Evaluation of new technique of sterilization using biological indicator

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Abstract

Background: A novel technique of sterilization of endodontic files is introduced in this article.

Aims: Newly introduced sterilization unit, named “SteriFast” is compared with autoclave and glass bead sterilizer using biological indicator.

Materials and Methods: Spore strips of Bacillus pumilus were cultured in nutrient broth. This cultured media was used to contaminate the experimental samples of endodontic files. These contaminated files were sterilized using three different techniques. The sterilized files were transferred into nutrient medium under aseptic condition. The results were observed after 24 h, 48 h, and 7 days.

Results: The results showed that autoclave and new sterilization device (SteriFast) showed complete sterilization. The files sterilized using glass bead sterilizer showed bacterial growth (80%).

Conclusions: Thus, it proves that autoclave and SteriFast are ideal techniques of sterilization of endodontic files. Glass bead sterilizer does not completely sterilize the files. The article also compares SteriFast and autoclave in other aspects such as its design, basic principle, advantages, and disadvantages. The article also describes features and design of SteriFast, used for all kind of small dental instruments.

Keywords: Autoclave; Bacillus pumilus; biological indicator; SteriFast; sterilization; ultraviolet germicidal irradiation

INTRODUCTION

Infection control is a primary means of disease containment in all health-care settings, including the dental office. During root canal therapy, the endodontic instruments come in contact with pulp tissue, blood, oral fluids, and saliva. Thus, these instruments can be considered as “reusable sharps” (according to Occupational Safety and Health Administration) and should be completely cleaned and sterilized before every use and even before reuse.

It is essential to ensure that all the microorganisms are killed during the sterilization process. Thus, the quality control is a significant part of the sterilization procedure. One of the most reliable methods of sterilization monitoring is biological indicator (BI) using spore strips. BI measure the efficiency of sterilizer to kill the highly resistant bacterial spores. The present study aims to evaluate the efficiency of autoclave, SteriFast (the new device), and glass bead sterilizer using BI, that is, Spore strips.

The new device is designed in such a way that it facilitates apt cleaning of endodontic files followed by its sterilization quickly. Comparing other parameters such as, “time period, extra armamentarium required; ease of handling; and chair-side availability in the clinic,” the new device is considered the best tool for chair-side sterilization.

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MATERIALS AND METHODS

The present study was carried out using 100 K-files (Mani, Japan), 21-mm long, size #10. Forty files were taken as control group (20 positive controls [PCs] and 20 negative controls [NCs]) and 60 files were divided into 3 experimental groups of 20 files each in 3 different forms of sterilization: Autoclave (Q-dent, Mumbai, India), SteriFast (Quest dental products, Mumbai, India), and glass bead (Q-dent, Mumbai, India).

All 100 files were presterilized in an endodontic instrument box by autoclaving for 30 min at 121°C at 15 pounds pressure, for standardization to eliminate any bias. Later, the files were divided into 5 groups of 20 files in each group and labeled as PC, NC, Group I (autoclave), Group II (SteriFast), and Group III (glass bead) and were numbered 1–20.

The spore suspension was prepared by immersing the commercially available Bacillus pumilus spore strip into nutrient media and incubating at 37°C for 48 h.

A total of 20 presterilized files of PC group were directly transferred into test tubes (under all aseptic conditions) containing nutrient media without contaminating with B. pumilus spores. Remaining 80 presterilized files were contaminated with B. Pumilus in a sterile Petri dish for 5 min. Then, 20 contaminated files (NC group) were transferred into nutrient media without any cleaning or sterilization. Other experimental groups were sterilized as below [Figure 1];

Group I:
- Step 1: Manual cleaning
- Step 2: Autoclave for 30 min at 121°C at pressure of 15 pounds
- Step 3: Transferred to test tube containing nutrient media under aseptic condition.

Group II
- Step 1: Manual cleaning using the attachment provided in SteriFast and brush
- Step 2: Placing files in SteriFast sterilizing chamber for 5 min
- Step 3: Transferred to test tube containing nutrient media under aseptic condition.

Group III
- Step 1: Manual cleaning
- Step 2: Placing in glass bead sterilizer for 45 s at 240°C
- Step 3: Transferred to test tube containing nutrient media under aseptic condition.

All the test tubes containing files were labeled accordingly and kept for incubation at 37°C. After 24 h, the test tube was checked for turbidity. The presence of turbidity in the test tube indicated the presence of B. pumilus and that those files were not sterilized completely. The readings were recorded as “+” in the presence of turbidity and “-” in the absence of turbidity. Similar recording for the presence of turbidity was done after 48 h (i.e., day 2) and after 7 days of experimentation. The test tube with turbidity were checked and confirmed for the presence of specific Bacillus using light operating microscope.

