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근관치료용 실러가 치아변색과 실활치 미백에 미치는 영향

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Effects of various root canal sealers on tooth discoloration and internal bleaching

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근관치료 후 발생하는 치아변색은 여러 가지 원인에 의해 나타나는 것으로 알려져 있다. 본 실험은 근관치료 후 치아변색이 일어나는 여러 원인 중 실러 종류에 따른 영향을 평가하고 변색을 치료하기 위한 방법으로 실활치 미백을 시행할 경우 미백 효과 정도를 비교해 보는 것이다. 24개의 치아를 대조군, AH plus, Endosequece BC, MTA fillapex군 4개의 군으로 나누어 실험하였다. 실러를 사용하여 통상적인 방법으로 근관충전을 시행한 후 과붕산나트륨을 이용하여 실활치 미백을 시행 하였다. 그 후 Vita easyshade를 사용하여 치아의 색을 CIE L*a*b 시스템으로 측정하였다. 근관충전 후 변색실험에서 대조군과 모든 실험군에서 시간에 따라 치아의 색이 변하였다. 미백제의 효과에 대해서는 Endosequence BC와 MTA fillapex에서 AH plus군에 비해 미백효과가 유의하게 높은 결과가 나타냈다. 본 연구를 바탕으로 근관치료 시 실러의 주의 깊은 사용이 필요하며, epoxy resin 계열에 비해 Calcium silicate 계열의 실러로 인한 치아 변색에서 과붕산나트륨을 이용한 미백은 효율적일 수 있다.

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Introduction

The final step in endodontic treatment is root canal filling to prevent the spread of bacteria and bacterial byproducts from root to root apex (1). Clinicians use sealers with filling material to fill the root canals. The sealer is necessary to seal the space between the dentin wall and the filling material such as gutta-percha (GP) cone, and act as a lubricant during the root canal filling (2). Sealers also act as the binding and antimicrobial ideal sealers exhibit excellent sealing capacity, volume stability, slow hardening, water insolubility, and biostability (2-4).

Among the clinically popular sealers, AH Plus (Dentsply Caulk, Milford, DE, USA) is an epoxy-amine resin sealer. AH plus is less viscous, and applied thinly, with the lowest solubility. Furthermore, it has the shortest curing time with a negative volume change (5).

The recently developed sealer, Endosequence BC (Brasseler USA, Savannah, GA, USA), is a bioceramic sealer containing tricalcium silicate, dicalcium silicate, calcium phosphates, colloidal silica, and calcium hydroxide as bioactive components, and zirconium oxide as a radiopaque agent (6). Recent studies have shown that Endosequence BC has a long working time and high solubility, and positive volume change (7). In the cytotoxicity experiment, Endosequence BC showed low cytotoxicity (8), and formed a chemical bond with dentin root canal wall (9).

Another newly developed sealer, MTA fillapex (Angelus, Londrina, PR, Brazil) is a mineral trioxide aggregate (MTA)-based sealer consisting of MTA, salicylate resin, diluting resin, natural resin, nanoparticulated resin, and bismuth trioxide. The MTA fillapex is the most viscous and is applied as a thick layer. Further, it has short working time and hardening time, and shows a large negative volume change. In a recent study, MTA fillapex has been found to reduce cell toxicity after hardening and promote the formation of hydroxyapatite crystals (10).

During root canal treatment, discoloration may occur due to pulp remnants, microleakage of the restorative material, internal absorption, and failure of root canal treatment (11-13). Therefore, the aim of this study was to compare the degree of discoloration and the effect of non-vital bleaching of the human tooth with the resin-based sealer and calcium silicate-based sealers.

Materials and Methods

1. Sample Preparation

Thirty-extracted anterior teeth were selected and stored in physiological saline. Of these, six teeth were excluded for various reasons: caries, large restorations, multiple roots, abnormal canals, crack, and fractures. The remaining 24 teeth were divided into four groups of 6 for each type of sealer along with a control group. The used sealers were AH Plus, Endosequence BC, and MTA fillapex (Table 1).

