SUMMARY:
The aim of this in vitro study was to establish and compare the amount of debris and irrigant extruded apically after root canal preparation with two rotary systems (K3 and RaCe).

Methods: Two groups of 24 extracted teeth with single canals were used. In group 1 (12 teeth) the root canals were instrumented using nickel-titanium K3 rotary instruments and “crown-down” technique. In group 2 (12 teeth) the root canals were instrumented using nickel-titanium RaCe rotary instruments and “crown-down” technique. Debris and irrigant extruded from the apical foramen were collected into pre–weighed vials (using Myers and Montgomery technique) and the amounts were determined. Time taken for each instrumentation technique was also determined. The data was input and processed using the statistical software package SPSS 17.0.1.

Results: The amount of the debris extruded through apical foramen in group 1 (K3 files) was 0.225 mg and in group 2 (RaCe files) was 0.213 mg. The volume of the extruded irrigant was 0.247 ml in group 1 and 0.238 ml in group 2. Time taken for instrumentation was 8.3 min by RaCe files and 8.7 min by K3 files. The difference in the amount of debris and irrigant produced among two groups was not significant.

Conclusions: It was concluded that the RaCe system induces less extruded debris and irrigant through the apical foramen, than the K3 system. The difference between two groups was not significant.

Key words: apical extrusion, K3 nickel-titanium instruments, RaCe nickel-titanium instruments, rotary endodontic systems

INTRODUCTION
Apical extrusion of debris and irrigant during cleaning and shaping of the root canal is one of the common problems encountered by an endodontist. Several studies have shown that dentin fillings, necrotic tissue, pulp remains, microorganisms and irrigating solution may be forced towards the periapical tissues during root canal instrumentation [1 - 8].

Apically extruded debris contributes to the severity of inflammation reaction. Tissue reactions following instrumentation shorter than the apex are milder than those reactions that follow instrumentation beyond the apex. Therefore, minimizing the amount of apically extruded debris should minimize postoperative reactions [9].

Instrumentation methods, file size, and file type can also have an effect. Researchers have observed that the file may act as a plunger in the canal. Various studies used different techniques for debris collection and their measurement. Most recent studies used a more standardized and replicable method. Myers and Montgomery (1991) were the first to evaluate a manual rotary technique, comparing Canal Master (hand instruments) with conventional hand filing techniques.

Nowadays, there are a lot of rotary instruments. They are available in various designs [10 - 12].

The aim of this in vitro study was to establish and compare the amount of debris and irrigant extruded apically after canal preparation with two rotary systems (K3 and RaCe).
The teeth were divided into two experimental groups of 12 teeth.

**Group 1: Crown down engine-driven technique - nickel-titanium RaCe rotary instruments (FKG, Switzerland)**
- In the coronal part - taper.08
  - 0.06/25 - ½ of a working length
  - 0.06/20 - between ½ and 2/3 of working length
  - 0.04/20, 0.04/25, 0.04/30, 0.04/35 – full working length
- After using each instrument the root canal was irrigated with distilled water. Distilled water was used as the irrigant solution. Each canal was irrigated with total 10 ml of distilled water applying 27G 3/4½ (0.4×19 mm) needles.

**Group 2: Crown down engine-driven technique - nickel-titanium K3 rotary instruments (Sybron Endo, USA)**
- In the coronal part - taper.08
  - 0.06/25 - ½ of working length
  - 0.06/20 - between ½ and 2/3 of working length
  - 0.04/20, 0.04/25, 0.04/30, 0.04/35 – full working length
- After each applied instrument the root canal was irrigated with distilled water. Each canal was irrigated with 10 ml of distilled water in total applying 27G 3/4½ (0.4×19 mm) needle. Distilled water was used to avoid any possible weight increase due to NaOCl crystal formation. Control group - five vials of distilled water were used as a control, which were dried the same way and weighed. Time taken for each instrumentation technique was also determined.
- Debris and irrigant extruded from the apical foramen during instrumentation were collected into vials (using the Myers and Montgomery technique) and the amounts were measured (fig.2).

The experimental model consists of two glass vials, one of them is larger and the other one is smaller (the smaller one is inside the larger one - separate vials). The large vial was closed with a rubber plug, which is pierced and the opening corresponds to the root diameter of the tooth. The root of the tooth is placed in this opening and the surface is sealed with plastic.

During the processing of the root canals irrigant and debris passed through the apical foramen are collected in a small glass vial. This vial contains distilled water, and the apical part of the root is immersed in it. All vials were numbered and measured by the quantity of distilled water in them prior to the root canal processing.

