

# CLEANING AND STERILIZATION EFFECT ON THE TORSIONAL PROPERTIES OF PROTAPER ROTARY TITANIUM COBALT (Ti-Co) ENDODONTIC INSTRUMENT



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## ABSTRACT

This study was conducted to evaluate the effect of the number of cycles of cleaning using NaOCl solution of different concentration and sterilization using autoclave and dry heat oven on the torsional properties of rotary (Ti-Co) instruments. A total of forty five rotary protaper finisher instruments were divided into 3 groups: Group 1 were subjected to neither cleaning nor sterilization cycles and assigned as the control group. Group 2 and group 3 were subjected to 5 and 10 cleaning and sterilization cycles respectively, soaked within (2% and 5%) NaOCl, were sterilized with autoclave and dry heat oven. Then, all instruments were subjected to a clockwise torsional load until fracture, the torsional moment and angular deflection at fracture were calculated. The results show a significant reduction in the torsional strength after cleaning and sterilization cycles regardless the concentration of NaOCl, type and number of sterilization cycles. For the angular deflection, there was a highly significant reduction, where, the number of cycles was the most influencing factor for reduction of the angular deflection whereas, the concentration of NaOCl and the type of sterilization were show no significant influence on the angular deflection.

## Introduction:

There are many pitfalls on the road to consistent results, with proper use of the Ti-Co systems, endodontists will be able to improve the quality of their endodontic obturations quickly. Cobalt increases the elastic modulus, strength, and hardness of the alloy more than does nickel (1).

The unique properties of titanium cobalt alloy, such as flexibility, have allowed the development of it endodontic instruments in order to achieve shaping objectives and overcome the limitations imposed by stainless steel alloy which often encountered during instrumentation(2).

However, the extent to which instrument design characteristics will influence clinical outcomes is difficult to predict(3). The cutting edge forms and deflects chips from the wall of the canal and severs or snags soft tissue. Its effectiveness depends on its angle of incidence and sharpness (4). Torsional fracture usually occurs when the instrument gets forced into the root canal and once jammed fractures at its weakest point.

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This type of failure is associated most often with an unwinding of flutes that can be recognized and the operating microscope. The fractured instruments usually are engaged into dentine along their whole lengths and it is very difficult to remove it. On the other hand, fatigue failure causes the instrument to fracture at the point of its maximum flexure. These instruments do not exhibit any unwinding of flutes when observed under the operating microscope(5).

Chelating agents in a paste type tended to adhere to the grooves in endodontic files leading to clogging of the grooves with dentine chips, while fluid irrigates tended to flush dentine debris away from the instrument. Use of paste type chelates is therefore not recommended(6).

## Materials & Methods:

The engine driven rotary instruments which studied for torsional and angular deflection, after cleaning and sterilization procedures, were Protaper rotary Ti-Co files.

They have a tip size ISO 30, length 25 mm, taper 0.09 and a diameter of 0.57 mm at the distance 3 mm

from the tip. A total of 45 instruments were withdrawn from a sealed boxes, then randomly divided into three groups:

Group 1: consisted of five instruments which were subjected to neither cleaning nor sterilization cycles and assigned as the control group.

Group 2: consisted of 20 instruments which were divided into two subgroups (10 instruments for each subgroup) 2Aa and 2Ab subjected to 5 cleaning (2% NaOCl) and autoclave sterilization cycles. 2Ba and 2Bb subjected to 5 cleaning (5% NaOCl) and dry heat sterilization cycles.

Group 3: consisted of 20 instruments which were divided into two subgroups, (10 instruments for each subgroup) 3Aa and 3Ab subjected to 10 cleaning (2% NaOCl) and autoclave sterilization cycles. 3Ba and 3Bb subjected to 10 cleaning (5% NaOCl) and dry heat sterilization cycles.

#### CLEANING PROCEDURE:

Each cleaning cycle involved immersion of the instruments in NaOCl solution for 10 minutes for each cleaning cycle, then they were thoroughly rinsed with distilled water immediately after each cycle shaken and allowed to dry 30 minutes before preceding the sterilization cycle. Diluted cleaning solution was daily prepared to get a fresh solution.

