A STUDY ON THE DEGREE OF CANAL TRANSPORTATION ACCORDING TO THE APICAL PREPARATION SIZE IN A CURVED CANAL

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만곡 근관에서 근첨 형성 크기에 따른 근관의 전이 정도에 관한 연구

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이 연구의 목적은 만곡 근관에서 다양한 크기로 근첨을 형성하였을 때 형성 전후의 근관의 전이 정도를 분석하고자 하는 것이다. 만곡된 근관을 가진 투명한 레진블럭 상에서 ProFile .06 taper와 K-flexofile을 이용하여 각각 근관형성을 시행하고 이를 똑같은 위치가 재현가능한 고정틀에 위치시킨 후 사진의 이중노출 기법을 이용하여 근관형성 전후의 근관의 전이정도를 분석한 결과 다음과 같은 결과를 얻었다.

1. ProFile의 경우 형성된 근관이 taper한데 비해 K-flexofiles의 경우 형성된 근관이 taper하지 못하고 확대가 더 컸다. K-flexofiles의 경우 ProFile의 경우보다 근첨 0~6mm부위에서 유의하게 더 굵었다($p<0.05$).
2. 만곡외측으로의 확대양상은 ProFile의 경우 대체적으로 taper하나 근첨 3~4mm부위가 약간 굵었다. K-flexofile의 경우 만곡외측으로의 확대양상은 taper하지 못하고 불규칙하였다. ProFile에 비해 근첨 0~2mm에서 유의하게 확대가 더 컸다($p<0.05$).
3. 만곡내측으로의 확대양상은 모든 군에서 taper하였으나 K-flexofile의 경우 ProFile의 경우보다 확대가 더 컸다. K-flexofile의 경우 ProFile에 비해 근첨 3~5mm 부위에서 유의하게 확대가 더 컸다($p<0.05$).

주요어 : ProFile, 근첨 형성 크기, 이중노출, 전이

Ⅰ. INTRODUCTION

A continuously tapering, conical, funnel-shaped canal with the smallest diameter at the end-point and the largest at the orifice is perceived to be the most appropriate for filling with gutta-percha[1]. Unfortunately, stainless steel hand files tend to create a number of aberrations during preparation, particularly in curved canals, including zips[2,3] and danger zones[4,5]. These undoubtedly occur as a result of the inherent stiffness of the metal which is confounded by instrument design and canal shape[5-7]. Thus, in most circumstances, the use of stainless steel files in narrow curved canals is difficult and limits apical enlargement to relatively small sizes[6,8], so hindering obturation.

Nickel-titanium files have two to three times the elastic flexibility of stainless steel files, due to their very low values of modulus of elasticity, and show superior resistance to torsional fracture, due to the ductility of the nickel-titanium[9]. The new generation of nickel-titanium endodontic instruments therefore have the potential to shape narrow and curved root canals more effectively[10].

Mechanical methods of root canal preparation using nickel-titanium instruments have evolved in recent years. In general, the results of most studies have concluded that canal shape was main-

tained by rotary nickel-titanium instruments and was significantly faster than hand preparation[11,12]. A number of reports have also demonstrated that these instruments, when used in simulated canals, produce few aberrations[13-15].

Many of the new nickel-titanium instruments have increased taper in the hope that the greater flare along the active element of the instrument shaft will create automatically the flare required in the canal shape. And a technique which uses as few files as possible is preferred because exchanging a file to another file is a tedious procedure. A instrumentation technique using only ProFiles .06 taper without ProFiles .04 taper has several advantages listed above. But the degree of the canal transportation according to the various apical preparation size by the above technique is not well known.

The purpose of this study was to evaluate the degree of the canal transportation accorting to the apical preparation size during the canal preparation with ProFiles .06 taper.

Ⅱ. MATERIALS and METHODS

Sixty clear casting resin blocks(Maillefer, Ballaigues, Switzerland) containing simulated root canals, whose apical and coronal diameters were 0.15 and 0.35mm(±0.02mm), respectively, were used. A mounting device was developed and used to accurately locate the camera and the resin blocks at the same position. All root canals were stained and photographed before and after instrumentation.

For visual comparisions a double exposure of the same frame of the film was obtained by first photographing the stained original canal, blocking the film winder and then re-exposing the same frame with the widened canal after repositioning in the mounting device.

