Comparison of apical sealing ability of continuous wave of obturation technique using EndoTwinn and System B

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ABSTRACT

The purpose of this study was to compare the apical leakage of the root canal filled with the System B and the EndoTwinn (the combined application of heat and ultrasonic vibration).

Sixty extracted premolars with straight root were cleaned and shaped to size 35. Group SB was obturated using System B and Group ET was filled with EndoTwinn. A size 35 of 0.06 tapered gutta-percha and Adseal were used and the plugger which could be introduced to 4 ㎜ short of working length was selected in the obturation procedure. As the positive control, Group PC was not filled. In Group SB, ET and PC, all external surfaces of each tooth were coated with nail varnish leaving only 1 ㎜ area around the apical foramen. In the negative control of Group NSB and Group NET, all of external tooth surface including apical foramen was coated with the nail varnish. The specimens were immersed in methylene blue dye solution for 2 days. Then the specimens were sectioned at each 1 ㎜ from apex to 5 ㎜ level. The final score of one specimen was given by summing up of the points at all levels.

The dye leakage of Group ET was significantly less than that observed in Group SB ($p < 0.05$). And the frequency of gutta-percha pulling out from root canal when the plugger was removed was more often with the System B than with EndoTwinn but there was no significant difference. 〔J Kor Acad Cons Dent 32(6):522-529, 2007〕

Key words : Sealing ability, Leakage, System B, EndoTwinn, Continuous wave

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Ⅰ. INTRODUCTION

The role of obturation in root canal treatment, although considered secondary to debridement and disinfection, still remains a critical stage for a successful outcome[1]. The aim of obturation is to seal the periradicular tissues from the residual microorganisms left in the root canal system after chemomechanical debridement.

Obturation of the root canal space has been performed using various techniques. The most commonly used and tested technique is cold lateral condensation. But cold lateral condensation offers the disadvantage of lacking of homogeneity and relying on spreader to fill the voids between the individual cones[2,3].

The technique of vertically compacting warm

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gutta-percha in the root canal had been found superior adaptation of gutta-percha to that provided by the cold lateral compaction[4,5].

The System B heat source (Analytic Technology, Redmond, WA, USA) was developed for use with a modified vertical condensation technique called the 'continuous wave of condensation', which was designed to simplify the vertical condensation technique[6]. It is claimed by the manufacturer that the System B heat source allows sufficient heat for the apical gutta-percha to be softened and adapted to the irregularities of the intracanal anatomy. However, some studies have found poor adaptation of gutta-percha to the canal wall in the important apical part of the canal[7,8]. And clinically, it sometimes happens for the apical gutta-percha to be pulled out from the canal when removing the plugger from the canal.

Some devices used in continuous wave technique had been introduced into the market. In addition to System B and Obtura II (Obtura Corporation, Fenton, MO, USA) which are the best known devices for warm gutta-percha filling techniques with vertical condensation, Duo-Alpha (B&L Biotech, Gunpo, Korea), Duo-Beta (B&L Biotech, Gunpo, Korea), E & Q Plus (Meta Biomed, Chungju, Korea) and Elements Obturation Unit (Sybron Endo, Orange, CA, USA) are used in clinics. The EndoTwinn (EndoTwinn, Amsterdam, Netherlands) which can apply both of heat and ultrasonic vibration simultaneously has introduced recently.

In endodontics, ultrasonic technique is used to remove post or broken instruments, to expose any missed or hidden canals and to irrigate the debris. Within the field of canal obturation, the ultrasonically energized spreader as an aid for lateral condensation of gutta-percha cones had been introduced to the market, but it is not used currently[9].

There were few reports which compare the apical leakage of the root canal filled with the EndoTwinn and former equipments. The purpose of this study was to compare the apical sealing ability and the frequency of gutta-percha pulling out between the System B and the EndoTwinn unit used in the continuous wave of obturation technique.

Ⅱ. MATERIALS AND METHODS

1. Root canal preparation

Sixty extracted human premolars with mature apex and straight root were used in this study. Soft tissue tags, attached bone, and calculus were removed and the teeth were stored in a 2.5% sodium hypochlorite. After preparing a conventional access cavity preparation, a K-type file of size 10 was inserted into the canal until it was just visible at the apical foramen. Working length was determined by subtracting 0.5 ㎜ from this length. The root canal of each tooth was cleaned and shaped to apical size 35 using rotary 0.06 taper Ni-Ti files (ProFile and ProTaper; Dentsply Maillefer, Ballaigues, Switzerland) with 16 : 1 reduction handpiece powered by X-Smart (Dentsply Maillefer, Ballaigues, Switzerland) at 300 rpm following the manufacture's recommendation in the presence of RC-Prep (Premier Dental, Plymouth Meeting, PA, USA).

