Physical and Chemical Effects of Different Disinfectant Solutions on Gutta-percha & Resilon cones

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا ۖ إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

صدق الله العظيم

سورة البقرة الآية (٣٢)

Dedication

This thesis is dedicated to my parents.

My father, my all-time hero, for his endless support and devotion, He did not only raise and nurture me but also taxed himself dearly over the years for my education and intellectual development.

My mother, my paradise on earth, for her genuine love & support, she has been always there for me, a source of motivation and strength during moments of despair and discouragement.

I dedicate this thesis also for my siblings, family & friends … God bless you all.

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Introduction:

Obturation is one of the most important procedures which determine the success of endodontic therapy. The main purpose of obturation is to promote healing and prevent percolation or ingress of microorganisms into the periapical area. A positive correlation has been established between bacteria and pulpal and periapical pathosis so aseptic techniques are paramount in the prevention of contamination of the root canal system to prevent breaking the chain of asepsis therefore eliminating possible flare ups or endodontic treatment failures.

Gutta-percha, at present, is the most commonly used material for obturation of the root canal system. It is the trans-isomer of polyisoprene differing dramatically in its tensile strength from natural rubber (cis-isomer) which is amorphous while GP is approximately 60% crystalline. GP polymeric molecule has two distinct interconvertible alpha and beta crystalline forms, but not convertible into natural rubber. It is composed of organic (gutta-percha polymer and wax/resins) and inorganic components (zinc oxide, barium sulfate). Coloring agents and antioxidants can also be present in small percentages. Gutta-percha shows favorable properties because of its easy handling; low cost; good biocompatibility; radiopacity; plasticity; reasonable dimensional stability; with easy removal in the presence of organic solvents; not causing the staining of the tooth structure, and being insoluble to the organic fluids.

Resilon is a thermoplastic synthetic polymer composite that has the potential to challenge the use of gutta-percha as a root filling material as it performs like gutta-percha in handling properties and is similar to GP in size. Resilon is composed of a parent polymer, polycaprolactone, which is biodegradable polyester with a moderately low melting point & filler particles consisting of bioactive glass, bismuth oxychloride and barium sulphate. The thermoplasticity of Resilon is provided by the polymer polycaprolactone, while its ability to bond with methacrylate based resins is because of the fact that dimethacrylate monomers were blended into the polymer.

There is some controversy as to whether the disinfection process is necessary because of the antibacterial characteristics of the GP cone itself, due to zinc oxide incorporation and/or the antibacterial activity of the sealer, which is

normally used with cones during obturation. Nevertheless some studies identified commercially available Gutta-percha & Resilon points contaminated either by the manufacturing process or by warehousing and storage even though they are manufactured under aseptic conditions. Also, they may be contaminated by either aerosols or handling during its use because there are several points in a same box. Therefore, to maintain the aseptic chain, even if the package is sealed, the points are not suitable for immediate use, and should undergo a chemical disinfection process because Gutta-percha and Resilon are thermolabile material and they cannot be sterilized through heat.

Several disinfectant solutions have been reported to be a suitable mean for rapid decontamination of filling materials. Sodium hypochlorite (NaOCl) is an excellent disinfecting agent most frequently used in endodontic therapy for irrigation and also for cone disinfection. It's an effective antimicrobial agent, but its effectiveness is related to concentration and exposure time. Another rapid disinfectant solution is Chlorhexidine (CHX), it's used as an irrigation solution because of its antimicrobial efficiency against bacteria and yeasts that are commonly found in endodontic infections and its substantivity. Polyvinyl Pyrrolidone Iodine (PVP-I) is also used in the dental operatory in scrubbing and operating field disinfection. It's a complex formed by combining Polyvinyl Pyrrolidone with iodine. It is less toxic than iodine, does not stain, and is effective for treating a variety of skin, mucosal infections & decontaminating Gutta-percha and Resilon cones. Ethyl Alcohol 70% has been also proposed for filling material disinfection, 70 % concentration by volume is widely used in dentistry. It has been claimed that it may be a reasonable choice for intermediate-level disinfection provided the items can be submerged for an adequate contact time.

However, there is a concern that these disinfectants may affect the physical, chemical and surface texture properties of the cone, thereby affecting the outcome of obturation. Therefore it's important to shed a light on the effects of different disinfecting solutions on filling materials' properties.

Review of literature

In this section, literature was reviewed regarding three aspects, the effect of different disinfectant solutions on the tensile strength, chemical composition and surface topography of gutta-percha and Resilon cones.

1. Physical & mechanical properties of obturating core material and the effect of disinfectant solutions:

Friedman et al. [(1)] used an Instron universal testing machine to determine the mechanical properties of gutta-percha. The crosshead speed (strain rate) was set at 10 inches per minute. The specimen gauge length was 1.5 cm, and the cross-sectional area was 0.105 $cm.^2$. Results showed that the gutta-percha behave as a viscoelastic strain rate-sensitive material consistent with partially crystalline polymeric materials. The mechanical properties were found to be extremely temperature and strain rate sensitive. Specimens loaded in tension at temperatures less than 23 C appeared to fall at relatively low strain. However, those loaded at temperatures greater than 25 C failed at relatively high strain.

Oliet & Sorin [(2)] examined the effects of storage at varying times up to 24 weeks and temperatures from -12" C. to 50" C, on the mechanical properties of size 100 hand-rolled gutta-percha cones. The mechanical properties were examined via tests of compression, tension, torsion and bend. The mechanical changes that occurred in most instances where most rapid during the initial 40- to 60-day period while subsequent changes were considerably slower to the end of the 16th day. Average deformation angle changed from 65 degrees to 90 degrees during the first 60 days and increased to 95 degrees only during the remainder of the program. The higher the storage