# Comparison of curved canal preparations by means of three different root canal curvature measurement techniques

# Eğri kanalların şekillendirilmesinin üç farklı kök kanal eğimi ölçüm yöntemi ile karşılaştırılması

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**SUMMARY**

**Aim:** The aim of this study was to compare the effects of two different rotary systems on the original canal curvature by means of three different root canal curvature measurement techniques.

**Materials and Method:** Mesiobuccal canals of thirty extracted human mandibular first and second molar teeth were equally allocated into two groups: Mtwo or ProTaper. After embedding in clear acrylic resin, preoperative radiographs were taken. Both systems were used according to the manufacturers' instructions. Pre- and postoperative angular and linear values of mesiobuccal canals were obtained from radiographs using AutoCAD R12.

**Results:** In both groups, the postoperative canal access angle (CAA) and Schneider angle (SA) were significantly decreased ($p \leq 0.005$). Postoperative AC distance (the distance between canal entrance and the point that the canal begins to move away from the long axis) significantly increased only in the ProTaper group ($p=0.005$).

**Conclusion:** The lack of a change in the AC distance in the Mtwo group indicated that the original canal curvature was maintained. Postoperative AC distance should also be measured, besides CAA and SA, in order to evaluate changes in the root canal curvature after root canal preparation.

**Keywords:** Canal access angle (CAA), curvature, Mtwo, ProTaper, Schneider angle.

**ÖZET**

**Amaç:** Bu çalışmanın amacı iki farklı döner eğe sisteminin, orijinal kök kanal eğimi üzerindeki etkilerinin üç farklı kök kanal eğimi ölçüm tekniği ile karşılaştırılarak incelenmesidir.

**Gereç ve Yöntem:** Otuz adet çekilmiş alt çene birinci ve ikinci büyük azı dişinin meziyobukkal kanalları Mtwo veya ProTaper ile şekillendirilmek üzere eşit olarak iki gruba ayrılmıştır. Dişler şeffaf akrilik rezin içine gömüldükten sonra pre-operatif radyografileri çekilmiştir. Her iki döner eğe sisteminin eğeleri üretici firma talimatları doğrultusunda kullanılmıştır. Meziyobukkal kanalların başlangıç ve işlem sonrası açısal ve doğrusal değerleri AutoCAD R12 programı kullanılarak radyografiler üzerinden hesaplanmıştır.

**Bulgular:** Her iki grupta da genişletme sonrası kanal giriş açıları (CAA) ve Scheider açıları (SA) anlamlı derecede azalmıştır ($p \leq 0.005$). Genişletme sonrası AC uzunluğu (kanal girişi ile kanalın uzun aksından ayrılmaya başladığı nokta arası mesafe) sadece ProTaper gurubunda belirgin olarak artmıştır ($p=0.005$).

**Sonuç:** Mtwo grubunda AC uzunluğunda değişiklik olmaması kanalın orjinal eğimini koruduğunu göstermektedir. Kök kanal şekillendirilmesi sonrası kanal eğimlerindeki değişikliklerin ölçülmesinde CAA ve SA açılarının yanısıra işlem sonrası AC uzunluğu da ölçülmelidir.

**Anahtar kelimeler:** Kanal giriş açısı, eğim, Mtwo, Protaper, Schneider açısı.

## INTRODUCTION

Endodontic preparation is difficult in the presence of curvatures and, all preparation techniques have a tendency to divert the prepared canal away from the original axis.[1-3] Procedural errors occurring during instrumentation (such as transportation of the apical foramen or the creation of zips, elbows, and ledges) may be accompanied by loss of working length, perforation and separation of instruments.[2,4,5] To improve clinical success of endodontic treatments and allow easier comparison between various investigations on curved root canals, a thorough knowledge of root canal morphology is essential; canal curvature should also be precisely measured and described.[6]

Several techniques were conducted to describe canal curvatures. Schneider angle was routinely used. Schneider method, is an intersection of a first line parallel to the long axis of the canal and a second line from the apical foramen to intersect the point where the first line left the long axis of the canal. Traditionally, root canal curvatures assessed by using the Schneider angle of curvature classifies root canals presenting an angle of 5° or less as straight canals, an angle between 10° and 20° as moderate curved canals, and a curve greater than 25° as severely curved canals.[7]

Weine angle is the intersection of a straight line which is drawn from the orifice through the coronal portion of the curve, and a second line which is drawn from the apex through the apical portion of the curve. Both Schneider angle and Weine angle mostly highlight the canal curvature in the apical region, not reflecting the overall root canal curvature. Therefore, Günday et al.[8] introduced the term Canal Access Angle (CAA) and two new curvature parameters concerning the coronal zone of curved root canals: the curvature starting distance (y) and the curvature height (x). In this method, 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) (which is also used in the Schneider technique), is defined as the CAA. They reported that CAA evaluates the root canal curvature more effectively than the Schneider angle. CAA together with height and distance of curvature offer more data about the coronal geometry of root canal curvatures.[9] The shape of root canal curvature can be more accurately described using the CAA alone[8] or in combination with the Schneider angle.[6]

The purpose of this study was to compare the effects of two rotary instruments, namely Mtwo and ProTaper, on the original canal curvature in vitro. The null hypothesis was that both systems would maintain the original curvature of the root canals.