The blocks were divided into six groups of 10: Group1, 2, 3 for instrumentation with K-flexofiles, Group4, 5, 6 was with Profile .06 taper with ISO sized tips. The working length(WL) was established with a size 10 instrument.

Group1, 2, and 3 were instrumented with the K-flexofiles(Maillefer, Ballaigues, Switzerland) which were precurved and used with a push-pull motion until the instruments fitted loosely in the canal, before using the next larger size. The apical preparation was completed with a size 25 file in group1, 30 in group2, and 35 in group3, followed by a step-back to a size 80, increasing one instrument size for each 1 mm step-back. Copious irrigation using water ensured that the canal was free of resin debris.

Group4, 5, and 6 were instrumented using the ProFile .06 taper in ISO sizes 15, 20, 25, and 30(Maillefer, Ballaigues, Switzerland) in a crown-down manner at a constant rpm of 250. A size 25 Profile was used one-half to two-thirds of the canal length. This was followed by a size 30 Profile used to approximately the same depth. A size 20 Profile was used to two-thirds to three-quarters of length, followed by a size 15 Profile placed to full length. Finally size 20, 25, 30, and 35 Profiles were sequentially used at full length. Preparation was then completed by using a size 25 Profile in group4, 30 in group5, and 35 in group6 at the WL.

A 1 : 20 scale was established by projecting the resulting slides over a fixed distance onto a hard projection screen. Measurements were made at eight different levels : 0, 1, 2, 3, 4, 5, 6 and 7mm from the apical foramen. At each level, three measurements were made : total canal width, width of outer enlargement, and width of inner enlargement. The original canal served as a reference for all measurements. The t-test test was used for statistical analysis.

Ⅲ. RESULTS

1. Total Canal Width

Profiles in group4, 5, and 6 caused a taper widening of a canal in total canal width(Fig. 1). But K-flexofiles caused nontapered and greater widening than Profiles. K-flexofiles caused significantly greater widening at apical 0~6mm than ProFiles($p<0.05$, Table 1~6).

2. Width of Outer Enlargement

ProFiles in group4, 5, and 6 caused a taper effect but somewhat more enlargement at apical 3 ~4mm to the outer side of the curvature(Fig. 1). K-flexofiles in group1, 2, and 3 caused nontapered and irregular enlargement to the outer side of the curvature. K-flexofiles caused significantly greater enlargement at apical 0~2mm than ProFiles($p<0.05$, Table1~6).

3. Width of Inner Enlargement

ProFiles and K-flexofiles also caused a taper enlargement to the inner side of the curvature, but K-flexofiles caused greater enlargement than