#### STERILIZATION PROCEDURE:

Sterilization was carried out according to (7,8) with the use of an autoclave and a dry heat sterilizers. Sterilization conditions for the autoclave sterilized files were a pressure of 30 PSI at  $136 \pm 2^\circ\text{C}$  maintained for  $30 \pm 0.5$  minutes, while the dry heat sterilized instruments at a temperature of  $180 \pm 5^\circ\text{C}$  maintained for  $30 \pm 0.5$  minutes and the oven was preheated for 20 minutes at  $180^\circ\text{C}$  before beginning the sterilization cycle. After completion of each cycle the instruments were allowed to cool down to room temperature for 30 minutes before starting the next cleaning and sterilization cycle.

#### TESTING METHOD:

The torsional moment (in g.cm) represented the moment when instrument failure occurred during a clockwise rotation and angular deflection (in degrees) represented the twist angle for breakage. One millimeter of the instrument shaft was secured in a driving chuck that was attached to the gearbox unit,

while the last 3mm of the working part of the instrument were held in a small chuck attached to the shaft of the torque meter. Torsional loading was performed manually through driving the input was calculated through the hand wheel in a manner that produces a clockwise rotation for the output shaft of the gearbox unit until the instrument fractured.

The maximum torque at the fracture formula (9):  
Maximum Torque (G.cm)= Maximum Load (G) $\times$ Radius (cm).

#### Results

The results of the present study, regarding the torque values (in g.cm) and the angular deflection values (in degrees) of all groups.

#### TORQUE AT FRACTURE:

The results of the descriptive statistics, minimum and maximum values of the torque at fracture (in g.cm) of all groups are presented in figure (1).

In comparison among the groups, a statistical analysis of the torque values of all groups, using analysis of variance (ANOVA) test, which showed that there was a statistically significant difference ( $P < 0.05$ ) among the tested groups, regarding their torque values.

A significant reduction in the torsional strength of rotary Ti-Co instruments after exposure to NaOCl and sterilization. This come in agreement with the findings of other studies (10, 11, 12, 13), which was the results of a combined adverse effects of corrosive NaOCl and sterilization on the mechanical properties of Ti- Co instruments.

Also, the present study showed that there was no significant differences between different experimental groups regarding the type of the sterilization (dry heat or autoclave), when other variables such as number of the cleaning and sterilization cycles and NaOCl concentration were fixed. This finding agreed with the findings of other studies (13,14).

#### THE ANGULAR DEFLECTION:

The descriptive statistic of the results regarding the angular deflection, minimum and maximum values of all groups are presented in figure(2).

Regarding the degree of the angular deflection, another analysis of variance (ANOVA) test, was performed, in comparison among the groups, and the results of this second (ANOVA) test showed a very

highly statistically significant difference among the tested groups( $P<0.0001$ ).

A lower values of the angular deflection for our new samples compared to controlled samples, may be related to fact that it was larger and has a greater taper (size 30 and taper 0.09) than the controlled samples, so consequently, it was stiffer and less flexible. This confirmed by a study showed that as the instrument was smaller and less taper, as it was more flexible and has a higher angular deflection values at fracture (15,16).

For instance, the present study results showed that values of angular deflection at failure was dramatically decreased after 5 and 10 sterilization cycles as a trend towards higher angle of rotation at fracture was observed with the new instruments compared to the sterilized ones. These findings are in full agreement with the results of (11,13,17).

Cleaning using NaOCl and autoclave and dry heat oven sterilization have a deleterious effects on the torsional load and angular deflection at fracture values of rotary titanium cobalt instruments.

- 1- The concentration of NaOCl, type of sterilization and the number of cleaning and sterilization cycles, were not significantly influencing the reduction of the torsional load at fracture values.
- 2- Clockwise torsional load application to the instruments causes a deformation in the spirals and the flutes of the instruments as unwinding, revers winding, revers winding with tightening of the flutes or a combination of them.