The root canals were irrigated with 1 ㎖ of 2.5% sodium hypochlorite as irrigant between instrumentations and a K-type file of size 15 was used to maintain the apical patency. Each canal was then rinsed with 1 ㎖ of 17% EDTA solution (MD-cleanser; Meta Biomed, Chungju, Korea) for 3 min to remove smear layer, followed by flushing again with 2 ㎖ of sodium hypochlorite. The root canals were dried with paper point.

2. Root canal obturation

The prepared specimens were randomly divided into five groups. Group SB (n = 20) and Group NSB (n = 5) were obturated with System B. Group ET (n = 20) and Group NET (n = 5) were obturated with EndoTwinn. Group NSB and Group NET were defined as negative control groups and the Group PC (n = 10) was defined as positive control group which was not filled.

A size 35/.06 tapered gutta-percha cones

(Diadent, Chungju, Korea) were trimmed and fitted to obtain tug-back at the 0.5 ㎜ shorter than working length. The heat source plugger was selected which introduced to the distance 4 ㎜ short of working length. The Adseal (Meta biomed, Chungju, Korea) was used as a sealer to be introduced into designated canals with a lightly coated master cone. Then the coronal end of the cone was removed by activating the heat source plugger at the orifice. The tip of heat source plugger was inserted to the predetermined length using steady pressure. Once at the proper depth, the heat was removed and apical pressure was maintained for 10s. A short burst of heat was used to separate the tip from the apical gutta-percha plug and the tip was removed. The remaining apical gutta-percha was compacted with hand plugger (S-Kondenser; Obtura Corporation, Spartan, USA). The needle of the Obtura II was placed immediately over the apical mass of gutta-percha and the canal was back-filled. The filled gutta-percha was compacted again for 20s using the hand plugger.

During the filling procedure, the frequency of pulling-out of the gutta-percha was counted.

All procedures had been practiced extensively beforehand and all specimens were prepared and filled by a 2-year endodontic resident. The filling procedures were done by turns to exclude the influence of experience between System B and EndoTwinn.

3. Leakage test

After canals were filled with gutta-percha using tested units, the access cavities were sealed with light-cure glass-ionomer cement (Fuji II LC; GC, Tokyo, Japan). The specimens were stored in 100% humidity at 37℃ for 48hr for sealer setting. In Groups SB, ET and PC, the external surface of all teeth were coated with multi-layer of nail varnish leaving only 1 ㎜ area around the apical foramen[2]. In negative control group (Group NSB and Group NET), all external surface including apical foramen was coated with nail varnish. Each specimen was immersed in a 2% methylene blue dye

Table 1. Criteria for five-point scoring system

Point	Dye penetration
0	No leakage
0.25	To quadrant
0.5	Quadrant to a half
0.75	Half to three quadrants
1	Three quadrants to whole leakage

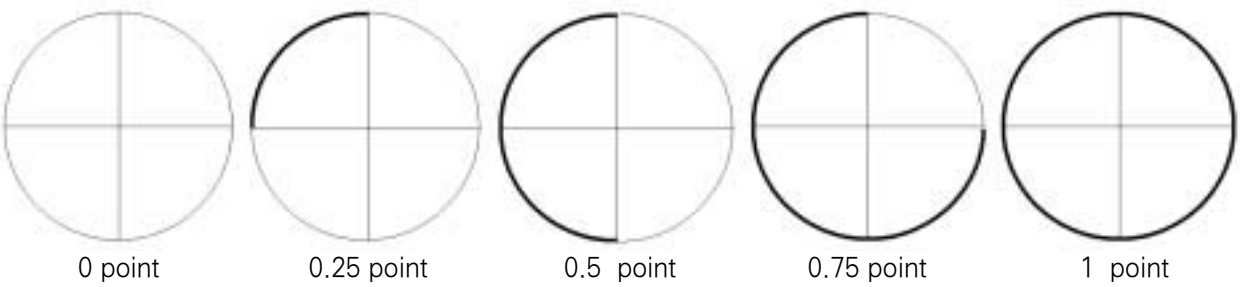

Figure 1. Schematic diagram for five-point scoring system.

solution for 2 days[10].

