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The sealing ability of canal obturation technique using Endoseal and AH plus sealer

조선대학교 대학원

치의학과

박 보 경

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-Endoseal과 AH plus 실러를 이용한 근관충전법의 봉쇄능-

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Endoseal MTA(Mineral Trioxide Aggregate) 실러(마루치, 원주, 대한민국)는 레진이 첨가되지 않은 순수한 MTA로 치근단에서 우수한 봉쇄능을 가지며 흐름성과 방사선 불투과성이 우수하여 근관충전용으로 사용할 수 있다. 본 연구에서는 Endoseal MTA 실러를 이용한 single cone technique과 AH plus 실러를 이용한 continuous wave compaction technique을 제II형 형태의 근관충전에 각각 사용하여 방사선 사진을 통해 비교, 평가하였다.

술전 방사선 사진을 통해 치아의 해부학적 근관 형태를 평가하여 제II형 형태의 치근을 가진 30개의 상악 소구치를 선별하였다. 각각의 실험 치아들을 무작위로 각 15개씩 2개의 실험군으로 나누었다. 실험1군(SC군)은 Endoseal MTA 실러를 이용한 single cone technique 사용하였고 실험2군(CW군)은 AH plus 실러를 이용한 continuous wave compaction technique 사용하였다.

촬영된 방사선 사진은 ImageJ 1.50i(Wayne Rasband, USA)를 통해 평가하였다. 기포의 총량은 CW군이 SC군 보다 적었다 ($P<0.01$). 치관 1/3에서는 SC군에서 CW군보다 많은 기포가 관찰되었지만 중앙, 치근단 1/3에서는 두 실험군간에 기포 비율은 유의한 차이를 보이지 않았다. 외부 기포의 비율은 두 실험군간 유의한 차이를 보이지 않았다.

Single cone technique은 continuous wave compaction technique보다 더 많은 기포를 보였다 ($P<0.01$). 근관충전의 성패에 영향을 끼칠 수 있는 외부 기포와 치근단 1/3에서의 기포의 비율은 두 실험군 간 유의한 차이가 없었다. Endoseal MTA 실러를 이용한 single cone technique은 타원형의 큰 근관보다 좁고 둥근 근관에서 효율적으로 적용될 것으로 사료된다.

Ⅰ. Introduction

The main purpose of root canal treatment is cleaning and shaping of all pulp space and its complete obturation with proper filling material.[1] Appropriate root canal obturation prevents residual bacteria and their toxin from affecting the periapical tissue.[2] One of the major cause of endodontic failure is microleakage which may occur between the gutta-percha and sealer. In many studies, inadequate root-filled teeth have a higher possibility of periapical lesion than teeth with adequate root canal filling.[3-5] Gutta-percha is usually used with sealers to achieve a fluid-tight seal. Root canal sealers fill the spaces between gutta-percha cone and between gutta-percha and root canal walls.[6] Therefore, canal obturation technique and sealing ability of root canal sealer are important factors for successful root canal treatment.

Continuous wave compaction technique is most widely used root canal obturation technique. But sometimes this standard root filling approach can fail to prevent microleakage within the root canal system.[7] During gutta-percha is heated, it expands and contracts, which can occur voids and gaps in and along the filling material.[8] In addition, this technique can cause vertical crown-root fracture of tooth. To overcome these disadvantages, various root canal filling techniques, materials and sealers have been developed and introduced to the market.

Recently, single-cone technique with newly developed MTA-based sealer has been revived.[9] Single-cone technique with conventional sealers have been thought to be less effective in sealing root canals than continuous wave compaction technique.[10] Newly developed calcium silicate based sealers have the good sealing of root canal fillings and high biocompatibilty.

An endodontic sealer in premixed injectable paste type was developed for clinical convenience. Endoseal MTA sealer (Maruchi, Wonju, Korea) is

calcium silicate based sealer and a pure MTA product with no resin added. It has the good sealing capability with excellent flowability, making it ideal for use in filling canals. The use of single-cone filling technique with Endoseal MTA sealer is recommended according to the manufacturers.

However, it has been reported the single cone technique has a number of voids in irregular shaped canal.[11-12] In addition, sealing ability to fill an oval or irregular canal space with single cone technique was clearly diminished according to its root canal form.[9] But comparative studies have also being published. Because of the MTA sealer has an good flowability, biocompatibility and dimensional stability, use of single-cone technique is recommended. Moreover, bioceramic sealers can be used for filling root canals with or without gutta-percha cone.[13-14]

The researches on sealing ability using single cone technique with calcium silicate based sealers in terms of voids for various root canal anatomy especially in Type II root canals are limited. The aim of this study was to evaluate the sealing ability in Type II root canal obturation by comparing the presence of voids between single cone technique using Endoseal MTA sealer and continuous wave compaction technique using AH plus sealer.

