visible and the surface is clean at high magnification. Arrows locate the same relative area. 19 (a). Bar = 10 µm. 19 (b). Bar = 1 µm.

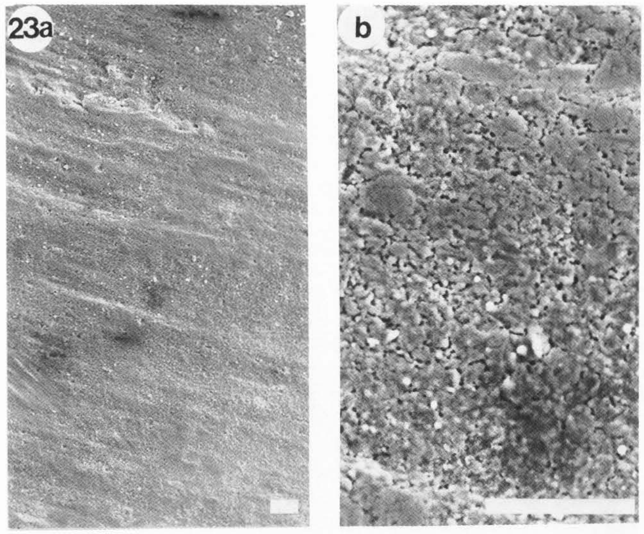
Figs. 20 and 21 illustrate precipitates on shank of an unused bur (i) resulting from a tap water rinsing following the SA detergent and prior to hot air drying.

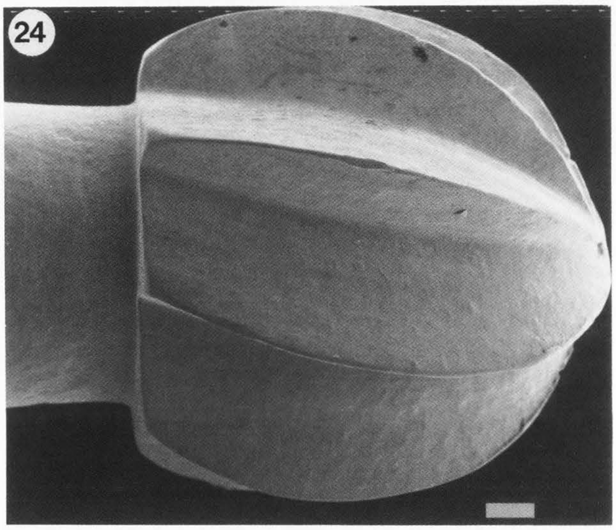
Fig. 20. Survey view to locate Fig. 21.

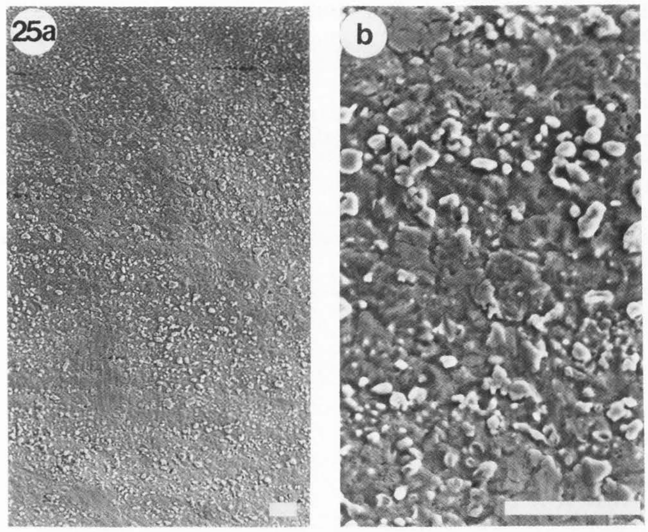
Fig. 21 (a). Higher magnification view of part of cluster arrowed in Fig. 20. Relatively clean bur surface is visible to right. Bar = 10 µm.

Fig. 21 (b). Higher magnification view of cluster in Fig. 21 (a) (arrow to same relative position) illustrating component needle-like crystallites. Bar - 1 µm.