Then the specimens were sectioned at every 1 ㎜ from apex to 5 ㎜ level with diamond disk (Horico, Berlin, Germany) using the low speed handpiece under water cooling. Each sectioned surface was photographed using a digital camera (EOS350D; CANON, Japan) attached to the operative microscope (OPMI pico; Carl Zeiss, Oberkochen, Germany) at 12.5 × 2.5 fold magnification. The captured images were investigated by two independent, calibrated examiners using a five-point scoring system (Table 1, Figure 1). At each level, sectioned root surface was divided into quadrant and if there was dye penetration in each quadrant, 0.25 point was given. The final score of each specimen was given by summing up the point at each level from 1 ㎜ to 5 ㎜ of apical root.

4. Statistical analysis

Student unpaired t-test was done to determine statistical difference between two tested groups in the dye penetration. Chi-squared test was used to see if there was an overall difference in the frequency of the gutta-percha pulling out. All the statistical tests were done by SPSS version 12.0 (SPSS Inc., Chicago, IL, USA) at 5% significance level.

Ⅲ. RESULT

The samples of each point were represented at Figure 2.

The dye leakage of Group ET was significantly less than that of Group SB ($p < 0.05$, Table 2).

Figure 2. Representative sample of each point.
A; 0 point from 1 ㎜ level of Group NSB, B; 0.25 point from 2 ㎜ level of Group ET, C; 0.5 point from 1 ㎜ level of Group SB, D; 0.75 point from 1 ㎜ level of Group SB, E; 1 point from 1 ㎜ level of Group SB

Table 2. Mean dye penetration score

Group	Mean	SD	Min. leakage	Max. leakage
Group SB	0.4659	0.94898	0	3.5
Group ET	0.0395	0.12536	0	0.5

The dye leakage of Group ET was significantly less than that of group SB ($p < 0.05$).

Table 3. The frequency of pulling out of the gutta-percha

Group	Pulled out case / Total case	χ^2 significance
Group SB	4 / 25	p = 0.157
Group ET	1 / 25	

Group PC (positive control group) showed whole dye penetration into the root canals and dentinal tubules to be scored 5 point. Group NSB and NET (negative control groups) showed no dye penetration into the canal space.

The frequency of gutta-percha pulled out from the root canal is showed in Table 3. In Group SB and Group NSB, gutta-percha was pulled out in 4 among 25 teeth. In Group ET and Group NET, gutta-percha was pulled out in only one tooth. However, the chi-squared test indicated that frequency of pulling out of the gutta-percha is not significantly different between System B and EndoTwinn.

Ⅳ. DISCUSSION

Apical periodontitis is caused by intracanal bacteria[11,12]. Prevention or healing of apical periodontitis involves a combination of disinfection of the root canal space through chemomechanical means[13,14] and sealing both of the root canal and access cavity with the materials that will prevent reinfection[15,16]. Even if voids were filled with sealer, it could be potentially broken down if it is exposed to oral or tissue fluids[3], and provide a path for bacteria to reach the periapical area. Therefore three-dimensional filling of the root canal system is the aim of root canal treatment with the goal to maximize the amount of solid core material and minimize the amount of sealer[17].

Although the continuous wave of obturation technique has been known to show thermal irritability to periradicular tissue, simultaneously, it has been found superior to some other canal filling techniques in terms of less apical leakage and procedural time[4,5,18,19]. However Silver et al.[7] reported the distribution of gutta-percha using the continuous wave of obturation technique did not achieve 90%. Similarly, Wu et al.[17] found that the apical gutta-percha ratio was low in some specimens and the sealer was too thick. Kececi et al.[20] reported that insufficient softening of the gutta-percha by heat was thought to be responsible for low gutta-percha adaptation.

On the other hand, the use of ultrasonically energized spreader as an aid for lateral condensation technique has been proposed. In a few studies, the ultrasonically energized spreader that vibrate linearly and produce heat could improve the traditional lateral condensation technique by thermo-plasticizing the gutta-percha to achieve a more homogeneous mass with decreased number and size of voids, producing a more complete three-dimensional obturation of the root canal system[21,22].

The EndoTwinn which is a new device recently introduced has the same handling with System B and additionally has special ability of ultrasonic vibration of 100 Hz.

Under the condition of this study, although the data had big standard deviations, the EndoTwinn showed lesser apical leakage than the System B. The reduced apical microleakage by EndoTwinn probably is related to the ultrasonic energy to soften the gutta-percha thermo-mechanically and simultaneously the ultrasonic vibration might be expected to help the compaction of softened gutta-percha to the canal walls.

Some authors have shown that the penetration depth of the plugger is significantly related to the quality of the vertically compacted filling[4,23,24]. Because deeper penetration of the heated plugger in the root canal allows better heating of the gutta-percha, which facilitates closer adaptation of gutta-percha to the root canal walls and their irregularities. To subtract the factor of depth, the plugger which expended 4 ㎜ shorter than the working length was selected. In addition to the plugger penetration depth, the set temperature of a heat source may also be related to the obturation. The EndoTwinn heat source was fixed at 200℃. So in the present study, the temperature of system B was set at 200℃. The condition of heat application time in each tooth was same. But there was still insufficient information available on the effect of thermal conductivity of plugger and discrepancy between the set temperature and the real temperature at the tip of a heated plugger.