Ⅱ. Materials and methods

1. Sample Preparation

35 extracted human single-rooted maxillary premolars without caries, root resorption, restorations, immature apices and fractures were selected after institutional review board (IRB) approval (CUDHIRB 1503 009). Preliminary periapical radiographs were taken in mesio-distal directions to evaluate the anatomy of the teeth. Except for teeth with Weire's Type II root canal, 3 teeth of the other types were excluded. Also, 2 teeth that have severe calcified canal were excluded.

All teeth were decoronated using diamond bur (Mani, Utsunomiya, Japan) and each root was adjusted to 12 mm length. Then, a size 10K hand file (Dentsply Maillefer, Ballaigues, Switzerland) was inserted into the root canal until the file tip was just visible in the apex. The working length was set by subtracting 1 mm from this length.

All samples were shaped with Protpaer Universal rotary instruments (Dentsply Maillefer, Ballaigues, Switzerland) driven by a VDW motor (VDW GmbH, München, Germany) according to the manufacturers' instructions. All samples were serially shaped from S1 to F2 using crown-down technique. Final apical enlargement was performed using a size 30 or 35 manual K-file.

During the root canal preparation, irrigation was performed with 2 mL 1.5% NaOCl and 1 mL of 10% EDTA delivered from a 3 mL syringe with a 27-gauge endodontic side vented needle. Finally, Endo-activator (Dentsply Maillefer, Ballaigues, Switzerland) was used for 1 minute during NaOCl irrigation Then, each samples were dried with sterile

paper points (B&L Biotech, Fairfax, VA, USA).

2. Root Canal Obturation

All samples were divided randomly into 2 experimental groups (15 teeth each). Root canal sealer was prepared according to the method by the manufacturer's recommendation.

Group 1 (SC group) used single cone technique with Endoseal MTA sealer (Maruchi, Wonju, Korea). A master gutta-percha cone (B&L Biotech, Fairfax, VA, USA) corresponding to the final instrumentation was set. Endoseal MTA sealer was injected into the root canal. Then, master gutta-percha cone was inserted into the root canal with gentle pumping motion. In order to penetrate for Endoseal MTA sealer into minute root canal, the ultrasonic vibration was used. The excess of gutta-percha and sealer was removed using a Duo alpha II (B&L Biotech, Fairfax, VA, USA).

Group 2 (CW group) used continuous wave compaction technique with Duo alpha II and Duo beta (B&L Biotech, Fairfax, VA,USA) using AH plus sealer (Dentsply Maillefer, Bellaigues, Switzerland). A Duo alpha II heating tip was prepared to fit 3-4 mm short of the working length. A master gutta-percha cone corresponding to the final apical instrument was adjusted until tug-back sensation was achieved. Then, its tip was covered with AH plus sealer and inserted to the root canal with pumping motion. The Duo alpha II plugger was inserted through the master cone with gentle motion to the 3-4 mm short point of the working length. The power was turn off and the plugger pushed apically for 10 seconds. A additional 1 second heat application was done and the plugger extracted. After removing the excess of gutta-percha, backfill of the middle and coronal thirds was performed. Gutta-percha of the coronal thirds was condensed with the plugger.

After the root canal filling, all samples were kept at 37℃ at 100% humidity for 5 days to ensure the sealer was set.

3. Radiograph Image Analysis

The samples were radiographed in mesio-distal directions to evaluate the presence of voids. Each radiograph image was evaluated by ImageJ 1.50i(Wayne Rasband, USA). Each sample was divided into three regions from the apical end of the root at a level of 0-4 (apical), 4-8 (middle), and 8-12 mm (coronal). For each regions, the mean volume of the root filling materials and voids were calculated. In addition, voids were classified as external voids (along the canal walls) and internal voids (inside the filling materials) (Figure.1).