Effect of varying the concentration and time of exposure to PA detergent (see Cleaning - 3, Table 1)

All exposures of the burs to the PA detergent resulted in detectable damage to the metal surface. There are four parts to this result (a) to (d). a) The exaggerated effect of 1 h ultrasonication in the PA detergent on bur (i) is shown in Figs. 13, 14. A severe honeycombing of the entire surface of the head of the bur has occurred. b) The lessened erosive effect of a reduction both in concentration (1/40 dilution) and in time of ultrasonication (4 mins) is clear (Figs. 15, 16) by comparison with Figs. 13, 14. The colony-like precipitates give the appearance of being related to the accelerated drying process, particularly the use of 70% ethanol (see below). c) The influence of ultrasonication was further explored by simply soaking the bur in a 1/20 dilution for 4 mins without sonication (Fig. 17a). Etching is still apparent (although a higher magnification is required to assess it) indicating that the essential causative agent is the PA

Figs. 22 to 25 compare the effect of a 70% ethanol rinse subsequent to 4 min ultrasonication of an unused bur (i) in a 1/20 dilution of SA based detergent and prior to hot air drying.

Fig. 22. Survey view of bur (i) rinsed in distilled water and hot air dried after ultrasonication in SA based detergent. The bur is unpitted and clean. Bar = 100 µm.

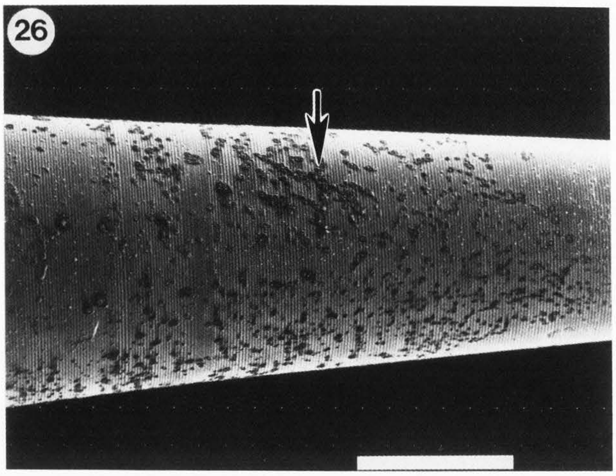
Fig. 23 (a) and (b). Progressive high magnification views of middle of bur showing lack of film, debris and precipitate. The basic grain structure is visible in Fig. 23 (b). 23 (a). Bar = 10 µm. 23 (b). Bar = 10 µm.

Fig. 24. Survey view of bur (i) washed in distilled water, rinsed in 70% ethanol and hot air dried after ultrasonication in SA based detergent. The bur appears quite clean at this magnification. Bar = 100 µm.

Fig. 25 (a) and (b). Progressive high magnification views of middle of bur showing particles over an otherwise clean surface. (cf. Fig. 22 and 23). 25 (a). Bar = 10 µm. 25 (b). Bar = 10 µm.

Fig. 26. Survey view of shank of unused carbon steel bur (i) washed in tap water and air dried after ultrasonication in SA based detergent and storage for 18 days. There are accumulated precipitates (? Fe $(OH)_2$) over the surface. Arrow locates field for Fig. 27. Bar = 1 mm.

Fig. 27. Higher magnification of arrowed area in Fig. 26 showing detail of precipitated cluster. Bar = 10 μm.



detergent. d) An attempt to minimise the adverse effect of the PA detergent on the metal surface involved a dilution to (w/w) 1%; the etching effect still occurred (Fig. 17b).

Effect of SA detergent (see Cleaning - 4, Table 1)

The SA detergent was found to be comparatively non-erosive. A clean and unpitted bur surface was thus obtained by substituting a 1/20 dilution of the SA detergent for the PA detergent after initial cleaning (Fig. 18) although small particles on the surface were apparent at high magnification (Figs. 19a, b).

Effect of varying the washing and drying procedures after detergent use (see Cleaning - 5, Table 1)

Distilled water was found to provide a superior rinse, post-detergent, compared to tap water; and drying in 70% ethanol was found to be of no advantage. There are three parts to this (a) to (c). a) Figs. 20, 21 illustrate the crystallite colonies occurring after tap water rinsing and hot air drying following sulfamic acid washing. b) Where distilled water is substituted for the tap water, the same clusters do not occur and the surface is physically clean (Figs. 22, 23a, b). c) Where a 70% ethanol rinse is added after the distilled water wash and before the hot air drying, there is a greater tendency for small particles to precipitate onto the surface of the metal (Figs. 24, 25a, b).