Table 1. Control group and experimental group

	Control	AH plus	Endosequence BC	MTA fillapex
N	6	6	6	6
Maxilla/Mandible	3/3	3/3	3/3	4/2
Filling material	GP cone	GP cone	GP cone	GP cone
Sealer	-	AH plus	Endosequence BC	MTA fillapex

Access cavity was prepared and the root canal length was measured using a #10 K file (Mani inc, Utsunomiya, Tochigi, Japan) in all teeth. The root canal was irrigated with 5 mL of 1.25 % NaOCl per tooth. The canal was enlarged and shaped from S1 size to F3 size using a Protaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) Ni-Ti file. The root canal was well dried and filled with 04 taper GP cone (Diadent Group international, Burnaby, Canada). The control group was filled with GP cone without sealer. The experimental groups were filled with the GP cone using the specified sealer. The filled GP cone was cut 1 ㎜ below the cemento-enamel junction (CEJ) and then temporarily restored with a cotton pellet and e-temp (Diadent Group international). The teeth were immersed in saline and stored at 37℃.

2. Color change measurement

Color changes in teeth were measured at baseline, 24 h, 1 week, 2 weeks, 4 weeks, 8 weeks, 10 weeks and 16 weeks using a spectrophotometer, VITA easyshade (VITA Zahnfabrik, Bad Sackingen, Germany). The color measurements at cervical, middle, and incisal area of the crown were performed under fluorescent lights at 9 pm. Measurements were made three times per tooth and the mean value was recorded. Measurements were recorded in CIE L*a*b* system. The value of ΔE was calculated based on the L*a*b* value, and the degree of discoloration was compared. The ΔE was calculated using the following formula and the difference from the initial value was used (14).

$$\Delta E = \{(L_2-L_1)^2+(a_2-a_1)^2+(b_2-b_1)^2\}^{1/2}$$

3. Non-vital tooth bleaching

After 7 months of discoloration experiment, non-vital bleaching of each tooth was performed to evaluate the effect of the sealer on bleaching (15). Baseline was measured before the experiment. For the tooth whitening, the temporary filling material was removed with a round bur and replaced with a cotton pellet. The GP cone was removed further downward, and All-bond universal® (Bisco Inc., Shaumburg, IL, USA) as a dentin bonding agent and 2 mm-Ionosit® (DMG, Hamburg, Germany) were applied as a base and light cured.

Sodium perborate was used as a whitening agent. A mixture of sodium perborate and physiological saline was applied and filled with temporary sealing material. The bleaching material was maintained for 1 week and the color changes in teeth were measured. The bleaching agent was removed and the treated teeth were neutralized by filling with calcium hydroxide. After 1 week, color changes in teeth were measured, calcium hydroxide was removed, and each tooth was restored with composite resin (Filtek Z350XT Body A2, 3M ESPE, St. Paul, USA), (3MESPE, St.Paul, MN, USA). A week later, the color change were finally measured.

4. Statistical analysis

One-way ANOVA was used for the comparison, and statistical significance was confirmed using the Tukey's post-test. SPSS 23 (IBM Corp., NY, USA) was used for statistical analysis and the difference was considered significant at $p < 0.05$.

Results

1. Tooth discoloration after root canal filling

The control, AH plus, Endosequence BC, and MTA fillapex groups showed increased ΔE values at cervical, middle and coronal 1/3 after 24 h to 16 weeks (Figure 1).