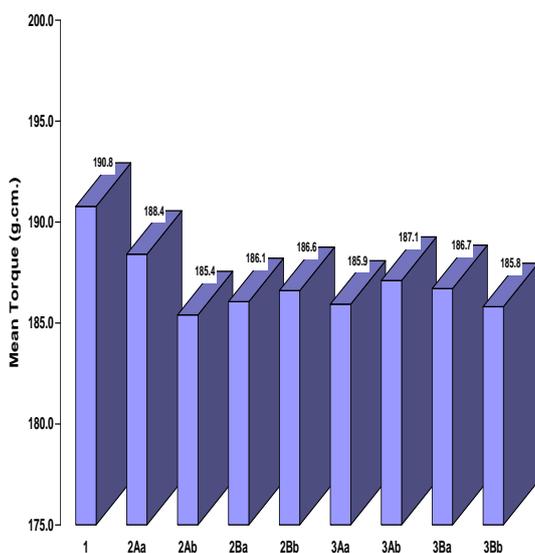


Figure (1): Bar chart of mean Torque values (in g.cm) of all groups.

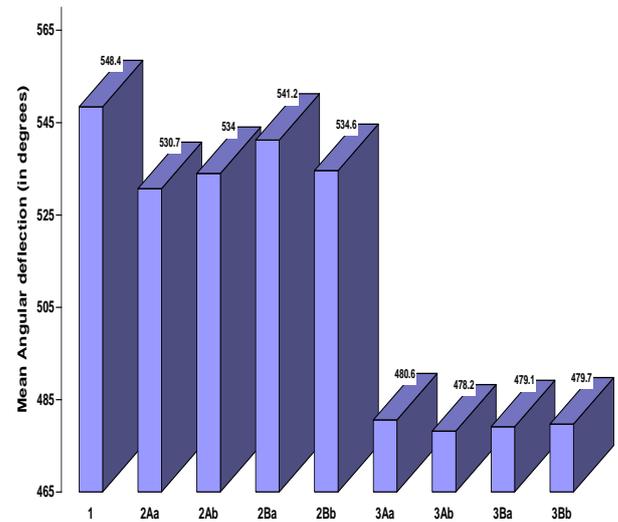


Figure (2): Bar chart of mean Angular deflection values of all groups.

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## تأثير التنظيف والتعقيم على عزوم الالتواء لمادة التيتانيوم كوبالت المستخدمة في توسيع قنوات جذور الاسنان.

ابراهيم حمد مخلف

### الخلاصة

أجريت هذه الدراسة لتقييم تأثير عدد مرات (دورات) التنظيف باستخدام محلول القاصر بتركيز مختلفة والتعقيم باستخدام جهاز التعقيم بواسطة البخار المحمي والضغط و فرن الحرارة الجاف على خواص الالتواء للأدوات الدوارة المصنوعة من التيتانيوم كوبالت. تم استخدام خمسة أداة دوارة نوع (بروتيبير المتممة) وقد تم تقسيمها إلى ثلاثة مجاميع:

- المجموعة الأولى: أدوات لم تعرض لأي من دورات التنظيف والتعقيم وتم تحديدها كمجموعة سيطرة.

- المجموعة الثانية والثالثة: تم تعريضهما لخمس وعشر دورات (تنظيف وتعقيم) بالتعاقب, غمرت بمحلول القاصر بتركيز 2% و 5% بمحلول القاصر, تم تعقيمها باستخدام جهاز التعقيم بواسطة البخار المحمي والضغط وفرن الحرارة الجاف. كل الأدوات تم تعريضها لأحمال التواء باتجاه عقارب الساعة حتى الكسر وقد تم احتساب قيم عزوم الالتواء والانحراف الزاوي لكل أداة بعد الكسر. أظهرت نتائج الدراسة تأثيرا ملحوظا في تقليل قيم عزوم الالتواء بعد دورات التنظيف والتعقيم بصرف النظر عن تركيز محلول القاصر ونوع التعقيم وعدد مرات التنظيف والتعقيم. بخصوص الانحراف الزاوي كان هناك تأثيرا عاليا ملحوظا في تقليل قيم الانحراف الزاوي للأدوات. حيث أن عدد مرات التنظيف والتعقيم كانت عاملا مؤثرا بينما كان تركيز محلول القاصر ونوع التعقيم ذو اثر غير ملحوظ.