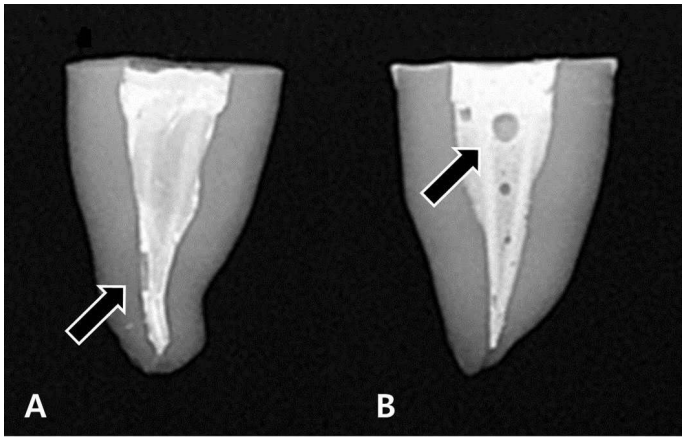

Figure 1. Classification of voids. (A) external voids and (B) internal voids indicated by arrow.

4. Statistical Analysis

The significance of the differences between the groups in mean volume of canal filling materials and voids was analyzed by Student's T-test (α=0.01).

Ⅲ. Results

Mean volume (%± SD) of the canal filling materials (gutta-percha and sealer) and voids (external and internal voids) was summarized in Table I. Numerous voids were observed in all the root canal filling. In addition, occurrence of voids was unpredictable in all samples.

Table I. Mean volume (%± SD) of the canal filling materials and voids (external and internal voids) in radiograph according regions (apical, middle, and coronal thirds).

Regions	Groups	Total (%)	External voids (%)	Internal voids (%)
Coronal third	SC	**7.07 ± 5.06**	1.01 ± 5.06	**6.06 ± 4.97**
	CW	**0.81 ± 1.10**	0.04 ± 1.10	**0.77 ± 0.15**
Middle third	SC	4.32 ± 3.55	0.61 ± 3.55	3.71 ± 3.27
	CW	5.65 ± 4.64	0.72 ± 4.64	4.93 ± 3.88
Apical third	SC	9.21 ± 5.15	4.17 ± 5.15	5.04 ± 3.64
	CW	9.88 ± 5.93	4.16 ± 5.93	5.72 ± 4.70
Total	SC	**6.65 ± 3.42**	1.31 ± 3.42	**5.34 ± 3.21**
	CW	**3.60 ± 1.64**	0.82 ± 1.64	**2.78 ± 1.42**

Values in bold letter mean statistical significant difference between groups (P<0.01).

CW group showed smaller voids than SC group, for the total volume. At the coronal thirds, SC group had more voids compared to CW group (Figure 2). But, no significant difference in the percentage volume of voids was found in the middle and apical thirds. In terms of external voids, no significant difference was found between two groups. SC group had more internal voids than CW group at the coronal third and total volume. Expression of external

or internal voids were not certain coherence.

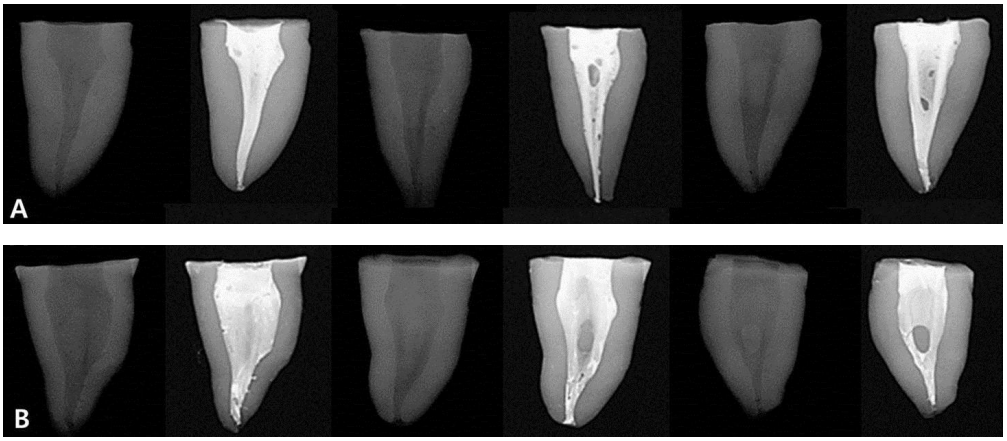

Figure 2. Radiographic images of maxillary premolars filled with single cone technique using Endoseal MTA sealer (A) and continuous wave compaction technique using AH plus sealer (B).

In CW group, percentage of voids had increased from the coronal thirds to apical thirds. However, voids was decreased in the middle thirds and then was increased in the apical thirds in SC group. In both group, the ratio of external voids was highest at the apical third.

