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Research Article

# Reprocessing of dental instruments in washer-disinfectors: does a representative test soil exist in dentistry?

## Aufbereitung des zahnärztlichen Instrumentariums im Reinigungs-Desinfektions-Gerät: Gibt es eine repräsentative Probeanschmutzung?

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## Abstract

**Background:** Reprocessing of medical devices, being classified as semi-critical B is recommended to be performed in a washer-disinfector. In order to estimate, whether the expected contaminants of the various medical disciplines can be effectively removed by this washer-disinfector, different so called “test soils” have been proposed to be tested as a marker of cleaning efficacy of the disinfector. Todays described test soils are optimised for the testing of contaminations occurring in surgical procedures, but not for dental procedures.
**Methods:** In this study the test soils being proposed in the EN 15883-5 (e.g. KMNE soil, recipe by Koller and coagulated sheep’s blood) were compared with 8 reference substances used in the conservative-prosthetic dental practice. The success of the cleaning efficacy in the washer-disinfector was checked visually and by determining the residual protein concentration on the contaminated instruments after the cleaning procedure.
**Results:** It could be shown that in contrast to the proposed test soils of the EN 15883-5, the used reference substances of the dental practice could not be removed by the washer-disinfector. Removal of these reference substances was only possible after manual or ultrasonic cleaning.
**Conclusions:** Since blood plays a subordinate role as a contaminant of instruments during conservative-prosthetic dental treatments, testing of the cleaning efficacy of the washer-disinfector with test soils according to the proposals of the EN 15883-5 is not representative in this discipline of dentistry. Most of the materials used in dental practice can only be removed manually or with the help of the ultrasound bath.

**Keywords:** reprocessing, cleaning, disinfection, washer-disinfector, dentistry, test soil, protein assay, dental materials

## Zusammenfassung

**Hintergrund:** Heute gilt für wieder verwendbares medizinisch genutztes Instrumentarium ab Klassifikation semikritisch B die Aufbereitung in einem Reinigungs-Desinfektions-Gerät (RDG) als Standard. Um erkennen zu können, ob die verwendeten Hilfsmittel bzw. vorkommenden Verunreinigung der unterschiedlichen medizinischen Disziplinen maschinell effektiv entfernt werden können, wurden so genannte Probeanschmutzungen vorgeschlagen. Die heute in Verwendung stehenden Probeanschmutzungen sind für chirurgische Instrumente, nicht jedoch für den zahnmedizinischen Einsatz optimiert.
**Methoden:** In dieser Studie wurden die in der EN 15883-5 vorgeschlagenen Probeanschmutzungen (KMNE-Schmutz, Rezeptur nach Koller und koaguliertes Schafsblut) sowie 8 Referenzsubstanzen aus der konservierend-prothetischen Zahnarztpraxis miteinander verglichen. Der Erfolg der Aufbereitung wurde optisch sowie durch Bestimmung der Restproteinkonzentration überprüft.

**Ergebnisse:** Es zeigte sich, dass die verwendeten Referenzsubstanzen im Gegensatz zu den vorgeschlagenen Anschmutzungen im RDG nicht entfernt werden konnten. Eine Entfernung der Referenzsubstanzen war nur durch manuelle Vorreinigung oder Ultraschallbad möglich.
**Schlussfolgerung:** Da im konservierend-prothetischen Bereich nur ein geringer Anteil der Behandlungen mit Blutkontakt abläuft, die meisten zahnärztlichen Materialien aus diesem Bereich ohne manuelle Vorreinigung oder Ultraschallbad auch nicht ansatzweise durch RDGs entfernt werden können und der Kontaminationsgrad nicht repräsentativ für Verunreinigungen in diesem Fachbereich der Zahnheilkunde ist, kann die Reinigungsleistung gem. EN 15883 als Indikator für die Entfernung von verwendeten zahnärztlichen Materialien nicht getestet werden. Dies stellt aber die generelle Aufbereitung des zahnärztlichen Instrumentariums im RDG in Frage.

