CLEANING EFFICIENCY OF PRE-STERILIZATION PROTOCOLS FOR REUSABLE DENTAL BURS

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INTRODUCTION AND AIM

• Many different decontamination and cleaning procedures for critical devices are nowadays present in dental practice.

• Dental burs are contaminated by patient’s blood or body fluids in addition to large and packed dentine debris.

• A thorough decontamination and cleaning of used burs before sterilization is mandatory in order to prevent the intra-oral expulsion of materials during subsequent reuse.

This study aimed to assess valuable associations of treatments to obtain a clean and decontaminated dental bur.
MATERIALS AND METHODS

- Sixty (30 diamond, 30 multiblade) new dental burs were heavily soiled by simulating clinical use for cavity preparation in extracted teeth.

- Six equivalent groups were created by randomly selecting 5 diamond and 5 multiblade burs per group.

- Each group was processed following one out of five selected protocols:
  - A) thermo disinfection,
  - B) presoaking in polyphenols + thermo disinfection,
  - C) presoaking in polyphenols + ultrasonication in proteolytic,
  - D) presoaking in polyphenols + ultrasonication in proteolytic + thermo disinfection,
  - E) presoaking in polyphenols + ultrasonication in polyphenol + thermal disinfection.
  - C+) positive control: simulated use but no treatment
MATERIALS AND METHODS

Further, 20 (10 diamond, 10 multiblade) new and unused dental burs were included for creating two additional groups in order to check the cleanliness status of new devices and to address the possibility of applying a specific pre-sterilization treatment:

- **C-)** new devices “as sold”;
- **C-US)** ultrasonication in polyphenol.
After steam sterilization, all the devices were analyzed by scanning electron microscopy (SEM) equipped with X-rays energy dispersive spectroscopy (EDX) to distinguish among residuals of biological origin and non-biological origin.
Qualitative evaluation by Scanning electron microscopy

Figure 1: Biological residuals on used bur (e.g. dentine) characterized by SEM and EDX spectrum.

Figure 2: Non-biological residuals on new burs (e.g. anticorrosive oil) characterized by SEM and EDX spectrum.
The amount of surface presenting residuals was quantified by image analysis techniques on a 50x time magnification image acquired by SEM in backscattered mode. The following procedural steps were realized for image analysis:

- Original acquired image by SEM (50x)
- Stretching with XLstretch32
- 12x12 pixels grid addition
- ROI selection (300x300 pixel, 25x25 matrix, 625 squares)
- Tagging and Counting of soiled squares with ImageTool

Figure 3: Schematic representation of the image analysis process: Acquired image (left), superimposed grid (Center), selection of the region of interest (right).
Quantification of residual amount

Selection criteria and methods for soiled squares tagging:
- 2:1 magnification,
- any visible debris in the square of interest imply that the area is soiled (counted as 1) independently from debris type

A quantitative index (S%), was calculated as the percent of soiled areas in respect to the whole investigated area.

Figure 4: Example of soiled area association for a multiblade dental bur

Figure 5: Example of soiled area association for a diamond dental bur
RESULTS: PROTOCOL A
Thermodisinfecto

Aboundant dentine residuals covering large amount of burs cutting surface

Large difference of residuals amount id related to bur morphology
RESULTS: PROTOCOL B

Presoaking in polyphenols + thermo disinfection,

Abundant dentine residuals covering large amount of burs cutting surface

Large difference of residuals amount id related to bur morphology
RESULTS: PROTOCOL C

presoaking in polyphenols + ultrasonication in proteolytic

No large areas covered by dentin. Presence of dentine fragments among diamond chips.

Some carbonaceous residuals still on multiblade burs
RESULTS: PROTOCOL D
presoaking in polyphenols + ultrasonication in proteolytic + thermo disinfection

Few dentine debris among diamond chips

Good cleanliness of multiblade burs
RESULTS: PROTOCOL E

presoaking in polyphenols + ultrasonication in polyphenol + thermal disinfection

Few or no debris of diamond burs

Good cleanliness of multiblade burs
NEW DEVICES: “as sold” (C-)

Presence of abundant carbonaceous residuals and anticorrosion preservatives on both diamond and multiblades burs
Cleaning of new devices (C-US)
ultrasonication in polyphenol
RESULTS: Quantification of soiled areas

Protocol

Soiled area (%)
• Diamond burs showed a higher residual soil in respect to multiblade tips independently from the applied protocol.
• Protocol A showed the lowest cleaning effect and the highest variability of cleaning effectiveness.
• Protocols B, C, and D realized intermediate burs cleaning.
• Protocol E was the most effective in cleaning cutting bur surfaces, providing also for preventive decontamination of soiled device immediately after use, thus minimizing infective risk for healthcare operators.

• We elicited the need for improving cleanliness of new dental burs.
• A specific pre-sterilization protocol (e.g. sonication with poliphenolic detergent) significantly removed residuals left by manufacturing process.
Non-homogeneity in reprocessing protocols for dental burs and endodontic files was relieved among the 14 dental ambulatories of the APSS, Health Authority in Trento Province.