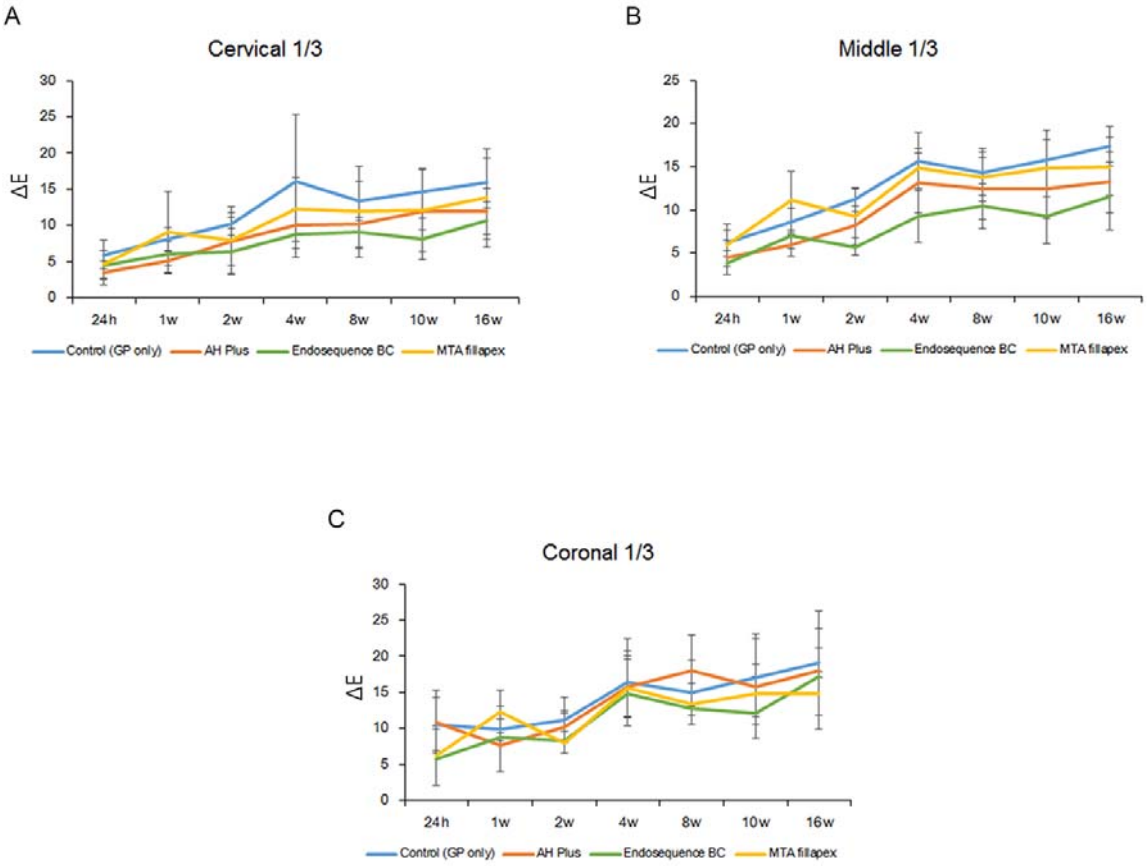

Figure 1. Changes in ΔE with time in the control group and the experimental group after root canal filling. Measurement of ΔL, Δa, Δb at cervical (A), middle (B) and coronal (C) 1/3 levels. The value of ΔE in control and experimental groups increased.

In the control group, the ΔE value increased steadily after the root canal filling, whereas ΔL, which represents the brightness, became negative and darker eventually. The value of Δa increased until the 2nd week and decreased, suggesting that the teeth turned red and green, respectively. Δb continued to increase with a negative value. Overall, the root canals were reddish, and bluish until 2 weeks after the root canal filling, followed by darkening to green and blue and discoloration. Use of AH plus sealer increased ΔE constantly after root canal filling, and the brightness eventually increased to a negative value and turned dark. Δa continued to turn reddish and Δb changed bluish. Overall, after the root canal filling, the brightness dimmed and turned to red and blue. Endosequence BC, and MTA fillapex showed continuous color changes according to ΔE value, darkening by ΔL, reddish according to Δa, and bluish according to Δb (Table 2).