**Schlüsselwörter:** Aufbereitung, Reinigung, RDG, Zahnheilkunde, Testanschmutzung, Protein-Assay, zahnärztliche Hilfsmittel

# Introduction

Today cleaning of reusable medical instruments in a disinfector is the standard for surgical equipment. Reprocessing of medical devices, being classified as semi-critical B is recommended to be performed in a disinfector. Therefore also in the dental practice the disinfector is more widely used.
In order to detect in advance, whether the expected contaminants of the equipment used during a surgical or medical invasive procedure are removed by the disinfector, test soils were implemented.
According to the EN 15 883-5 standard [1], the cleaning efficacy of the disinfector as a part of the reprocessing cycle has to be tested with test soils on instruments, which resemble the expected contamination like for example blood contamination during the surgical procedure. In the relevant standard, different test soils for different equipment are recommended. No test soil is listed resembling a contamination of typical instruments after dental procedures.
Oral instruments used in oral surgery or parodontology may have increased blood contact, but this is not the case in the field of conservative-prosthetic dentistry. This type of dental treatment dominates the treatment in a general dentistry practice. Only about 5% of these treatments are bloody. On the other hand materials like cement play a big role and leads to contamination of the instruments.
The aim of this study was to compare the cleaning efficacy of disinfectors using dental instruments being spotted with test soils described in the EN 15 883-5 standard with reference substances, used in the daily work of conservative-prosthetic dentistry.
In preparation to this test series, the measurement results of residual protein on dental instruments, which were carried out in the past were analysed. The measurement of residual protein was performed routinely, to estimate high residual proteins on instruments, which could pose a problem in the cleaning efficacy of the disinfector.

# Materials and methods

## Test soils

As test soiling we used KMNE-soil, recipe by Koller [2], [3], coagulated sheep's blood and 8 reference substances used in conservative-prosthetic dental practice (Table 1). Instruments used in conservative-prosthetic dentistry and parodontology were soiled with KMNE-soil, reference substances and coagulated sheep's blood. Exposure time of all test soils before reprocessing in a washer-disinfector (Miele G 7881) was one hour. Additionally, test bodies (TOSI®) were used for the monitoring of the cleaning performance of the automated washer-disinfector.

## Quantitative protein evaluation

After reprocessing in a washer-disinfector each instrument was put in a separate sterile plastic container. 10 ml of sterile distilled water were added and plastic containers were put on a shaker for one hour. After one hour instruments were removed and remaining distilled water was transferred into a sterile test tube. Fluid samples were analyzed with a Micro BCA™ Protein Assay Kit for the colorimetric detection and quantitation of total protein [4], [5].

**Table1: Materials used in this study**

| Material | Indication | Manufacturer |
|---|---|---|
| Glyde™ FILE PREP | Root canal conditioner | Dentsply, DeTrey GmbH, Konstanz, Germany |
| Ledermix | Intra-canal dental paste | Riemser Arzneimittel AG, Greifswald, Germany |
| Cavit™ | Temporary filling material | 3M ESPE AG, Seefeld, Germany |
| Temp Bond; Base + Modifier | Temporary fixing cement | Kerr Corporation, Orange, USA |
| Calxyl | Calciumhydroxid paste for root canal treatment and temporary filling material | OCO Präparate GmbH, Dirmstein, Germany |
| Ketac Molar | Glasionomer restorative | 3M ESPE AG, Seefeld, Germany |
| Fermit | Temporary filling material | Ivoclar Vivadent AG, Schaan, Liechtenstein |
| Harvard cement | Zinc phosphate cement | Harvard Dental International GmbH, Hoppegarten, Germany |
| Coagulated sheep's blood | | Fiebig Nährstofftechnik, Idstein-Niederauroff, Germany |
| KMNE soiling, recipe by Koller | Aequeous solution of nigrosin, flour paste, egg white, yolk and flocked potatoes. | |
| TOSI®<br>Cleaning indicator | Test body to monitor the cleaning performance of the automated washer-disinfector | Pereg, Waldkraiburg, Germany |
| Micro BCA™ Protein Assay Kit | Test kit for the colorimetric detection and quantitation of total protein. Test tube procedure (Linear working range of 0.5–20 µg/ml) | Pierce, Rockford, USA |
| Neodisher Mediclean Forte | Alkaline cleaning agent | Dr.Weigert UK Ltd, Bridgtown, UK |
| Neodisher Mediklar | Rinsing agent | Dr.Weigert UK Ltd, Bridgtown, UK |

# Results

The majority of reference substances from the conservative-prosthetic dental practice as cement and cement like material could not be removed from the dental instruments after reprocessing them in the washer-disinfector (Table 2).