## MATERIALS AND METHOD

Thirty extracted human mandibular first and second molars with curved canals were used in this study. Teeth with similar height, with an angle of canal curvature ranging between 25-‐45- were selected according to the criteria described by Schneider.[10] Teeth with incompletely formed apices, external resorption, and very narrow or obturated canals that would make identification impossible were eliminated. After extraction, all the molars were placed in 10% formalin and remnants on the root surfaces were removed by using distilled water. The mesiobuccal canals of the mandibular molar teeth were studied. Access cavities were prepared using round diamond burs (Mani Inc., Tochigi-Ken, Japan). In order to verify the presence of the canal and determine the angle of root canal curvature, periapical radiographs showing the buccolingual view were taken using a size 10 K-file (Mani Inc.).

### Instrumentation procedure

The 30 teeth were randomly divided into two experimental groups. Teeth were prepared using Mtwo instruments (Vdw, Munich, Germany) in Group I (n=15) and, with ProTaper instruments (Dentsply Maillefer, Ballaigues, Switzerland) in Group II (n=15).

For Group I, all Mtwo® instruments were used to the full length of the canals according to the manufacturer's instructions, using a gentle in and out motion. Once the instrument had reached the full end of the canal and had rotated freely, it was removed.

For Group II, crown down technique recommended by the manufacturer was used in the cleaning and shaping of the canals. All shaping files (SX, S1 and S2) were used in a brushing motion, away from the furcation area. All finishing files (F1, F2) were withdrawn from the root canal once they reached the WL.

An X-Smart (Dentsply-Maillefer) torque-limited electric motor was used with a 16:1 reduction rotary hand piece (X-Smart Contra-Angle, Dentsply-Maillefer) and the speed of rotation was adjusted to 300 rpm. Care was taken to ensure that the instruments did not stay for more than 10 seconds within the root canals. A chelating agent with 15% ethylenediaminetetraacetic acid (EDTA; Wizard, Rehber Chemistry, Istanbul, Turkey) was used. Canals were irrigated copiously with 2 mL of 5.25% sodium hypochlorite (NaOCL) solution (Wizard). After the use of each rotary instrument, recapitulation was performed using a patency file (size 10 file). Each instrument was changed after five canals according to the manufacturers' recommendation.

### Standardized radiographic evaluation

All teeth were embedded in clear acrylic resin. A contrast medium (Urografin, Schering AG, Berlin, Germany) was injected into the mesiobuccal canals and pre- and postoperative radiographs of the teeth were taken with a special apparatus, which was designed for this purpose. The radiographs were digitized with a scanner (Agfa-Duascan, Germany) and images were then transferred to a computer.

### Analysis of the canal preparation

A line was drawn between the canal orifice (A) and the apex (B) points. Günday et al. 8 defined 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 (using the Schneider method), the canal access angle (CAA), as shown in Figure 1.[8] Using Free Hand program (Macromedia, Inc. San Francisco, USA), the pre- and postoperative angular and linear measurements of each tooth were drawn, and the CAA and AC distance were measured, along with the Schneider angle, using AutoCAD R12 (Autodesk, Inc. San Rafael, USA), as shown in Figure 1.

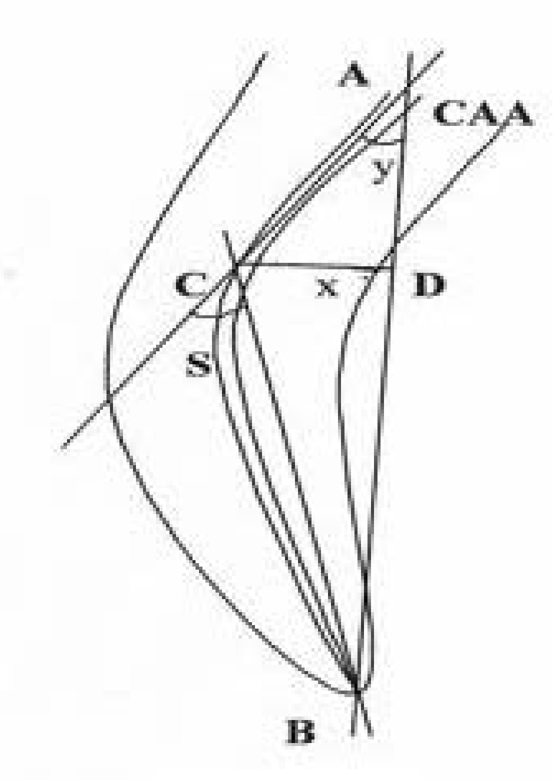


**Figure 1.** CAA: Canal access angle (The angle between the line from the canal entrance [A] to apex [B] and a line parallel to the long axis of the canal extending from the coronal part of canal), S: Schneider angle, AC: The distance between points A and C, CD(x): Curvature height, AD(y):Curvature distance.8

### Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) for Windows (version 10.0; SPSS Inc., Chicago, IL, USA). Differences among the groups were tested using a paired t-test. Results were analyzed with 95% confidence interval, and p value < 0.05 was considered statistically significant.