The EndoTwinn allowed definite severance of

the coronal surplus of gutta-percha from apical mass, and the plugger was withdrawn with the entire coronal gutta-percha surplus. According to the manufacturer, the tip size of four pluggers in EndoTwinn system is 0.5 ㎜. Although the pluggers fitted apically were selected, the pluggers in EndoTwinn system could move more actively with ultrasonic vibration than System B to severe the gutta-percha.

The use of plugger activated ultrasonically as an aid for lateral condensation of gutta-percha cones did not appear to predispose for overfilling[9]. However, a few previous investigations have shown that warm gutta-percha techniques frequently lead to extrusion of the filling material through the apical foramen[25-27]. Because the EndoTwinn is used as warm vertical technique, there is some possibility of extruding of gutta-percha. Adequate fitting of the master gutta-percha cone to obtain tug-back and proper use of ultrasonically activated plugger provided good control of the gutta-percha to limit in root canal.

Clinician should remember that the use of any new instrument and/or technique always requires training. However a certain device to show the better result with minimal training is preferable in clinics and that might pass current as better device.

This *in vitro* study may not be extrapolated into the clinical conditions but it showed a certain implication of superior sealing ability of EndoTwinn than the System B. Other investigation with regard to case result will be needed to see if there is any *in vivo* benefit. Additionally, a certain quantitative analysis of leakage or adaptation of the gutta-percha to the canal walls would strengthen our conclusion.

Ⅴ. CONCLUSION

Under the condition of this study, the EndoTwinn which has specific function of ultrasonic vibration might improve the conventional continuous wave of obturation technique by thermo-plasticizing the gutta-percha to achieve a lesser leak obturation, producing a more complete three-dimensional obturation of the root canal system with ultrasonic vibration.

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국문초록

EndoTwinn과 System B continuous wave of obturation units를 이용한 근단부 근관충전 효율비교

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최근 continuous wave of obturation technique을 이용한 근관 충전 장비로서 열 적용뿐 만 아니라 초음파 진동의 기능이 부가된 EndoTwinn이라는 기구가 소개되었다. 이 연구의 목적은 일반적으로 널리 사용되는 System B와 새로운 기구인 EndoTwinn을 사용한 근관충전 시 근단 폐쇄 효율을 비교하기 위한 것이다.

직선형 치근을 가진 60개의 발치된 소구치와 상악 절치를 근관장 측정 후, 6% 경사의 엔진 구동형 니켈-타이타늄 파일을 이용하여 #35 파일까지 확대 및 세척하였다. SB군 (n = 20)은 System B, ET군 (n = 20)은 EndoTwinn을 이용해 충전하고, Obtura II를 이용하여 backfill하였다. 양성 대조군으로서 PC군 (n = 10)은 근관 형성 후 빈 근관으로 남겨두었다. SB, ET, PC군의 시편은 치근첨 주위 1 ㎜를 제외한 모든 치근면에 nail varnish을 적용하고 음성 대조군인 NSB군 (n = 5)과 NET군 (n = 5)의 시편은 치근첨을 포함한 모든 치근면에 nail varnish를 도포하였다. 각 치아의 치근첨을 메틸렌블루 용액에 2일간 담궈 보관한 후, 치근첨에서 5 ㎜까지 1 ㎜간격으로 절단하여 근관벽의 착색 정도를 평가하였고, 각 높이에서의 점수를 합하여 그 시편의 점수로 정하였다.

두 장비 간의 염색제 누출의 유의성 검정을 위해 student t 분석을 시행하였다. 완전히 잘려지지 않고 플러거에 가타퍼챠가 달려나오는 빈도를 비교하기 위해 카이 분석을 시행하였다.

PC군은 모든 근관과 상아세관이 착색되었으며, NC군은 착색이 되지 않았다. ET군의 착색 정도가 SB군보다 유의하게 적게 나타났으며 ($p < 0.05$). 플러거에 가타퍼챠가 달려나오는 빈도는 유의한 차이가 없었다.

이 실험의 조건하에서, EndoTwinn을 이용해 충전한 경우에 System B를 이용해 충전한 경우보다 근단부 밀폐 정도가 더 좋은 것으로 사료된다.

주요어: 근관 폐쇄 효율, 누출, System B, EndoTwinn, Continuous wave 충전법