Immediately after the canal instrumentation the smaller vials are removed from the big one and measured. Then they are placed in an electric oven at a temperature of 50-60° for 12-24 hrs until the liquid has evaporated (fig. 3). All tubes with vaporized liquid are placed in a desiccator containing CaCl₂ in order to prevent absorption and measured three times with analytical balance. The average of the measured values has been taken into consideration for the final result.

Measurements were done with an analytical balance with indication of the scale accurate to fifth place.

The data was input and processed using the statistical software package SPSS 17.0.1. The level of significance for rejecting the null hypothesis was fixed at p<0.05.
RESULTS
The amount of the debris extruded through apical foramen in group 1 (RaCe files) was 0.213 mg (table 1 and fig.4) and in group 2 (K3 files) was 0.225 mg.
The volume of the extruded irrigant was 0.238 ml in group 1 and 0.247 ml in group 2 (fig. 5).
Time taken for instrumentation was 8.3 min by RaCe files and 8.7 min by K3 files (fig. 6).
The difference in the amount of debris and irrigant produced among two groups was not significant.

Table 1. Weight of dry debris and irrigant extruded apically during shaping and cleaning by each rotary system

<table>
<thead>
<tr>
<th>Index</th>
<th>Crown-down technique</th>
<th>Crown-down technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RaCe files (n=12)</td>
<td>K3 files (n=12)</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>SD</td>
</tr>
<tr>
<td>Extruded debris (mg)</td>
<td>0.213</td>
<td>0.020</td>
</tr>
<tr>
<td>Extruded irrigant (ml)</td>
<td>0.238</td>
<td>0.020</td>
</tr>
<tr>
<td>Time taken for instrumentation (min)</td>
<td>8.300</td>
<td>0.670</td>
</tr>
</tbody>
</table>

n-number of samples
X - arithmetic mean of the amount of extruded debris and irrigant
SD – standard deviation

Fig. 4. Average extruded debris with RaCe file and K3 file.

Fig. 3. Dry substance after distilled water evaporation and moisture.
Fig. 5. Average extruded irrigant with RaCe file and K3 file.

Fig 6. Average time taken in both rotary systems of canal instrumentation.

**DISCUSSION**

Our results showed a better performance of the crown down technique with RaCe instruments compared to the K3 files. All movements of the file used in this study were rotational. Rotation during instrumentation tended to pack the dentinal debris into the flutes of the files and directed them toward the orifice. According to studies, instrumentation with the rotary systems could reduce the amount of debris extrusion to the periapical area [10, 11, 5, 13, 14].

In group 1, a crown-down technique is used by the RaCe files. Despite being a .04 taper instrument, the extrusion of debris is due to its typical instrument design. Easy RaCe (FKG, Switzerland) are Ni-Ti instruments with alternating cutting edges. These files implement more cutting dentin than scraping. They have a safe peak with a triangular cross-section. They have two cutting edges - the first is switched to a second, which is arranged at a different angle and a cutting body with a length of 8 mm, which allows varying helical angle and a variable angle of inclination. This increases the files’ “antiscrewing” characteristics. The presence of the protective disc is an easy and convenient method for monitoring the metal fatigue. Files are used at 500 rev. / min. During the processing with machine instruments dentine debris accumulated in the grooves of the files, and then they go directly to the orifice.
In group 2, a crown-down technique is used by the K3 files. Despite being a .04 taper instrument, the extrusion of debris is due to its typical instrument design: positive rake angle provides the active cutting action of the K3 endo files, wide radial land provides blade support while adding peripheral strength to resist torsional and rotary stresses, the third radial land of K3 files stabilizes and keeps the instrument centered in the canal and minimizes over engagement, radial land relief reduces friction on the canal wall. 

The present results are also in accordance with those reported by other authors who demonstrated a lower extruded debris, irrigant and bacteria using rotary Ni-Ti files [9, 15]. In the in-vitro studies the tooth is suspended in the air or vacuum, but in vivo it is surrounded by periapical tissues.

Obviously, one of the aims of canal preparation should be to minimize apical extrusion in order to prevent unwanted pain and inflammation. Using instruments and techniques which minimize this extrusion of debris and irrigant during the root canal preparation is recommendable.

CONCLUSIONS
It was concluded that the RaCe system induces less extruded debris and irrigant through the apical foramen than the K3 system. Processing time for root canal shaping with RaCe files was less than K3 files. The difference between two groups was not significant.

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REFERENCES:

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