Ⅳ. Discussion

Radiography is the only way to evaluate the completeness of the root canal fillings in the clinical situation. Also, it is only possible to perform bucco-lingual projection or some degree eccentric projection. But, well-obturated bucco-lingual root canal radiograph image can disclose defects such as voids that can be shown in mesio-distal projection.[16] In addition, these defects were also detected by other methods such as the dye-penetration test. So, it is difficult to evalutate the success or failure of root canal treatment only through radiographic analysis in bucco-lingual directions. Conventional bucco-lingual radiographic projection may be of limited value for evaluating the quality of the root canal filling.[15] Large number of root fillings, which are considered of good quality, can be insufficiently sealed in fact.[16] In this study, evaluation of root fillings between two different techniques was performed through radiograph analysis in mesio-distal direction.

Root canal filling material should prevent the penetration of micro-organisms and toxins. Even after root canal treatment, micro-organism have survived.[17] Residual bacteria can be re-grown in the unfilled space such as voids. Frequently, there are voids in the root canal filling materials. Voids inside filling materials (internal voids) could be considered less clinically relevant because bacteria, if present, are confined in an unfavorable environment. Voids along the canal walls (external voids) can be a factor of re-infection, because they are in contact with potentially infected canal walls.[18] The number of voids was no significant difference in samples filled with different filling techniques (lateral compaction, Thermafil), whereas void volumes were little higher in

species with the single-cone technique.[19] The single-cone technique using a calcium silicate cement produced less porosity than did the lateral compaction method.[20] The bioceramic sealers (Endo-Sequence BC sealer, Smartpaste bio) produced similar voids which had the smallest in the apical thirds of root canals among the sealers tested.[21] In this study, no significant difference in the percentage volume of external voids was found in all regions. But total and coronal mean percentage volume of voids, especially internal voids was significantly larger in the single cone technique groups.

The two samples did not show a complex root canal anatomy form such as intercanal connections. Total percentage volume of voids of that 2 specimens were measured very small. The value was respectively 0.89% and 0.68%. Single round root canal was thought to be more easier to achieve hermetic root canal filling. So, in a single root canal filling, both methods is expected to bring sufficient results. But, in a oval and broad root canal form, single cone technique is considered to be not a sufficient hermetic root canal filling. In this study, at the coronal thirds, SC group had more voids compared to CW group. It is thought that the wide root canal space that does not fit into single cone has the high potential of voids generation. The more space that can't be filled with master cone, the more voids can be generated. Using single cone technique with Endoseal MTA sealer, the fitness of the master cone along the canal preparation space is considered to be important. So, degree of fitness of master cone and root canal wall will be an important factor in successful single cone technique.

Anatomical variations such as lateral canal are most common in the apical thirds. Therefore, voids in the apical thirds may be more susceptible to re-infection. The presence of a gap between the filling material and lateral canal can be a factor of failure of root canal treatment.[18] MTA Flow sealer had lower voids in the apical third than AH plus sealer whereas

similar voids were seen in the middle and coronal thirds.[22] In this study, no significant difference in the percentage volume of voids between CW and SC group was found in the apical thirds.

Improper and excessive pressure during root canal filling using continuous wave compaction technique can lead to vertical root fracture and tooth loss.[23-24] Single cone technique may be less damaging to the tooth than lateral compaction and vertical condensation methods. Incidence of fractures using single cone technique was smaller than conventional techniques such as cold lateral and warm vertical compaction.[25] In addition, the single-cone technique was significantly faster in clinical situation.

Radiographic analysis has the limitation as a two-dimensional image. In fact, internal voids assessed in radiography can be external voids. Recently, Micro CT is able to evaluate filling materials, voids and tooth structures with high accuracy.[26] So, Micro CT analysis about single cone technique using endoseal MTA sealer will be required.

Ⅴ. Conclusion

Single cone technique group showed more voids than continuous wave compaction technique group in the total volume. But, no significant difference in the percentage volume of voids was found in the middle and apical thirds between two groups. In addition, the percentage volume of external voids that can affect the success and failure of the endodontic treatment between two groups had no significant difference. In the large oval form of the root canal, especially coronal thirds, there can be a lot of voids using single cone technique. So, single cone technique with Endoseal MTA sealer is thought to be efficient in narrow round and single canals.

