The effects of rotary ni-ti canal instruments on canal curvature in the preparation of curved canals

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Summary

This study compared the effects of Hero 642 and Profile Ni-Ti canal instruments, to which a file is attached, on the original canal curvature.
This study was performed on the mesiobuccal canals of 20 extracted human mandibular first and second molar teeth. The teeth were embedded in clear acrylic resin and separated into two test groups. Pre- and postoperative radiographs of the teeth were made using a special apparatus. The radiographs were digitized and transferred to a computer. Using the program Free Hand, the pre- and postoperative angular and linear values of each tooth were determined, and then the curved canals were evaluated using AutoCAD R12.
In the teeth prepared using the Profile system, no statistically significant difference was found between the pre- and postoperative canal access angle (CAA), Schneider angle, or AC distance ($p > 0.05$). However, in the samples prepared with the Hero 642, the postoperative CAA decreased significantly ($p < 0.01$). Furthermore, there was also a significant decrease in the postoperative AC distance.

Key words: nickel-titanium rotary instruments, canal curvature, canal access angle (CAA)

Introduction

The goals of root canal preparation in endodontic treatment are to remove all pulp tissue, microorganisms, and affected dentin tissue and to clean and shape the root canal space. During canal preparation, the original canal curve and apical foramen should be protected without being transported [1].

When the root canal is curved, difficulty occurs during biomechanical preparation. Weine [2] reported that the case became more complex and complications were more likely during canal preparation if the canal curvature exceeded 30°. Recent studies revealed irregular preparation forms (such as ledges, zips, and elbows), apical foramen, and transportation of the canal, especially in narrow, curved canals [3,4,5].

In recent years, nickel-titanium (Ni-Ti) alloys have been use to make endodontic instruments because of their elasticity [6,7]. Moreover, Ni-Ti files fit the original canal anatomy better, reducing the risk of canal transportation during preparation [8,9].

The production of Ni-Ti instruments has increased the expectation of developing canal forms and reducing aberrations that impede the filling of canals [6]. Several studies suggest that the use of Ni-Ti files attached to rotary devices allows faster canal preparation and reduces patient and physician fatigue compared with the use of manual Ni-Ti instruments [10,11,12,13,14].

Hornberger et al. [15] investigated transportation in curved canals shaped using Flex-R (stainless steel), Onyx-R (Ni-Ti), Lightspeed, and Profile .04 instruments. In

preparations made using Ni-Ti rotary devices, transportation in the apical region and internal curvature decreased significantly. In a study of extracted maxillary molar teeth, Frick et al. [16] concluded that Ni-Ti rotary devices resulted in very little or no transportation in the apical one-third of the root canal.

The present study is a statistical comparison of the effects in terms of angularity of Hero 642 and Profile Ni-Ti canal instruments with attached files on the canal curve in curved root canal preparations.

Materials and Methods

Twenty-one and second molar teeth were studied. Teeth with incomplete apex formation, external root resorption, and canals too narrow and obstructed for entrance were excluded from the study. The mesiobuccal canals of the mandibular molar teeth were studied. When choosing samples, teeth of similar height were selected, with curves between 25° and 40° according to the Schneider method; there was no secondary curve, and care was taken to select teeth that allowed an ISO # 15 canal file to reach the foramen apicale. In order to obtain optimum working conditions, molds were prepared from plexiglass; clear acrylic (Ortokril Dentaurum, Germany) was poured into the molds, and the teeth were embedded in it. After the blocks have been numbered, the teeth were separated into two groups: Group I (n = 10), teeth widened using Profile canal files (Dentsply Maillefer, Ballaigues, Switzerland) and Group II (n = 10), teeth widened using Hero 642 canal files (Micro-Mega, France). The 20 roots were randomly assigned to one of the two groups.

Standardized radiographic evaluation

Preoperative radiographs were made by placing contrast material (Urografin, Schering AG) in the mesiobuccal canals, after creating access cavities in the teeth. In order to standardize the conditions for the radiographs, a special apparatus was prepared and placed within the molds in which the teeth were embedded. The radiographs were transferred to a computer using a scanner (Scanner: Agfa-Duascan, Germany).