Table 2. Values of ΔL, Δa and Δb with time in the control group and the experimental group after canal filling

			24h	1w	2w	4w	8w	10w	16w
Control	ΔL	cervical	-2.6±3.3	-0.2±4.8	-1.9±4.1	-0.9±4.2	-2.0±4.5	-4.7±5.2	-5.0±4.9
		middle	-0.9±2.7	-1.9±1.9	-3.3±2.0	-4.8±3.1	-5.0±2.4	-6.9±2.6	-7.6±2.3
		incisal	-8.7±4.3	-7.2±1.9	-7.5±2.9	-10.8±6.0	-9.7±4.6	-12.2±6.0	-14.3±2.7
	Δa	cervical	0.0±0.9	1.1±1.0	1.2±1.1	-1.0±1.9	-0.7±1.6	-0.6±1.7	-1.0±1.8
		middle	-0.4±1.0	1.1±1.4	1.3±1.6	-0.5±2.1	-0.4±2.0	-0.4±2.1	-0.4±2.3
		incisal	0.1±0.5	1.4±0.8	1.7±0.7	0.0±1.0	0.2±1.0	0.2±1.0	0.0±1.0
	Δb	cervical	-4.5±1.4	-6.7±1.4	-9.3±0.8	-15.5±9.3	-12.5±2.2	-13.1±1.9	-14.4±2.6
		middle	-5.5±1.6	-8.0±2.2	-10.3±2.2	-14.5±3.6	-13.1±3.1	-13.8±3.7	-14.9±3.5
		incisal	-5.4±1.4	-6.3±0.9	-7.9±2.1	-11.9±3.2	-11.0±3.0	-11.4±2.5	-12.5±2.2
AH plus	ΔL	cervical	-1.0±2.0	-2.1±3.1	-4.1±2.9	-3.1±4.8	-4.4±3.7	-6.2±3.5	-4.7±4.7
		middle	-2.5±2.0	-3.4±1.5	-4.7±1.6	-7.3±4.5	-6.8±2.0	-6.8±3.2	-7.2±3.4
		incisal	-7.6±9.0	-5.2±6.3	-6.4±6.8	-10.9±8.6	-11.4±12.3	-11.0±11.3	-14.5±9.1
	Δa	cervical	0.1±0.2	2.3±1.0	1.5±0.9	0.5±1.0	0.6±1.2	0.3±1.4	0.0±1.5
		middle	0.5±0.7	2.5±0.8	1.9±0.7	0.9±1.0	0.8±0.8	0.8±0.8	0.7±0.8
		incisal	0.8±0.6	2.7±0.6	1.9±0.8	1.2±0.8	1.1±1.4	1.0±0.9	0.9±1.0
	Δb	cervical	-2.8±1.3	-2.5±1.7	-6.1±2.5	-8.4±1.7	-8.6±2.5	-9.7±2.3	-10.1±3.0
		middle	-3.0±2.2	-3.6±2.4	-6.2±2.3	-10.2±2.7	-10.4±3.2	-10.1±2.6	-10.8±2.8
