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Original Article

Effect of NaOCl solution on the cyclic fatigue resistance of traditional and heat-treated file systems

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Abstract

Aim: To compare the cyclic fatigue resistance at distilled water and %5.25 NaOCl of immersed ProTaper Gold (Dentsply Sirona, Ballaigues, Switzerland) and ProTaper Universal (Dentsply Sirona, Ballaigues, Switzerland) file systems.

Material and Methods: The ProTaper Gold F2 (25.06v taper) and ProTaper Universal F2 (25.06v taper) file systems were immersed in distilled water andNaOCl for 5 minutes. After immersion process files were rotated at artificial canal with 60O curvature and a 5-mm radius until fracture occurred. Time to fracture and fractured lengths were recorded. Data were analyzed statistically using independent t-tests. Statistical significance was set at P <.05.

Results: ProTaper Gold files had a significantly higher resistance to cyclic fatigue than ProTaper Universal files (P < .05). When ProTaper Universal immersed in distilled water showed higher resistance to cyclic fatigue than immersed in NaOCl solution (P < .05).

Conclusion: ProTaper Gold system more resistant than ProTaper Universal system to cyclic failure. The effect of NaOCl were higher on the ProTaper Universal system.

Keywords: Corrosion, cyclic fatigue; NaOCl; ProTaper Gold; ProTaper Universal.

INTRODUCTION

One of the main goal of endodontics is to achieve bacterial elimination and to completely remove necrotic or vital tissues in to the root canal system. Today, it is known that nickel-titanium (NiTi) rotary files are faster and more effective to prepare root canals than conventional hand files (1). However, despite the increased flexibility, torsional and cyclic durability of the rotating files, instrument fracture can occure in the root canal is one of disadvantages (2,3). Advances in surface treatments, design and application of heat treatments reduce the fracture incidence of files (4-6). It is known that the thermomechanical processing applied to the files significantly increases the durability of the files (6,7). A previous study showed that the heat-treated ProTaper Gold (PTG; Dentsply Sirona, Ballaigues, Switzerland) file had higher cyclic fatigue resistance than the non-heat-treated ProTaper Universal (PTU; Dentsply Sirona, Ballaigues, Switzerland)file (8). Instrumentation is not enough to clean the root canal system, but also the irrigation solutions plays an important role like as sodium hypochlorite (NaOCl) solution (9). NaOCl is one of the most used irrigation solution for root canal irrigation due to its antimicrobial and tissue dissolving properties (10). However, one of the disadvantages of NaOCl is its corrosive effect on metals (11,12). Previous studies have reported a decrease in cyclic fatigue resistance of NiTi files with NaOCl corrosion (13,14). A previousstudy (8) comparing the cyclic fatigue resistance between traditional PTU and heat-treated PTG files in the literature. However there is no study that compare the cyclic fatigue resistance of these two same cross-section files after treated with NaOCl solution. The main purpose of the study was to understand the effect of NaOCl on the cyclic fatigue resistance of PTU and PTG files. The null hypothesis of the study was that:

1. No difference between groups.
2. NaOCl does not affect fracture resistance

MATERIAL and METHODS

In the study, PTU F2 (25.06v taper) and heat treated PTG F2 (25.06v taper) files were used. Files were examined with a stereo microscope (SMZ1500, Nikon Corp., Tokyo, Japan) under 25X magnification to detect deformities and defects.

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Files with deformity and defect were excluded from the study. A total of 30 files were used for each main group with 15 files in each group. 15 PTU and 15 PTG files were used in artificial canal in Group 1 without immersed any solution as a control group. In group 2, used 15 PTU and 15 PTG files were used in artificial canal after immersed in 5.25% NaOCl (CanalPro; Coltene Whaledent, Altstätten, Switzerland) solution at room temperature (23±1 C°) for 5 minutes as a previous study (15). The artificial canal where the files were tested was made of stainless steel and had a 60° curvature and a 5-mm radius. All files were tested at 300 rpm and minimum torque with the 6:1 reductive VDW Silver Reciproc endodontic motor (VDW GmbH, Munich, Germany). Lubricant oil (WD-40, Milton Keynes, England) was used to minimize the torsional force in the artificial root canal (Fig. 1). Against the jumped of broken files, the artificial canal was covered with a glass protector. In the experiments, all the files were rotated in the static artificial canal model until they were broken and the time until the fracture was measured by a stopwatch (Timex, Middlebury, USA). In order to determine the area exposed to the cyclic force on the files, all the fractured parts were measured by caliper and recorded.