The proposed test soils described in the 15 883-5 standard for instruments used in surgery, like coagulated sheep's blood and also KMNE soil according to the recipe of Koller, were removed from all dental instruments after reprocessing in the disinfector (Table 2).

In daily practice even small remnants of these materials on dental instruments have to be removed manually prior to reprocessing in the disinfector. Only materials like Glyde™ FILE PREP and Ledermix were easily removed and showed a similar behaviour as the test soil proposed for instruments used after surgical procedures.

In the period 2007–2011 residual protein was measured out of a total of 384 instruments.

This was also applied to instruments from the area of oral surgery and parodontology. Increased residual protein could be detected in 57 samples (Table 3). The determined protein levels were extremely low in almost all cases, and were only relatively slightly above the detection limit of the protein assay kit. Only one elevator showed a significantly elevated level of 10.8 microgram/ml of residual protein. It is noticeable that even for instruments, such as mixing spatula, which have no contact with mucous membrane slightly increased protein levels could be detected.

**Table 2: Results for the test soiling with reference substances used in the conservative-prosthetic dental practice, KMNE-soil, coagulated sheep's blood and TOSI® cleaning indicator. The evaluation of the samples was carried out using the following scores: 0 = Test soil completely removed; 1 = Test soil not entirely removed; 2 = Test soil not removed**

| Instruments | Number of tested instruments | Type of test soil | Scores |
|---|---|---|---|
| Dental tweezers | 1 | Temp Bond | 2 |
| Ball plugger | 1 | Temp Bond | 2 |
| Mixing spatula | 1 | Temp Bond | 2 |
| Ball plugger | 1 | Temp Bond | 2 |
| Heidemann spatula | 1 | Temp Bond | 2 |
| Ball plugger | 1 | Ketac Molar | 1 |
| Heidemann spatula | 1 | Fermit | 2 |
| Ball plugger | 1 | Cavit | 1 |
| Protaper | 7 | Calxyl | 2 |
| Mixing spatula | 7 | Harvard Cement | 2 |
| Ball plugger, large | 7 | Harvard Cement | 2 |
| Dental tweezers | 7 | Harvard Cement | 2 |
| Heidemann spatula | 7 | Harvard Cement | 2 |
| Suction device | 6 | Harvard Cement | 2 |
| Protaper | 97 | Glyde | 0 |
| Protaper | 97 | Ledermix | 0 |
| Protaper | 96 | KMNE | 0 |
| Mixing spatula | 108 | KMNE | 0 |
| Heidemann spatula | 119 | KMNE | 0 |
| Ball plugger | 128 | KMNE | 0 |
| Dental tweezers | 126 | KMNE | 0 |
| Suction device | 105 | KMNE | 0 |
| Tooth probe | 18 | KMNE | 0 |
| Dental mirror | 18 | KMNE | 0 |
| Dental mirror | 9 | KMNE | 0 |
| Discoidexcavator | 9 | KMNE | 0 |
| Composite filling instrument | 9 | KMNE | 0 |
| Endodonic probe | 9 | KMNE | 0 |
| Dental mirror | 18 | Coagulated sheep's blood | 0 |
| Tooth probe | 9 | Coagulated sheep's blood | 0 |
| Discoidexcavator | 9 | Coagulated sheep's blood | 0 |
| Composite filling instrument | 9 | Coagulated sheep's blood | 0 |
| Endodonic probe | 9 | Coagulated sheep's blood | 0 |
| Mixing spatula | 9 | Coagulated sheep's blood | 0 |
| Ball plugger, large | 9 | Coagulated sheep's blood | 0 |
| Ball plugger, small | 9 | Coagulated sheep's blood | 0 |
| Heidemann spatula | 9 | Coagulated sheep's blood | 0 |
| Dental tweezers | 18 | Coagulated sheep's blood | 0 |
| Protaper | 9 | Coagulated sheep's blood | 0 |
| TOSI® Cleaning indicator | 46 | Fibrin, protein, haemoglobin | 0 |