		incisal	-2.3±1.9	-1.2±1.1	-4.4±2.0	-8.8±1.9	-8.5±4.0	-7.8±2.5	-9.4±3.6
Endosequence BC	ΔL	cervical	-3.9±2.1	-2.1±2.3	-2.4±1.2	-3.3±3.6	-3.9±3.2	-2.9±2.3	-5.9±3.8
		middle	-2.8±0.5	-4.3±1.8	-3.9±1.2	-5.0±3.0	-6.9±2.1	-5.8±2.8	-7.9±3.9
		incisal	-5.0±4.2	-7.1±4.8	-5.9±5.4	-11.7±5.7	-9.7±3.7	-8.9±5.7	-14.4±7.2
	Δa	cervical	1.1±0.3	1.9±1.0	2.2±1.2	1.0±1.1	0.9±1.3	1.0±1.2	1.0±1.3
		middle	1.0±0.3	2.5±0.4	2.8±0.3	1.6±0.6	1.4±0.5	1.6±0.7	1.6±0.7
		incisal	1.1±0.4	2.3±0.4	2.5±0.6	1.3±0.7	1.3±0.6	1.4±0.6	1.4±0.8
	Δb	cervical	-1.5±1.0	-4.9±1.6	-4.6±4.1	-7.3±3.1	-7.1±3.2	-7.0±3.2	-8.0±2.6
		middle	-2.1±1.9	-4.9±0.9	-3.0±0.9	-7.4±2.0	-7.6±2.4	-6.8±2.5	-7.9±3.0
		incisal	-1.7±1.7	-4.0±1.2	-3.2±3.0	-8.5±3.4	-7.8±2.3	-7.4±2.2	-8.7±2.3
MTA fillapex	ΔL	cervical	-2.1±2.4	-2.8±5.2	-2.2±5.1	-1.9±6.3	-1.7±5.9	-2.7±5.7	-3.1±5.8
		middle	-2.8±1.4	-5.3±3.0	-4.1±2.2	-6.2±4.6	-6.0±4.8	-6.8±4.5	-6.8±5.3
		incisal	-4.1±5.1	-7.8±4.3	-4.0±4.5	-9.6±7.0	-6.2±7.6	-8.1±8.3	-8.7±6.4
	Δa	cervical	1.1±0.6	1.1±0.8	1.5±0.8	-0.1±1.4	-0.2±1.4	0.2±1.4	0.3±1.6
		middle	1.5±0.6	1.9±1.0	2.1±0.8	0.9±1.5	0.9±1.6	1.3±1.7	0.9±1.7
		incisal	1.3±0.4	1.1±0.9	1.5±0.7	0.2±1.1	0.2±1.3	0.4±1.3	0.2±1.3
	Δb	cervical	-2.5±2.9	-7.1±5.4	-5.4±5.2	-10.2±5.3	-10.1±6.6	-10.5±5.8	-12.2±7.0
		middle	-4.8±2.2	-9.2±2.9	-7.8±2.9	-12.5±2.8	-11.5±3.3	-12.4±3.7	-12.4±3.4
		incisal	-2.6±2.4	-8.8±2.3	-5.3±1.5	-11.0±1.1	-9.5±1.5	-10.3±1.2	-10.7±1.4