Statistical analysis

All statistical analyses were performed using SPSS 24.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov Smirnov test was used to examine the normal distribution of data. An independent sample t-test was used to compare the cyclic fatigue resistance and length of fractured parts among groups. P <.05 was determined as statistically significant.

RESULTS

The PTG file, which was immersed for 5 minutes in two different environments (DW & NaOCl), had a higher cyclic fatigue resistance than the PTU file (P <.05). The cyclic fatigue resistance of the PTU file immersed in DW was higher than the PTU file immersed in NaOCl (P <.05). PTG file immersed in DW increased the time to fracture compared with immersed in NaOCl without no statistically significant difference (P >.05). There was no significant difference between the fracture lengths of all groups (P >.05) (Table 1).

Table 1. ProTaper Universal (PTU) and ProTaper Gold (PTG) files, time to fractured (TF; second) and fractured part lengths (FL; millimeter) results (mean ± standard deviation)

	TF(s)	FL(mm)
PTU with istilled water	74.3 ± 12.5a	4.4 ± 0.14k
PTU with 5.25% NaOCl	51.2 ± 7.2b	4.3 ± 0.22k
PTG with distilled water	180.7 ± 18.1c	4.2 ± 0.08k
PTG with 5.25% NaOCl	156.2 ± 16.5c	4.4 ± 0.1k

Different superscript letters indicate significant differences between groups in the vertical column (P <.05)

DISCUSSION

In the present study, the cyclic resistance of the PTG file with gold heat treatment was significantly higher than the PTU file. The first hypothesis was accepted. There was a decrease in the cyclic resistance of the PTU file while immersed in the NaOCl solution, whereas the resistance of the PTG file was not decreased. Therefore, second null hypothesis was partially rejected because of PTG file not few resistances after immersed NaOCl solution. Heat treatment applied to NiTi files during production increases the torsional and cyclic resistance of the files (8,16,17). A 5.25% NaOCl solution was recommended for rapid cleaning of root canals (18). However, many studies have not been conducted to investigate the effect of NaOCl on heat-treated NiTi files. Therefore, this study aimed to investigate the cyclic fatigue resistance of the traditional PTU file and the heat-treated PTG file when NaOCl used as irrigant. The findings of the present study were consistent with the findings of previous studies that the PTG file had higher cyclic fatigue resistance than the PTU file (8,19,20). It was observed that the gold heat treatment increased the flexibility of the PTG file and increased its cyclic resistance. Within the limitation of the study, the files used were immersed in 5.25% NaOCl solution, but in clinical practice the files were used with NaOCl solution in the root canal. However, in the root canal, NaOCl solution is mixed with pulp residues and debris and its effectiveness decreases relatively (21,22). Therefore, the effect of NaOCl on NiTi files may be different. The cyclic resistance of the PTG file decreased significantly after immersion in NaOCl solution. This is expected because the corrosive effect of NaOCl solution leads to the formation of micro cracks on the files. During the tensile and compression forces that occur in cyclic fatigue tests, these cracks may suddenly tear and fracture may occur earlier in the file (23). Another limitation of the present study was the static test model used in the experiments. In the static test model, the rotating file in the artificial canal does not make packing motion, and therefore the compressive tensile forces are continuously effect in the same location on file, which does not fully meet the clinical conditions. The results of the tests showed that the lengths of the fractured file length were very close to each other, indicating that the regions where the cyclic fatigue intensity was the same, so that the metal volumes affected were close to each other.

CONCLUSION

PTG file system more resistant from PTU file system to cyclic failure. Although the effect of NaOCl was efficient on PTU files, it did not efficient on PTG files.

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