Results of this assessment evidenced an area of activity where realizing an amelioration of the professional practice.
A practical educational training (PET) for the APSS ambulatory operators was defined and realized with the following general objectives:

1) harmonize operators behavior in cleaning and disinfection of dental devices,
2) verify the transferability of the most effective protocol in clinical practice;
3) elaborate a shared protocol to submit to APSS Committee for Surveillance and Control of Hospital Infections related to Assistance Procedures (CIPASS) for approval and enforcement.

The following educational objectives were also pursued:
1) Improve the critical approach of nurses and technical operators to reprocessing and re-sterilization issues;
2) Enlarge operative competences for sterilization operators;
3) Elaborate educational instruments for better knowledge transfer from specialist to operators.
The working program has been articulated in 10 months with tutored activity (survey on available instrumentation, personnel advanced formation on cleaning and disinfection topics) and practical sessions experimenting the new proposed cleaning protocol for 6 months.

PHASE 1 Status pre-intervention and personnel training

PHASE 2 Implementation of the shared protocol

PHASE 3 Monitoring on protocol adoption

PHASE 4 Experimental validation

PHASE 5 Output
PRACTICAL EDUCATIONAL TRAINING
Operative phases

PHASE 1 Status pre-intervention and personnel training

PHASE 1.1
Elaboration of a check-list for the assessment of instrumentation, personnel, competencies, and procedures in-use among the 14 dental ambulatories of the provincial health Authority.

PHASE 1.2
Tutors inspection for data collection on pre-intervention status in each single ambulatory.
Randomized sampling of 1 dental bur and 1 endodontic file per ambulatory, selected among the actual devices just processed and ready to use on patients (sampling ante shared protocols).

PHASE 1.3
Tutors meeting for summarizing first inspection results and definition of the status ante adoption of the shared protocol.
Drafting of a proposed shared protocol to be proposed and discussed with ambulatory operators.
PRACTICAL EDUCATIONAL TRAINING
Operative phases

PHASE 1 Status pre-intervention and personnel training

PHASE 1.4
Plenary meeting with tutors, invited experts, and ambulatory operators (nurses and technicians) for:

• giving a theoretical background about decontamination, disinfection, sterilization principles and currently available technologies for treating dental reusable medical devices;
• presenting and discussing the shared operative procedure (Shared Protocol) on the base of previous experimental results (in vitro) and technical and practical issues.
PRACTICAL EDUCATIONAL TRAINING
Operative phases

PHASE 2 Implementation of the shared protocol
Implementation of the Shared Protocol in each ambulatory with training of the whole ambulatory personnel.

PHASE 3 Monitoring on protocol adoption
Tutor inspection in each ambulatory with the aim of verifying and helping adoption of the shared protocol.
Monitoring of the proper adoption of the shared protocol by filling a specific checklist.
Randomized sampling of 1 dental bur and 1 endodontic file per ambulatory (sampling post shared protocols).
PHASE 4 **Experimental validation**
Observation and characterization by scanning electron microscopy (SEM) of samples coming from *ante* and *post* shared protocol adoption. Quantification of residual soil on burs and files by an objective evaluation procedure based on the definition of a quantitative index (S%). S% was calculated as the percent of soiled areas in respect to the whole investigated area. Results analysis and discussion among tutors and experts.

PHASE 5 **Output**
Plenary meeting with tutors, experts, and ambulatory operators for: presenting data showing changes due to the adoption of the shared protocol Drafting a final report for to submit to APSS Committee for Surveillance and Control of Hospital Infections related to Assistance Procedures (CIPASS).
Shared protocol for files and burs pre-sterilization treatment

On the basis of previous experimental findings and considering experts suggestions, operators feedback and available infrastructures, the following protocol was drafted:

- soaking the device immediately after use in polyphenolic solution for more than 10 minutes;
- ultrasonication in polyphenolic solution by using special net containers for avoiding operators punctures and/or injuries;
- thermo-disinfection;
- packaging;
- steam autoclaving.
Quantification of residual soil

The amount of surface presenting residuals was quantified by image analysis techniques on images acquired by SEM in backscattered mode.

Specific image analysis routines were applied to quantify the percent of soiled area in respect to the whole area of interest of the device (S%).

Figure 1: Example of image analysis for the detection of soiled areas (red dots) in a diamond dental bur

Figure 2: Example of image analysis for the detection of soiled areas (in red) in an endodontic files
Quantitative analysis of cleaning status in endodontic files and dental burs showed the efficiency of the drafted shared protocol. The adoption of the drafted shared protocol lowered the average value of the soiled area (decreasing of average values of S%) and increased the predictability of the cleaning protocol efficiency, reducing results dispersion.
The integration of operator expertise and technical evaluation conducted in the context of a practical educational training allowed introducing a shared, and validated protocol for pre-sterilization processing of dental burs and endodontic files. Equipment and operators behaviors were homogenized and operators’ compliance to recommended protocol and procedural practices improved. The drafted protocol was proposed to the Committee for Surveillance and Control of Hospital Infections related to Assistance Procedures and a operative harmonized guideline has been realized and is undergoing final approval for implementation and enforcement in all the APSS ambulatories.