RESULTS [TABLE 2 AND FIGURE 2]

The results showed that autoclave (100%) and SteriFast (100%) sterilized the files completely, whereas glass bead do not sterilize the files (80%).

Figure 1: Division of groups
Sterilization of endodontic instruments is mainly done using autoclave or glass bead sterilizer. The present study aims to revisit the technique of ultraviolet (UV) radiation for sterilization. The current article aims to introduce the newly designed device for sterilization of endodontic files, using germicidal UV radiations. This device named; “SteriFast” (Quest Dental Product) is designed, especially for small dental instruments such as endodontic files.

**DISCUSSION**

Sterilization of endodontic instruments is mainly done using autoclave or glass bead sterilizer. The present study aims to revisit the technique of ultraviolet (UV) radiation for sterilization. The current article aims to introduce the newly designed device for sterilization of endodontic files, using germicidal UV radiations. This device named; “SteriFast” (Quest Dental Product) is designed, especially for small dental instruments such as endodontic files.
dental burs, scaler tips, implant keys, and orthodontic bands. The special design of SteriFast makes it compact, user-friendly, quick, easy to maintain, and cost-effective. The further details about the new said device is described later in this article.

A total of 100 K-files were taken of size #10, 21-mm long for the standardization of samples. Bir[9] is considered as most reliable technique for monitoring sterilization process because they measure if highly resistant bacterial spores have been killed. If the spores are destroyed, it may be assumed that all other microbes present on the files have also been killed. B. pumilus spores used in the current study are light-resistant bacteria, thus they were selected for testing in the current study.

Autoclave works on the principle of moist heat under pressure. Rutala and Weber[10] stated that moist heat destroys microorganisms by the irreversible coagulation and denaturation of enzymes and structural proteins. The present study indicated that autoclave sterilizes the files (in endodontic box) completely. This is significantly comparable to the findings from other studies done by researchers like Venkatasubramanian et al.,[7] Raju et al.,[8] Hurtt and Rossman,[9] Velez et al.[10]

Dry heat alters proteins of microorganisms and results in oxidation, desiccation, and changes in osmotic pressure owing to evaporation of moisture. Dry heat is slower and requires temperatures higher than those used in moist heat sterilization. In the present study, glass bead sterilized the files up to 80% and that total sterility was not found even after sterilizing for 45 s at 240°C. Incomplete sterilization was in the range of 20%. The present study result was in accordance to that of the previous research done by Venkatasubramanian et al.[7] and Hurtt and Rossman.[9] Glass bead sterilizer does not sterilize the handle or nonworking end of endodontic files. This can be one of the reasons for turbidity of nutrient broth.

In the current study, the third technique used was germicidal UV radiation. UV light is maximum absorbed by bacterial DNA at wavelength 254 nm. This causes cross-linking between neighboring pyrimidine nucleotide bases (thymine and cytosine) in the same DNA strand. This, in turn, impairs formation of hydrogen bonds to the purine bases on the opposite strand. DNA transcription and replication is, thereby, blocked, compromising cellular functions and eventually leading to cell death.[11] Thus, UV light at 254 nm (240–280 nm range) kills the microorganisms.

UV light is commonly used as surface disinfectant. Its maximum bactericidal effect occurs at 240–280 nm.[9] The UV rays can kill only those microorganisms that are struck directly by UV light beams. For surfaces that cannot be reached by the UV rays, any microorganisms present will not be killed. However, in case of endodontic instruments, the diameter of the instrument per se is small, and also, its design permits more surface area to come in contact with the light source.[12] For this reason, it was believed that UV light can sterilize endodontic instruments.

CONCLUSIONS

It can be concluded that the new sterilization device is an inventive step to enhance the quality of work done by a dental professional. This can help the clinician to sterilize the endodontic instruments chairside within few minutes. This experiment can provide a new sterilization unit to the global dental market, and hence, can be named as “SteriFast.”[12,13]

Limitation and future perspective of study

The current study was performed on endodontic files only. Similar test can be done for other instruments such as dental burs and scaler tips.

Research highlights

Advantages of the device:[12,14]
- Less time-consuming
- No corrosion (as no moist heat)
- Portable and compact
- Cleaning and sterilization both procedures provided in one single compact device
- Easy to use
- Can be used chairside
- Can be used in between two consecutive appointments.

Special features of the device:[12]
- Easy to maintain
- User friendly
- Quick (5 min)
- Special attachment for cleaning
- Cost-effective
- Safe to use.

Applications of the device:
- Sterilization of:
  - Endodontic files
  - Burs
  - Matrices and wedges
  - Scaler tips
  - Implant keys
  - Orthodontic bands.
- Disinfection of:
  - Impression trays
  - Impression surfaces
  - Dentures.

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Conflicts of interest
There are no conflicts of interest.

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