Effect of storage time on variously washed burs (see Cleaning - 6, Table 1)

Tap water rinsed burs showed continued surface deterioration with time compared to a distilled water rinse: a) where cleaned burs stand for 18 days after tap water washing, progressive surface changes occur (Figs. 26, 27) - the crystallite clusters are surrounded by a smooth-surfaced ring; b) similarly stored burs washed in distilled water do not show the same surface deterioration (Fig. 28). By naked eye examination, burs washed in tap water are obviously discoloured ("rusty") and those washed in distilled water retain their original surface lustre.

Discussion

The most significant finding from this series of observations is the corrosive action on carbon steel burs of a phosphoric acid based cleaning solution (Fig. 12) which was in routine use for bur decontamination in the sterile supply unit of our Dental School. The original basis for our use of the agent was its known effectiveness on stainless steel instruments. This was the natural result of a predominant experience by the sterilizing staff in, and concern for, instruments

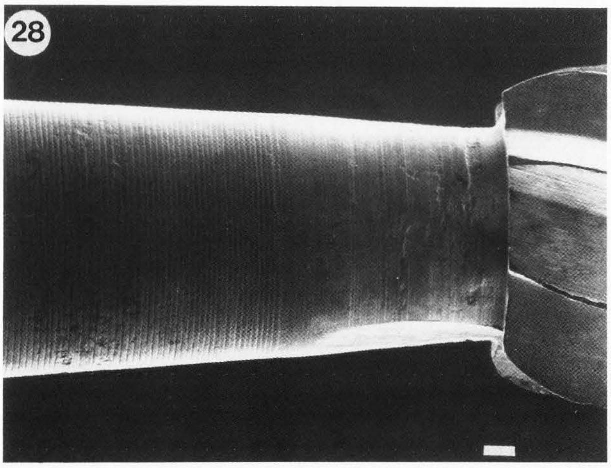


Fig. 28. Unused carbon steel bur (i) washed in distilled water and air dried after ultrasonication in SA based detergent and storage for 18 days. There is no surface precipitation of the kind seen when washing is with tap water. Bar = 100 μm.

associated with operating room activity. Thus, the phosphoric acid based detergent had been used as an instrument cleaning and brightening agent in the main (central) sterilizing unit at Westmead Hospital (servicing over 900 beds) for some time. It was felt that such an agent would be useful in cleaning small dental instruments (burs and endodontic reamers and files) which were found very difficult to clean in an alkaline detergent. In the absence of contrary data, the procedures outlined involving the phosphoric acid based detergent were adopted. The present observations show the effectiveness of an alternative detergent based on sulfamic acid which is entirely non-corrosive by comparison (cf. Figs. 11, 12 and Figs. 22, 23).

Two other findings have influenced our handling of small steel instruments: the need for distilled water rinsing after the cleaning agent rather than a tap water rinse (cf. Figs. 26 and 28); and the finding that new burs as unpackaged are unacceptable without first being subjected to a cleaning (de-greasing) process.

Our recommendation for a cleaning procedure for new unused burs is: i) ultra-sonicate for 4 mins in 70% ethanol (made up with distilled water); and ii) hot air dry. Our recommendation for a cleaning procedure for used burs is: i) place in a 1/20 dilution of a 16.5% sulphamic acid based detergent and tap water; ii) ultrasonicate for 4 mins; iii) wash generously in distilled water; and iv) hot air dry. If there is concern for the especial de-greasing of a used bur, a 70% ethanol (in distilled water) rinse can be added before drying. For grossly contaminated burs, the prior use of a bur brush, although not evaluated in this study, makes good sense.

Arriving at indisputable conclusions from studies such as this can be somewhat problematical; there being difficulties in both the strict analysis and the presentation of the results. Very careful attention is required to detail in terms of: exact relocation of the bur target area for comparative examination through repetitive cleaning and usage cycles (possible with careful scribing of bur shank and specimen holder); the need to look at the working end of the instrument and the difficulty of focussing the whole field of examination where there is in-built and significant change in profile (e.g., the spiralling flutes of a round bur); the considerable variation which may exist in the quality of the steel and the standards of manufacture and packaging from one bur to the next; the difficulty of controlling the quality of solutions and water supplies; and, the question of adequate sampling and comparison of fields even of instruments subject to the same variables.