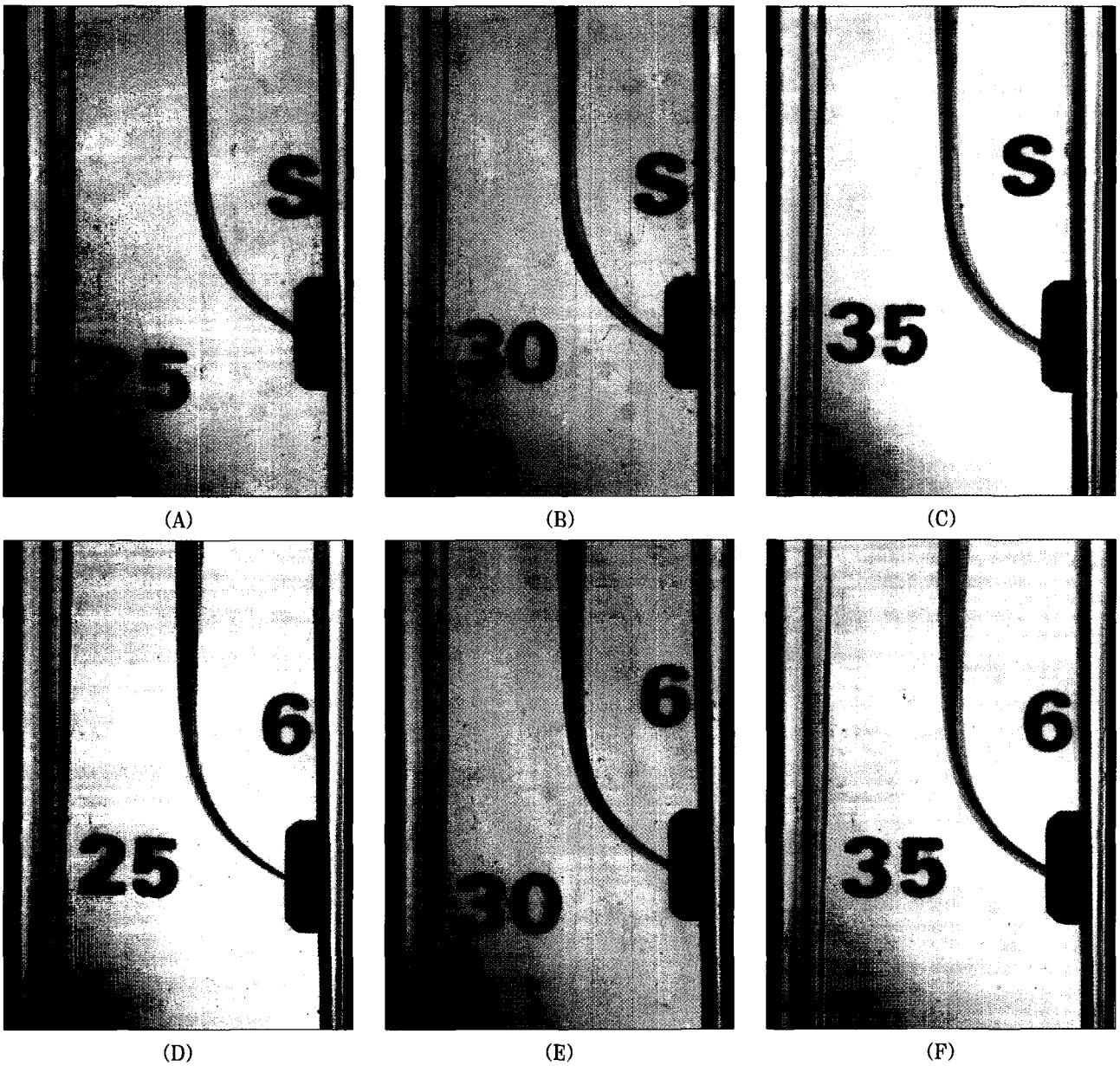

Fig. 1. Double exposure images of unprepared and prepared canal space. The red portion represents unprepared canal space and the pink portion represents prepared canal space. A(group1), B(group2), and C(group3): K-flexofile groups. D(group4), E(group5), and F(group6): ProFile groups.

Table 1. Mean values of total canal width(TCW), width of outer enlargement(WOE), and width of inner enlargement(WIE) of group1

Group1		K-flexofile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.398±0.016	0.217±0.011	0.017±0.003
	1mm	0.413±0.008	0.188±0.006	0.067±0.008
	2mm	0.467±0.005	0.198±0.005	0.101±0.004
	3mm	0.524±0.006	0.174±0.006	0.156±0.003
	4mm	0.571±0.006	0.151±0.007	0.228±0.006
	5mm	0.573±0.006	0.098±0.004	0.259±0.008
	6mm	0.567±0.007	0.106±0.005	0.243±0.010
	7mm	0.546±0.006	0.114±0.006	0.202±0.009

Table 2. Mean values of total canal width(TCW), width of outer enlargement(WOE), and width of inner enlargement(WIE) of group2

Group2		K-flexofile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.489±0.101	0.302±0.005	0.021±0.003
	1mm	0.417±0.006	0.211±0.005	0.051±0.006
	2mm	0.509±0.021	0.237±0.003	0.098±0.005
	3mm	0.595±0.007	0.239±0.008	0.179±0.006
	4mm	0.653±0.005	0.211±0.006	0.252±0.005
	5mm	0.702±0.006	0.177±0.005	0.319±0.011
	6mm	0.667±0.010	0.099±0.006	0.357±0.011
	7mm	0.603±0.007	0.081±0.004	0.301±0.008

Table 3. Mean values of total canal width(TCW), width of outer enlargement(WOE), and width of inner enlargement(WIE) of group3