Instrumentation procedure

The working length of each canal was determined by placing an ISO # 15 Nitiflex K-File (Dentsply, Maillefer, Ballaigues, Switzerland) up to the apical foramen, and then pulling it back 1 mm from this point. The canal was prepared using the crown-down technique according to the manufacturer's instructions. The different instruments (tapers 0.02, 0.04 and 0.06) were fixed on a Micro-Mega handpiece (Micro-Mega, Besanon, France) with a regular speed head. Each instrument was used once, and irrigation was performed with 2 ml of 5.25 % Na OCL (Chem-Bright, Brighton, MI) after each instrument size. The canals were prepared by the same operator, who was experienced in the technique.

After the preparation procedure had been completed, contrast material was again placed within the mesiobuccal canal and postoperative radiographs were made. These radiographs were again scanned and transferred to a computer.

Analysis of the canal preparation

The canal orifice (A) and apex (B) points were connected with a line. The angle formed by the intersection between this line (AB) and one drawn parallel to the long axis of the canal from the coronal part (AC), (used in the Schneider method) is defined by Günday et al. as the CAA (Figure 1), [17]. Using the program Free Hand (Macromedia, Inc. San Francisco, USA), the pre- and post-operative angular and linear values of each tooth were drawn, and the CAA and AC dis-

tance were measured, along with the Schneider angle, using AutoCAD R12 (Autodesk, Inc. San Rafael, USA) (Figure 1).

Statistical analysis

Statistical analyses were performed using SPSS for Windows 10.0. The pre- and postoperative values of the groups were compared using the Wilcoxon rank test.

Results

Our findings are summarized in Table 1. There were no significant differences in the pre- and postoperative CAA, Schneider angle, or AC distance in the samples prepared using Profile ($p > 0.05$). In contrast, the samples prepared using Hero 642 exhibited a significant ($p < 0.01$) postoperative decrease in CAA and a significant ($p < 0.01$) postoperative increase in AC distance.

Discussion

When shaping curved root canals, it is essential to protect the original canal curve and to prevent flattening that may impair canal integrity, especially at the apex [18] and in the internal part of the canal curve [3].

This study examined the changes in root canal shape during the preparation of curved canals using Profile and Hero 642 rotary Ni-Ti canal instruments. A reduction in the canal curve during the preparation of root canals indicates flattening of the original canal shape. The literature includes few studies that evaluate the alteration of the angle of the root canal curve. Esposito and Cunningham [19] compared the efficacy of stainless steel K-Flex and Ni-Ti canal files, used manually, in protecting the original canal. They found that Ni-Ti files shaped the original canal appropriately in all cases. The alterations to the canal curve produced using stainless steel and Ni-Ti files were similar to those produced using small-caliber files. However, they suggested that the results were better with Ni-Ti files of number 30 and above.

In this study, we used the crown-down technique with both the Profile and Hero 642 systems. With some canal widening techniques, beginning the preparation in the coronal region facilitates the entrance of the canal device and provides more comfortable working conditions [20,21]. In addition, some complications that may occur in the root canal are prevented, and canal transportation is decreased. Cunningham and Senia [22] investigated the effect of coronal flaring on the Schneider angle and reported that coronal flaring decreased this angle significantly.

We found no statistically significant differences in the CAA, Schneider angle, or AC distance pre- and postoperatively in canals prepared using the Profile system, indicating that the Profile system preserves the original shape of the root canal. In their study of curved canals, Bryant et al. [23] reported that the Profile system made very few alterations to the working length of the root canal, although they did not evaluate angles.

After canal preparation with the Hero 642 system, we found that the CAA decreased and AC distance increased significantly, while the Schneider angle did not change. This means that there was significant flattening of the root canal configuration. Moreover, our results indicated that determining the Schneider angle alone is not sufficient; it is necessary to determine the CAA and AC distance of the prepared root canal. Thompson and Dummer [24], who investigated the effects of the Hero 642 system on curved root canals, reported that there was significant canal transportation at the root canal entrance, root edge, and curvature apex, but they did not evaluate the canal angle. Their findings are in accordance with our results. They also suggested

that the Hero 642 system resulted in a significant alteration of canal shape [14]. Likewise, Karagöz-Küçükay et al. showed that final canal curvatures and working lengths by preparation with Hero 642 were significantly reduced compared with those of original values [25].

Under the conditions tested, the Profile system appeared to protect the original shape of the root canal better than did the Hero 642 system. To evaluate changes in the root canal curve after root canal preparation, the CAA and AC distance must be evaluated as well as the Schneider angle.

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