References

1. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1984;58(5):589-599.
2. Michaud RA, Burgess J, Barfield RD, et al. Volumetric expansion of gutta-percha in contact with eugenol. J Endodod 2008;34:1528-1532.
3. Boucher Y, Matossian L, Rilliard F, Machtou P. Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopluation. Int Endod J 2002;35:229-238.
4. Kirkevang L-L, Hørsted-Bindslev P. Technical aspects of treatment in relation to treatment outcome. Endod Top 2002;2:89-102.
5. Segura-Egea JJ, Jiménez-Pinzón A, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV. Periapical status and quality of root fillings and coronal restorations in an adult Spanish population. Int Endod J 2004;34:198-205.
6. Sönmez IS, Oba AA, Sönmez D, Almaz ME. In vitro evaluation of apical microleakage of a new MTA-based sealer. Eur Arch Paediatr Dent 2012;13:252-255.
7. Magura ME, Kafrawy AH, Brown CE, Jr, Newton CW. Human saliva coronal microleakage in obturated root canal : an in vitro study. J Endod 1991;17:324-331.
8. Peng L, Ye L, Tan H, Zhou X. Outcome of root canal obturation by warm gutta-percha versus cold lateral condensation: a metal-analysis. J Endod 2007;33:106-109.
9. Gordon MPJ, Love RM, Chandler NP. An evaluation of .06 tapered gutta-percha cones for filling of .06 taper prepared curved root canals. Int Endod J 2005;38:87-96.
10. Beatty RG. The effect of standard or serial preparation on single cone obturation. Int Endod J 1987;20:276-281.

11. Bergmans L, Moisiadis P, De Munck J, Van Meerbeek B, Lambrechts P. Effect of polymerization shrinkage on the sealing capacity of resin fillers for endodontic use. J Adhes Dent 2005;7:321-329.
12. Weis MV, Parashos P, Messer HH. Effect of obturation technique on sealer cement thickness and dentinal tubule penetration. Int Endod J 2004;37:653-663.
13. Zhang W, Li Z, Peng B. Assessment of a new root canal sealer's apical sealing ability. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:79-82.
14. Zhang W, Li Z, Peng B. Effects of iRoot SP on mineralization-related genes expression in MG63 cells. J Endod 2010;36:1978-1982.
15. Eckerbom M, Magnusson T. Evaluation of technical quality of endodontic treatment - Reliability of intraoral radiographs. Endod Dent Traumatol 1997;13:259-264.
16. Kersten HW, Wesselink PR, Thoden Van Velzen SK. The diagnostic reliability of the buccal radiograph after root canal filling, Int Endod J 1987;20:20-24.
17. Saunders, Coronal leakage as a cause of failure in root-canal therapy: a review. Endod Dent Traumatol 1994;10:105-108.
18. F. Somma, Quality of thermoplasticized and single point root fillings assessed by micro-computed tomography, Int Endod J 2011;44:362-369.
19. Celikten B, Uzuntas CF, Orhan AI, Orhan K, Tufenkci P, Kursun S, Demiralp KO. Evaluation of root canal sealer filling quality using a single-cone technique in oval shaped canals: an in vitro micro-CT study. Scanning 2015 In press.
20. Moinzadeh AT, Zerbst W, Boutsioukis C, Shemesh H, Zaslansky P. Porosity distribution in root canals filled with guttapercha and calcium silicate cement. Dental Mater 2015;31:1100-1108.
21. Berkan Celikten, Ceren Feriha Uzuntas, Evaluation of Root Canal Sealer

Filling Quality Using a Single-Cone Technique in Oval Shaped Canals: An In Vitro Micro-CT study, Scanning VOL. 2015;9999:1-8.

22. Gandolfi MG, Parrilli AP, Fini M, Prati C, Dummer PM, 3D micro-CT analysis of the interface voids associated with Thermafil root fillings used with AH plus or a flowable MTA sealer. Int Endod J 2013;38:87-96.
23. Karapinar Kazandg M, Sunay H, Tanalp J, Bayirli G. Fracture resistance of roots using different canal filling systems. Int Endod J 2009;42:705-710.
24. Meister F Jr, Lommel TJ, Gerstein H. Diagnosis and possible causes of vertical root fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1980;49:243-253.
25. Capar ID, Saygili G, Ergun H, Gok T, Arisian H, Ertas H. Effects of root canal preparation, various filling techniques and retreatment after filling on vertical root fracture and crack formation. Endod Dent Traumatol 2014;31:302-307.
26. Jung M, Lommel D, Klimek J. The imaging of root canal obturation using micro-CT. Int Endod J 2005;38:617-626.