**Table 3: Results for the determination of the residual protein concentration of instruments used in conservative-prosthetic, parodontological and surgical dentistry after reprocessing in a washer-disinfector**

| Instruments | Number of Instruments | Concentration of residual protein in µg/ml (mean ± standard deviation) |
|---|---|---|
| Periosteal elevator | 7 | 1 out of 7 values was above detection limits: 10.8 |
| Dental tweezers | 67 | 7 out of 67 values were above detection limits: 4 ± 4.26 |
| Dental mirror | 46 | 12 out of 46 values were above detection limits: 2.62 ± 3.3 |
| Cloth clamp | 3 | 1 out of 3 values were above detection limits: 2.5 |
| Endodonic probe | 20 | 6 out of 20 values were above detection limits: 2.44 ± 1.51 |
| Irrigation needle | 12 | 1 out of 12 values was above detection limits: 2.1 |
| Protaper | 3 | 7 out of 20 values were above detection limits: 1.9 ± 0.27 |
| Suction device | 50 | 7 out of 50 values were above detection limits: 1.89 ± 0.23 |
| Mixing spatula | 27 | 8 out of 27 values were above detection limits: 1.88 ± 0.12 |
| Lever | 5 | 1 out of 5 values was above detection limits: 1.72 |
| Ball plugger large | 26 | 2 out of 26 values were above detection limits: 1.68 ± 0.11 |
| Periosteal elevator, small | 2 | 2 out of 2 values were above detection limits: 1.6 ± 1.27 |
| Heidemann spatula | 27 | 1 out of 27 values was above detection limits: 0.58 |
| Scaler | 21 | values were below detection limits |
| Mucosa scissors | 7 | values were below detection limits |
| Discuid excavator | 6 | values were below detection limits |
| Twirler | 5 | values were below detection limits |
| Sharp spoon | 4 | values were below detection limits |
| Surgical forceps | 4 | values were below detection limits |
| Moskito clamp | 4 | values were below detection limits |
| Blecklöffel 1 | 4 | values were below detection limits |
| Clamp | 4 | values were below detection limits |
| Freer | 4 | values were below detection limits |
| Anatomical forceps | 4 | values were below detection limits |
| Scissors | 3 | values were below detection limits |
| Forceps | 3 | values were below detection limits |
| Stodger | 3 | values were below detection limits |
| Turning chisel | 2 | values were below detection limits |
| Langenbeck | 2 | values were below detection limits |
| Twirler | 2 | values were below detection limits |
| Automatrix | 1 | 1 out of 1 values was above detection limits: 1.84 |
| Pliers | 1 | value was below detection limits |
| Hook | 1 | value was below detection limits |
| Kelly scissors | 1 | value was below detection limits |
| Straight probe | 1 | value was below detection limits |
| Probe | 1 | value was below detection limits |
| Forceps grip | 1 | value was below detection limits |

# Discussion

Only few medical treatments in conservative-prosthetic dental practice result in a contact to blood. Furthermore most of the dental materials used in dentistry can not be removed without manual precleaning or the use of an ultrasound bath. The degree of contamination indicated by the use of KMNE-soil or coagulated sheep's blood is not representative for soiling in this discipline of dentistry. Therefore the assessment of cleaning performance used as an indicator for the elimination of adherent dental materials can not be tested.
This raises the question if after manual pre-cleaning or the use of an ultrasound bath the processing of dental instruments in a washer-disinfector is required. Further studies are necessary to clarify this problem.

# Notes

## Competing interests

The authors declare that they have no competing interests.

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