Group3		K-flexofile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.589±0.011	0.355±0.010	0.048±0.011
	1mm	0.502±0.008	0.268±0.005	0.068±0.006
	2mm	0.611±0.008	0.301±0.005	0.131±0.007
	3mm	0.673±0.010	0.271±0.008	0.216±0.009
	4mm	0.759±0.012	0.253±0.005	0.311±0.011
	5mm	0.724±0.007	0.131±0.005	0.386±0.007
	6mm	0.687±0.011	0.076±0.006	0.407±0.005
	7mm	0.659±0.007	0.099±0.006	0.336±0.008

Table 4. Mean values of total canal width(TCW), width of outer enlargement(WOE), and width of inner enlargement(WIE) of group4

Group4		ProFile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.252±0.007	0.024±0.008	0.011±0.005
	1mm	0.268±0.019	0.436±0.008	0.014±0.004
	2mm	0.298±0.016	0.114±0.014	0.026±0.006
	3mm	0.362±0.013	0.145±0.010	0.039±0.009
	4mm	0.422±0.007	0.157±0.009	0.085±0.006
	5mm	0.492±0.006	0.128±0.011	0.154±0.009
	6mm	0.549±0.009	0.122±0.007	0.191±0.007
	7mm	0.643±0.008	0.187±0.008	0.215±0.005

Table 5. Mean values of total canal width, width of outer enlargement, and width of inner enlargement(mm) of group5

Group5		ProFile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.306±0.012	0.122±0.008	0.023±0.002
	1mm	0.321±0.008	0.136±0.007	0.025±0.003
	2mm	0.381±0.012	0.151±0.007	0.071±0.004
	3mm	0.471±0.011	0.194±0.006	0.095±0.010
	4mm	0.536±0.020	0.193±0.010	0.146±0.006
	5mm	0.576±0.010	0.136±0.006	0.231±0.005
	6mm	0.651±0.007	0.132±0.006	0.292±0.007
	7mm	0.697±0.013	0.189±0.011	0.296±0.007

Table 6. Mean values of total canal width(TCW), width of outer enlargement(WOE), and width of inner enlargement(WIE) of group6

Group6		ProFile		
		TCW(mm)	WOE(mm)	WIE(mm)
apical	0mm	0.368±0.010	0.187±0.003	0.028±0.004
	1mm	0.371±0.005	0.199±0.009	0.039±0.007
	2mm	0.426±0.009	0.196±0.006	0.082±0.005
	3mm	0.492±0.009	0.223±0.006	0.102±0.008
	4mm	0.561±0.011	0.211±0.008	0.161±0.006
	5mm	0.597±0.005	0.141±0.007	0.249±0.008
	6mm	0.669±0.005	0.147±0.007	0.321±0.006
	7mm	0.719±0.036	0.193±0.007	0.328±0.007

ProFiles(Fig. 1). K-flexofiles caused significantly greater enlargement than ProFiles at apical 3~5 mm($p<0.05$, Table1~6).

Ⅳ. DISCUSSION

The use of clear casting resin blocks appears to be not only valid substitution for root canals in natural teeth[16], but it is of great help for improving our understanding of the behaviour of endodontic instruments in root canals. The double exposure method provided enlarged images of root canals which could be clearly elucidated and accurately quantified. The method provided a clear view of the areas that were enlarged or remained unchanged after the instrumentation.

As a result of this study, K-flexofiles caused nontapered and greater widening than Profiles in total canal width. To the outer side of the curvature, they caused nontapered and irregular enlargement. They showed significantly greater enlargement at apical 0~2mm than ProFile groups. To the inner side of the curvature, they caused a taper enlargement, but greater enlargement than ProFiles. They caused significantly greater enlargement than ProFiles at apical 3~5 mm.

Profiles caused a taper widening of a canal in total canal width. They caused a taper effect but somewhat more enlargement at apical 3~4mm to the outer side of the curvature. They caused a taper enlargement to the inner side of the curvature.

Bryant[17] found that the use of ProFile instruments was effective and produced good canal shapes. Other studies[12,15,18] partly supported the observations of Bryant. The results of the present study were consistent and support these previous findings since ProFile .06 taper used in a rotary fashion performed significantly better than hand instruments. The technique may be preferred because exchanging a file to another file is a tedious procedure. In out daily practice, we only use ProFiles .06 taper to complete the preparation of a canal.

Further research is needed to evaluate this technique to determine whether they can be safely and effectively used.