Despite these technical hurdles to data collection and presentation, we feel it is an important part of an institution's responsibility to monitor cleaning, sterilizing and supply services; and the use of the scanning electron microscope is a valuable adjunct in this aspect of quality assurance. Perhaps the ultimate arbiter, however, for a change of decontamination procedure after initial use of small instruments should be a strict comparison of the cost of handling involved in their proven decontamination with the cost of their simply being discarded and replaced with a new instrument.

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Discussion with Reviewers

M. Baker: Sulfamic acid based detergent decontamination of dental burs seems to be less damaging than a phosphoric acid based cleaning solution, but does SA detergent effectively sterilize the burs?

Authors: The paper deals entirely with cleaning of dental burs and, despite our use of the word "decontamination", concentrates solely on pre-sterilization technique. All burs passing through the Sterilizing Unit are wrapped in tin foil and dry heat sterilized subsequent to the cleaning described in this paper.

A. Carrassi: You stated that after a 70% ethanol rinse "there is a greater tendency for small particles to precipitate on the surface of the metal". 70% ethanol is a solution utilized worldwide during biological specimen preparation for SEM, and no data about this artefact have been reported in the literature. Can you suggest an explanation for the presence of these small particles on the surface of your specimens treated with 70% ethanol?

Authors: This is a good question and also puzzled us a great deal. We suspect that the answer in our study rests with the (previous) use of tap water to make up the bulk 70% ethanol solution in the

Sterilizing Unit. Our essential conclusion, therefore, is to confirm the need for distilled water rather than tap water as the vehicle for the final rinse after cleaning.

V.A. Marker: Did the contamination particles on the 'as packaged' burs match the packing material or did this debris seem to be contamination from the manufacturing process?
Authors: To a degree, and with regard to soft plastic packaging, there was a correlation. However, other elements were involved also. The major contaminant appeared to be mineral oil or grease either purposefully placed by the manufacturer to prevent deterioration and rusting of the bur or present inadvertently as a result of the manufacturing process. The metal particles, where present, we assume resulted from the manufacturing process.

V.A. Marker: Was the contamination on the 'as packaged' burs sufficient to warrant cleaning the burs before use?
Authors: Yes, we regard this level of contamination as quite gross especially because it would prevent subsequent sterilization being achieved. The presence of the oil would not be beneficial were the bur to be used as unpackaged for any intricate preparation of a biological surface.

V.A. Marker: If the burs were not used in an in vivo situation, would the authors expect that the debris on the used bur was any different than the clinician would see in practice, i.e., do differences in procedures, such as cutting with a waterspray, or length of time used, or amount of pressure applied to the bur, affect the outcome?
Authors: We would anticipate that there would be some differences depending on the mode of use but these factors were not variables in our study. These and other results lead us to believe that this level of gross contamination after use (see Fig. 10) is not at all unusual.

V.A. Marker: Were the decontamination procedures sufficient to provide sterilization of the burs? If so, how do you know (i.e. a reference), and, if not, what additional procedure is needed and how would that affect the surface?
Authors: The cleaning procedures described were quite separate from the normal and subsequent dry heat sterilization of the burs. We do not anticipate that dry heat sterilization would greatly affect the bur surface, at least as far as could be assessed by routine scanning electron microscopy.

I.E. Barnes: Why did the 70% alcohol rinse leave either a film or crystals on the burs?
Authors: We suspect that the deposit from the 70% alcohol rinse was the result of crystallization from the local tap water used for making up the bulk 70% alcohol rinse in the Sterilizing Unit. Whether the film or crystals will be deleterious rather begs the question of the significance of cleanliness at this level of magnification and examination. We would prefer to stay with the fundamental principle that only a clean surface can be sterilized.

I.E. Barnes: Why does tap water leave crystals on the cleansed burs. Why is this deleterious after long-term shortage?
Authors: The crystals are most probably reaction products between sulfamic acid and the normal constituents of the local tap water which is moderately hard. It would seem that the reaction products initiate a process which, with available atmospheric moisture, will continue as a function of time.