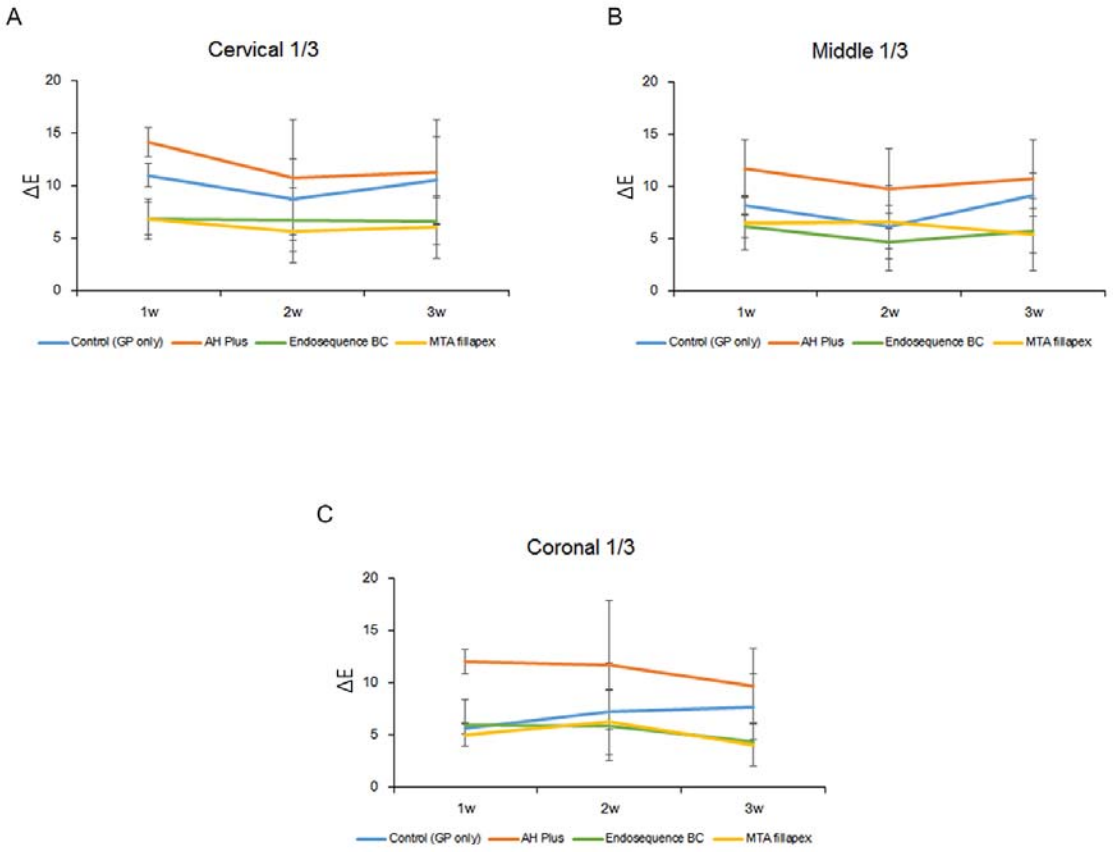

Figure 2. Changes in ΔE with time in the control group and the experimental group after non-vital bleaching. Measurement of L, a, b at cervical (A), middle (B) and coronal (C) 1/3 levels. The value of ΔE in control and experimental groups showed increasing tendency. Values of ΔE increased in all groups 1 week after the addition of bleaching agent.

2. Color change of tooth after non-vital bleaching

In this experiment evaluating the effect of bleaching agents by the sealer, we compared the values of ΔL, Δa, Δb, and ΔE between the baseline and 1 week after the addition of bleaching agent. Values of ΔE increased in all groups. The control and AH plus groups showed larger change in tooth color than Endosequence BC and MTA fillapex groups. Subsequently, during the 3 weeks, minor changes were observed (Figure 2).

After the whitening, the brightness intensified and the Δa turned greenish as opposed to discoloration, whereas Δb still remained bluish. The brightness tended to darken only in the cervical region (Figures not shown).

3. Tooth color change

The significance of ΔE between 24 h and 16 weeks after root canal filling was determined. After 24 h of root canal filling, ΔE increased in all experimental groups. The cervical and middle 1/3 sites showed the greatest change in the control group, and the coronal 1/3 showed the greatest change in the AH plus group. However, the degree of discoloration among the groups was not significantly different after 24 h of root canal filling. The greatest ΔE value in all groups was observed at 16 weeks after canal fillings and the degree of discoloration among groups was not significantly different. Comparison of the significance of ΔE between 16 weeks after root canal filling and 1 week after non-vital bleaching showed that