Ⅴ. CONCLUSION

The purpose of this study is to evaluate the degree of the canal transportation accorting to the apical preparation size during the canal preparation with ProFiles .06 taper. Curved canals on translucent resin blocks were prepared with K-flexofiles and with ProFiles .06 taper. And they were placed at the platform which can reproduce the same position. The unprepared and prepared canal forms were accurately compared by double exposure technique of photography.

The results were as follows :

1. ProFiles caused a taper widening of a canal in total canal width. But K-flexofiles caused nontapered and greater widening than ProFiles. K-flexofiles caused signicantly greater widening at apical 0~6mm than ProFiles($p<0.05$).
2. ProFiles caused a taper effect but somewhat more enlargement at apical 3~4mm to the outer side of the curvature. K-flexofiles nontapered and irregular enlargement to the outer side of the curvature. They caused significantly greater enlargement at apical 0~2mm than ProFiles($p<0.05$).
3. All six groups caused a taper enlargement to the inner side of the curvature, but K-flexofiles caused greater enlargement than ProFiles. K-flexofiles caused significantly greater enlargement than ProFiles at apical 3~5mm($p<0.05$).

REFERENCES

1. Schilder H. Cleaning and shaping the root canal. Dent Clin N Am 1974:18:269-96.
2. Weine FS, Kelly FR, lio PJ. The effect of preparation procedures on original canal ㅏ,shape and on apical foramen shape. J Endod 1975:1:255-62.
3. Alodeh MHA, Doller R, Dummer PMH. Shaping of simulated root canals in resin blocks using the step-back technique with K-files manipulated in a simple in/out motion. Int Endoddon J 1989:22:107-17.
4. Abou-Rass M, Frank AL, Glick DH. The anticurvature filing method to preapre the curved root canal. J Am Dent Assoc 1980:101:792-4.

5. Al-Omari MAO, Dummer PMH, Newcombe RG. Comparison of six files to prepare simulated root canals. Part 2. Int Endod J 1992;21:67-81.
6. ElDeeb M and Boraas J. The effect of different files on the preparation shape of severely curved canals. Int Endod J 1985;18:1-7.
7. Al-Omari MAO, Dummer PMH, Newcombe RG, Doller R. Comparison of six files to prepare simulated root canals. Part 1. Int Endod J 1992;25:57-66.
8. Schafer E, Tepel J and Hoppe W. Properties of endodontic hand instruments used in rotary motion. part 2. instrumentation of curved canals. J Endod 1995;21:493-7.
9. Walia H, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of nitinol root canal files. J Endod 1988;14:346-51.
10. Bishop K, Dummer PMH. A comparison of stainless steel Flexofiles and nickel-titanium NiTiFlex files during the shaping of simulated canals. Int Endod J 1997;30:25-34.
11. Esposito PT and Cunningham CJ. A comparison of canal preparation with nickel-titamium and stainless steel instruments. J Endod 1995;21:173-6.
12. Glosson CR, Haller RH, Dove SB, del Rio CE. A comparison of root canal preparations using Ni-Ti hand, Ni-Ti engine-driven, and K-flex endodontic instruments. J Endod 1995;21:146-51.
13. Thompson SA, Dummer PMH. Shaping ability of ProFile 0.04 Taper Series 29 rotary nickel-titanium instruments in simulated root canals. Part 2. Int Endod J 1997;30:8-15.
14. Thompson SA, Dummer PMH. Shaping ability of NT Engine and McXim rotary nickel-titanium instruments in simulated root canals. Part 2. Int Endod J 1998;30:270-8.
15. Kum KY, Spangberg L, Cha BY, etc. Shaping ability of three ProFile rotary instrumentation techniques in simulated resin root canals. J Endod 2000;26:719-23.
16. Lim KC and Webber J. The validity of simulated root canals for the investigation of the prepared root canal shape. Int Endod J 1985;18:240-6.
17. Bryant ST, Dummer PMH, Pitoni C, Bourba M, Moghal S. Shaping ability of .04 and .06 taper ProFile rotary mickel-titanium instruments in simulated root canals. Int Endod J 1999;32:155-64.
18. Barthel CR, Gruber S, Roulet JF. A new method to assess the results of instrumentation techniques in the root canal. J Endod 1999;25:535-8.