The Impact of Multiple Autoclave Sterilization Cycles on The Cyclic Fatigue Resistance and Surface Roughness of E Flex Blue and Protaper next Rotary Files

Razan Muawia Osman Mohamed (✉ razan.osman@dentistry.cu.edu.eg)
faculty of dentistry, Cairo university

Method Article

Keywords:

Posted Date: October 25th, 2023

DOI: https://doi.org/10.21203/rs.3.pex-2420/v1

License: ☑️ ☑️ This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

The aim of this study is to evaluate the effects of repeated sterilization cycles on cyclic fatigue resistance and surface alterations of E flex blue and ProTaper Next (PTN) rotary systems. The two groups of new files will be divided to three sub groups. In first group, we will measure the cyclic fatigue resistance and surface roughness tests before any cycle of sterilization. In second group, we will measure the cyclic fatigue resistance test and surface roughness test after one cycle of sterilization in an autoclave at 121°C for 15 min and results will be recorded. In third group, we will measure the cyclic fatigue resistance test and surface roughness test after three cycles of sterilization in an autoclave at 121°C for 15 min and results will be recorded. Surface roughness will be assessed using scanning electron microscope for each group. Statistical analysis will be done and comparison will be made between the different groups.

Introduction

Sterilization is a fundamental step in the reuse of endodontic instruments. The sterilization Procedure follows the steps of disinfection, cleaning, washing, drying and packaging. The disinfection and cleaning steps reduce the bacterial load and remove debris from the blades of the instruments, which is not enough for reusing the instruments. Therefore sterilization step is performed to kills any form of microorganism, including spores.

The most widely used method described in the scientific literature for sterilization in the dental field is heat sterilization. Sterilization by heat involves the use of autoclaves that reach a temperature of 134 °C, together with the action of steam at a pressure of 30 psi.

Heat sterilization can lead to changes in the physical and mechanical properties of dental instruments. These changes can affect the external surfaces with micro pitting and corrosion phenomena, causing reduction in cutting efficiency. It can also affect the resistance to cyclic or torsional fatigue.

Rupture of the endodontic instrument is an unfavorable event that can occur during probing, pre-flaring and shaping phases. It could be caused by cyclic or torsional stress. Rupture due to torsion occurs when part of the instrument, more frequently the tip is locked in the canal while the file continues rotating.

Heat sterilization procedures can influence the torsional properties of endodontic instruments. Studies on resistance to torsional stress have related the number of sterilization cycles to the torsional properties, showing variations in the resistance to torsion and in the angle of deflection during torsion.

The challenge is that sterilization cycles can either lead to deterioration, have no influence, or improve the mechanical properties of the instruments. In 2000, Hil et al reported no influence on the torsional properties of both steel and nickel-titanium alloy (NiTi) instruments. Whereas in 2011, King et al. reported a reduction in torsion resistance for GT Series X rotary instruments (Dentsply, Tulsa Dental Specialities, Tulsa, OK, USA) and an increase in resistance for Twisted Files (SybronEndo, Orange, CA,
USA). Additionally, in 2011, Casper et al. showed an increase in resistance to torsional fatigue for controlled memory (CM) wire files. Alazemi et al. in 2014 showed a recovery effect on the instrument shape after autoclave sterilization.

The scientific literature is therefore not always in agreement with the effects of sterilization. These differences may be derived from the heterogeneity of the rotary systems investigated, regarding the alloy composition, diameter, taper at the tip and shapes of the sections.

The relationship between cyclic fatigue and sterilization procedures were investigated, but not conducted till 2019. The literature, however, some studies proved that there is an increase in cyclic fatigue after sterilization process, other studies conducted that there is a decrease and others reported that there is no effect.

Reagents

Equipment

Procedure

Sample preparation:

The samples of both groups will be measured before sterilization, after 1 cycle and after 3 cycles of sterilization.

The new files of all group will be used for 5 sec in transparent acrylic canal block suitably fit the instruments in size and taper and having 17 mm in length.

Cyclic fatigue resistance test:

A special custom-made device will be made for the evaluation of cyclic fatigue resistance. This device will consist of a main metal frame to which a mobile support and a stainless steel block containing the artificial canals will be attached. The mobile support will be used to accommodate the electric hand piece to ensure precise and reproducible insertion of each file into the canal in terms of sustaining the same insertion depth and the 3-dimensional alignment.

The artificial canals will be machined to suitably fit the instruments in size and taper having a length of 16mm and a diameter that is greater than the instruments maximum diameter by about 1.4 mm. These canals will have a 60° angle of curvature and a 5mm radius of curvature. The curved segment will be approximately 5mm in length with its center being 5mm from the tip of the instrument.

The hand-piece powered by a torque controlled endodontic motor will be used to rotate the files at a constant speed of 300 rpm and a torque of 3N cm for all groups. Prior to each file insertion, lubricating synthetic oil will be used to reduce the friction between the instrument and the canal walls thus
decreasing the amount of heat generated. Moreover, a glass will be used to cover the artificial canals in order to prevent the file from slipping and ensure the reproducibility. All instruments will be rotated until fracture occurs. This will be confirmed by both audible and visible signs.

Time to fracture will be recorded in seconds using a digital chronometer (stopwatch) to be followed by calculation of the number of cycles to failure (NCF) using the following equation:

\[ \text{NCF} = \text{Time to fracture (seconds)} \times \text{Number of rotations per minute} \]

**Surface roughness test:**

Surface roughness will be assessed using scanning electron microscope for each group

**References**