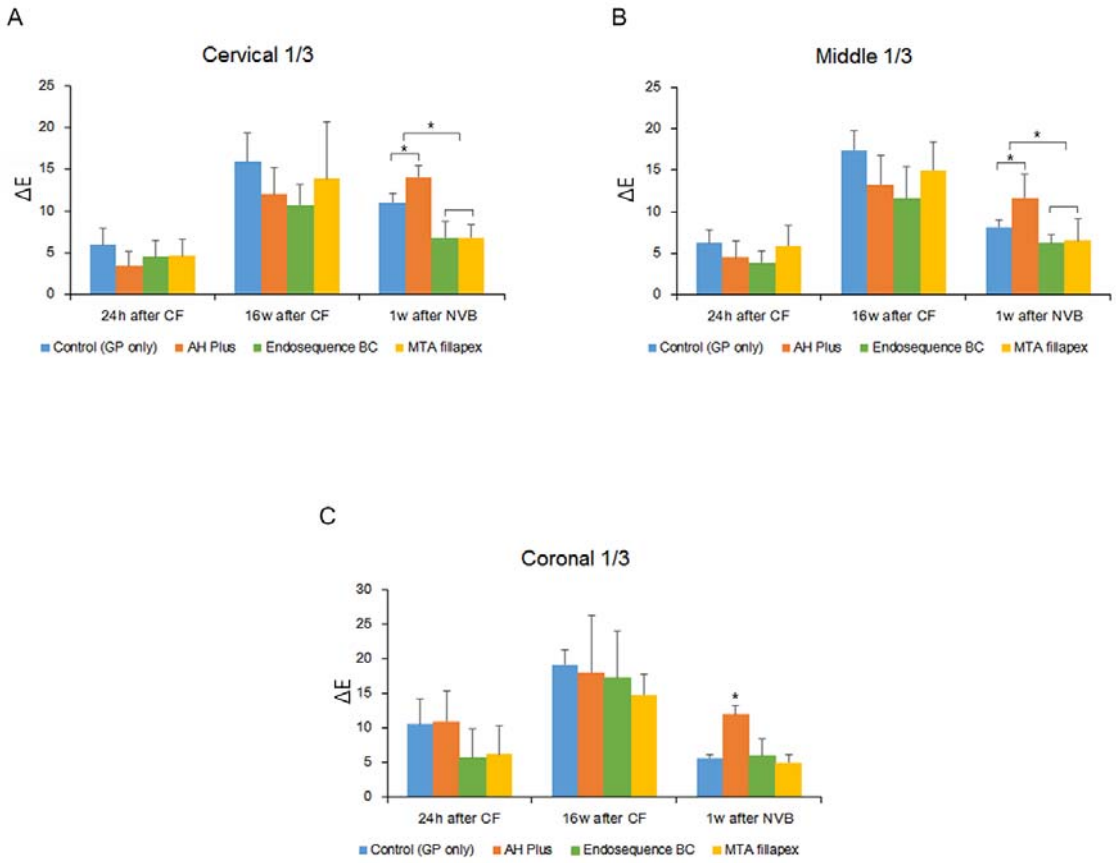

Figure 3. Total color changes. AH Plus showed lowest ΔE between 16 weeks after root canal filling and 1week after non vital bleaching.

AH Plus had a significantly low ΔE when compared with the control group. Further, in the Endosequence BC and MTA fillapex groups, ΔE was significantly higher than in the AH plus groups suggesting that Endosequence BC and MTA fillapex groups yielded a higher bleaching effect than AH Plus (Figure 3).

Discussion

The graphs of ΔE, ΔL, Δa, and Δb values over time were obtained for each sealer condition. The results were obtained by dividing them by the measurement position. ΔL denotes the degree of change in brightness; 'a' indicates the value between red (+) and green (-) axes, and Δa is the degree of change in red-green; 'b' denotes the value between the yellow (+) - blue (-) axis and Δb is the variation between yellow and blue colors (16). The degree of discoloration was confirmed by the value of ΔE calculated using ΔL, Δa, and Δb values.

Non-vital bleaching is a technique involving the action of hydrogen peroxide as an oxygen generator (17). In the bleaching experiment, Endosequence BC and MTA fillapex were significantly effective in the cervical region. AH plus had low effect on bleaching. This result might be attributed to the difference in dentin bond strength between calcium silicate-based sealers and AH Plus suggesting that dentin bond strength affects non-vital bleaching. Several studies reported significantly higher bond strengths with epoxy resin-based sealer such as

AH Plus (18-20). In several studies, MTA fillapex showed the lowest bond strength to root dentine. The release of calcium and hydroxyl ions from the sealer results in the formation of apatites as the material contacts phosphate-containing fluids (21-23). Apatite was deposited within collagen fibrils promoting controlled mineral nucleation on dentine, seen as the formation of an interfacial layer with tag-like structures (1,24). The low bond strength of MTA fillapex in the present study may be due to the low adhesion capacity of these tag-like structures (25).

Conclusions

In conclusion, tooth discoloration after root canal treatment occurs irrespective of the type of sealers and may cause discoloration with only GP cone. The effect of non-vital bleaching following the use of calcium silicate-based sealers such as Endosequence BC and MTA fillapex was higher than that of AH plus. Therefore, it needs to careful use of sealers in endodontics and calcium silicate-based sealers have advantages of bleaching in case of the discolored tooth. Further studies are also needed to improve the bleaching effects with various sealers.