## RESULTS

The mean values of CAA, SA and AC before and after canal preparation by Mtwo and ProTaper were presented in Table 1.In Group I (Mtwo Group), the postoperative CAA and Schneider angles (SA) were significantly narrower compared to the preoperative values (p=0.001 and p<0.001, respectively), while postoperative and preoperative AC measurements were similar (p=0.177).

**Table 1.** The mean and standard deviation values of CAA, SA and AC before and after canal preparation by Mtwo and ProTaper. (SD: standard deviation/ CAA: canal access angle/ SA: Schneider angle/ AC: the distance between points A and C)

| | | Preoperative | Postoperative | p |
|---|---|---|---|---|
| | | X ± SD | X ± SD | |
| Mtwo | CAA | 23.04±6.10 | 18.54±4.47 | 0.001*** |
| | SA | 35.33±7.67 | 30.25±7.28 | 0.000*** |
| | AC | 4.76±1.45 | 5.65±1.39 | 0.177 |
| ProTaper | CAA | 22.24±4.11 | 20.24±4.21 | 0.000*** |
| | SA | 35.74±4.49 | 32.30±5.52 | 0.002** |
| | AC | 4.82±1.31 | 5.60±1.17 | 0.005** |

In Group II (ProTaper Group), the postoperative CAA and SA were significantly narrower compared to the preoperative values (p<0.001 and p=0.002, respectively). The postoperative AC measurements in the ProTaper Group was significantly longer than the preoperative measurements (p<0.01).

There was no significant difference between the two groups with respect to postoperative CAA, SA and AC measurements (p>0.05).

## DISCUSSION

One of the main objectives of root canal instrumentation is cleaning and shaping the root canal system effectively, while maintaining the original canal shape and ensuring that the smallest diameter is at the apical endpoint.[11] Several studies[12-15] investigating root canal preparations have shown that rotary NiTi instruments maintain the original canal shape, even in extremely curved canals. Therefore, our study compared the effects of Mtwo and ProTaper NiTi rotary instruments on original canal curvature in vitro by evaluating changes in the canal-related parameters CAA, SA and AC distance.

As CAA and SA decreases and the AC distance increases, transportation of the original canal and straightening of the canal curvature occur. Reductions in the postoperative CAA and SA values were noted in both groups. While the AC distance remained unchanged in the Mtwo group, it increased in the ProTaper group. An increase in the AC distance indicates transportation in the middle part of the canal curvature and straightening of the canal curvature. Considering these results, we suggest that transportation in the middle of the curvature occurred in the ProTaper group. The lack of a change in the AC distance in the Mtwo group indicates that transportation in the middle of the canal is less and the canal maintains its original shape better than in the ProTaper group.

For most rotary NiTi instruments, including the ProTaper rotary system, a crown down instrumentation sequence has been recommended, where larger files precede smaller ones, which in turn progress further apically.[16] However, crown down instrumentation sequence is not used in Mtwo systems. According to the manufacturers of MTwo, instruments should be used in a single working length technique.[17] This means that all files of the instrumentation sequence should be used to the full length of the root canal. Furthermore, the Mtwo system has no orifice shaper. The differences between the outcomes might be related to the above-mentioned differences between these two instruments. Consistent with this idea, a study conducted by Sonntag et al.[18] reported that less zips and a lower percentage of canal transportation was observed by using the Mtwo system when compared to the ProTaper system. Kuzekanani et al.19 also compared the effects of Mtwo and ProTaper NiTi systems on the curved root canals in their study. There were no significant differences between two systems regarding preparation time and crack formation, but it was reported that the Mtwo system led to a smaller change in canal curvature and thus was better for maintaining the original shape of the root canal.[19] Also the results of Vahid et al.[20] showed that, the ProTaper system significantly changed the canal curvature compared with the Mtwo system. The data in the current study supports these findings, and the observed lack of a change in the AC distance in the Mtwo group indicates that the canal maintains its original shape.

Typically, when an increase in apical enlargement is aimed in curved canals, there is a tendency to remove more excessive dentine towards the outer apical curve [21] and resulting in the widening of the inner curvature, that is the danger zone. To prevent these complications, we tend to increase flaring and reduce the apical instrumentation size. Increasing flaring under such circumstances would result in the reduction of the angle of curvature, in shortening the length of curvature, in increasing the radius of curvature and in relocating the curvature apically.[7]

Postoperative measurements showed that CAA and SA decreased significantly in both the Mtwo and ProTaper groups, and there was no significant difference between these two rotary systems. Therefore, the null hypothesis was rejected. The lack of a change in the AC distance in the Mtwo group indicated that the canal maintained its original shape. Thus, the AC distance should also be measured, besides CAA and SA, in order to evaluate changes in the root canal curvature after root canal preparation.

## CONCLUSION

The AC measurement pre- and post-operatively did not change in the Mtwo group, conferring that Mtwo instruments were better in maintaining the original canal curvature. Postoperative AC distance should also be measured, besides canal access angle and Schneider angle, in order to evaluate changes in the root canal curvature after root canal preparation.

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