

**The Effect of Autoclave Sterilization
on the Cutting Efficiency and
Cleaning Ability of Two Different
Nickel Titanium Rotary Systems.
(An In Vitro Study)**

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Dedication

To my great father, my beloved mother, and a wonderful brother for their endless support and encouragement throughout my life.

To my beloved wife and my little angel Lara who are sharing with me the moments of joy and hardship.

To my most-valued professors who spared no effort to help me excel and progress in my academic and practical career.

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Root canal success is dependent upon two major factors: cleaning and shaping. Proper cleaning is essential in order to provide an adequate seal and to prevent failure. The goal of shaping the canal is to develop a continuously shaped three-dimensional conical form from the apex of the root to the crown. During shaping, it is critical that the canal anatomy be maintained and tooth structure be conserved.

Nitinol alloys exhibit superelastic behaviour, allowing them to return to their original shape upon unloading following deformation. Endodontic files of nickel titanium (NiTi) are useful instruments for canal preparation. Used by themselves or in combination with stainless steel instruments, they allow efficacious preparation of pulp canals and decrease the working time.

Protaper Next files (made from M-wire) is the successor to Protaper Universal system, which has been the gold standard in endodontics for many years. The M-wire NiTi material improves the file flexibility while still retaining cutting efficiency. Hyflex CM files (made from CM wire) are manufactured utilizing a unique process that controls the material's memory , making the files extremely flexible with no rebound.

Infection control is of great significance in today's clinical practice. Apart from bacteria, there is a constant threat of cross infection involving viruses and prions. Autoclave sterilization, after a stringent cleansing protocol with the use of chemicals is needed for complete sterilization of endodontic instruments.

Introduction

Up to date, there is a little data in the literature about the effect of autoclave sterilization on Protaper Next and Hyflex rotary files.

- **Sterilization and Cutting Efficiency of Enlarging Instruments:**

Cutting dentin is an important step during root canal preparation, as it is necessary to remove contaminated dentin and shape the canal to create conditions for it to be filled. With the advancement in technology, NiTi endodontic instruments come in a variety of designs and manufacturing processes, each aiming to improve performance and safety.

Morrison et al¹ evaluated the effects of steam sterilization and usage on cutting efficiency of endodontic instruments. The effects of steam sterilization and usage on sharpness were assessed on size #25 endodontic files. Files were used to instrument 1, 5, and 10 molars. Control groups determined the effect of steam sterilization alone on cutting efficiency of unused files. A cutting efficiency test was performed on an apparatus that compares sharpness of files when used in linear motion. Scanning electron microscopic analysis was performed in each group. Significant differences were found between experimental files used to instrument 1 molar and those used for 5 or 10 molars. The difference in cutting efficiency between the second and third experimental groups was not significant, indicating that most of the decrease in sharpness occurred with use between one and five molars. No significant difference was found between the control groups, indicating no decrease in cutting efficiency by sterilization alone. The scanning electron microscopic analysis supported the statistical data.

Zettlemoyer et al² discussed effects of sterilization procedures on the cutting efficiency of stainless steel and carbon steel gates glidden drills. One-hundred fifty carbon steel Gates Glidden drills were compared with one-hundred fifty stainless steel Gates Glidden drills before and after sterilization in an autoclave, salt beads, dry heat, or 2% alkaline glutaraldehyde. Cutting efficiency and separation rates of the drills were evaluated. Stainless steel size 1&2 Gates Glidden drills resisted separation and maintained their cutting efficiency statistically better than the carbon steel size 1&2 Gates Glidden drills after one sterilization cycle in an autoclave, salt bead sterilizer, or dry heat oven.

Tepel et al³ studied the cutting efficiency of endodontic hand instruments used in rotary motion. Cutting efficiency of 24 different types of endodontic hand instruments, which are primarily designed for a rotary working action, was investigated under standardized conditions. With a computer-driven testing device, resin specimens with simulated cylindrical canals were instrumented using a defined working motion simulating the clinical use of the instruments. Maximum penetration depth was the criterion for cutting efficiency. Sample size was 12 instruments for each type and size (#25 and #35). Nitinol K-files showed the least cutting efficiency. Stainless steel reamers and especially K-files showed better cutting efficiency than Nitinol K-files. Flexible stainless steel instruments displayed the best results. With regard to cutting efficiency, flexible stainless steel instruments were clearly superior to stainless steel K-files, and especially to Nitinol K-files.

Haikel et al⁴ studied the effects of cleaning, disinfection, and sterilization procedures on the cutting efficiency of endodontic files. Unifile (De Trey, Bois Colombes, France), (Flexofile Maillefer, Ballaigues,

Switzerland), and H-File (Maillefer) were investigated. The cross-infection control treatment procedures investigated were as follows: chemical disinfection using NaOCl (2.5%) for 12 and 48 h, and NH₄ (5%) for 1 and 4 h; ultrasonic cleaning for 4 and 16 cycles of 15 min; and sterilization methods with chemiclave for 5 and 10 cycles of 20 min, Poupinel for 5 and 10 cycles of 120 min at 180 degrees C and glass beads for 10 and 40 cycles of 40 at 250 degrees °C. Cutting efficiency was evaluated as the mass of Plexiglas cut per unit of energy expended by the instrument in microgram/Joule. The cutting efficiency decreased from 1 to 77%, depending on the file design and type of treatment procedures. Heat sterilization (Poupinel) did not modify the cutting efficiency of Unifile and Flexofile. The decrease in cutting efficiency was independent of frequency and duration of treatment procedures.

Hurt and Rossman⁵ analyzed several different methods of file sterilization in order to determine the best method of providing complete file sterility, including the metal shaft and plastic handle. Six test groups of 15 files were studied using *Bacillus stearothermophilus* as the test organism. Groups were sterilized by glutaraldehyde immersion, steam autoclaving, and various techniques of salt sterilization. Only proper steam autoclaving reliably produced completely sterile instruments. Salt sterilization and glutaraldehyde solutions may not be adequate sterilization methods for endodontic hand files and should not be relied on to provide completely sterile instruments.

Tepel and Schafer⁶ assessed cutting efficiency, instrumentation of curved canals, bending and torsional properties of endodontic instruments. Two aspects are of particular interest for the endodontist: the cutting efficiency of the instruments and their ability to enlarge curved