References

1. Silva EJ, Rosa TP, Herrera DR, Jacinto RC, Gomes BP, Zaia AA. Evaluation of cytotoxicity and physicochemical properties of calcium silicate-based endodontic sealer MTA Fillapex. J Endod. 2013;39(2): 274-7.
2. Grossman LI. An improved root canal cement. JADA. 1958;56(3):381-5.
3. Branstetter J, Von Fraunhofer J. The physical properties and sealing action of endodontic sealer cements: a review of the literature. J Endod. 1982;8(7): 312-6.
4. Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. Eur J Gen Dent. 2013;2(3): 199-218.
5. Lim ES, Park YB, Kwon YS, Shon WJ, Lee KW, Min KS. Physical properties and biocompatibility of an injectable calcium-silicate-based root canal sealer: in vitro and in vivo study. BMC Oral Health. 2015;15(1):129-35.
6. Takagi S, Chow LC, Hirayama S, Eichmiller FC. Properties of elastomeric calcium phosphate cement–chitosan composites. Dent Mater. 2003;19(8):797-804.
7. Zhou H, Shen Y, Zheng W, Li L, Zheng Y, Haapasalo M. Physical properties of 5 root canal sealers. J Endod. 2013;39(10):1281-6.
8. Loushine BA, Bryan TE, Looney SW, Gillen BM, Loushine RJ, Weller RN, et al. Setting properties and cytotoxicity evaluation of a premixed bioceramic root canal sealer. J Endod. 2011;37(5):673-7.
9. De-Deus G, Canabarro A, Alves G, Marins J, Linhares A, Granjeiro J. Cytocompatibility of the ready-to-use bioceramic putty repair cement iRoot BP Plus with primary human osteoblasts. Int Endod J. 2012;45(6): 508-13.
10. Salles LP, Gomes-Cornélio AL, Guimarães FC, Herrera BS, Bao SN, Rossa-Junior C, et al. Mineral trioxide aggregate–based endodontic sealer stimulates hydroxyapatite nucleation in human osteoblast-like cell culture. J Endod. 2012;38(7):971-6.
11. Van der Burgt T, Mullaney T, Plasschaert A. Tooth discoloration induced by endodontic sealers. Oral Surg Oral Med Oral Pathol. 1986;61(1):84-9.
12. Vallés M, Mercadé M, Duran-Sindreu F, Bourdelande JL, Roig M. Influence of light and oxygen on the color stability of five calcium silicate–based materials. J Endod. 2013;39(4):525-8.
13. Kang SH, Shin YS, Lee HS, Kim SO, Shin Y, Jung

IY, et al. Color changes of teeth after treatment with various mineral trioxide aggregate–based materials: an ex vivo study. J Endod. 2015;41(5):737-41.
14. Okubo SR, Kanawati A, Richards MW, Childressd S. Evaluation of visual and instrument shade matching. The Journal of prosthetic dentistry. 1998;80(6):642-8.
15. Boksman L, Jordan RE, Skinner D. Non-vital bleaching—internal and external. Aust Dent J. 1983;28(3): 149-52.
16. Zhang Q, Kamata S-i, editors. A novel color space based on RGB color barycenter. Acoustics, Speech and Signal Processing (ICASSP), 2016 IEEE International Conference on; 2016: IEEE.
17. Rotstein I, Zalkind M, Mor C, Tarabeah A, Friedman S. In vitro efficacy of sodium perborate preparations used for intracoronal bleaching of discolored non-vital teeth. Dent Traumatol. 1991;7(4):177-80.
18. Lee KW, Williams MC, Camps JJ, Pashley DH. Adhesion of endodontic sealers to dentin and gutta-percha. J Endod. 2002;28(10):684-8.
19. Saleh I, Ruyter I, Haapasalo M, Ø rstavik D. The effects of dentine pretreatment on the adhesion of root-canal sealers. Int Endod J. 2002;35(10):859-66.
20. Parsons JR, Walton RE, Ricks-Williamson L. In vitro longitudinal assessment of coronal discoloration from endodontic sealers. J Endod. 2001;27(11):699-702.
21. Sarkar N, Caicedo R, Ritwik P, Moiseyeva R, Kawashima I. Physicochemical basis of the biologic properties of mineral trioxide aggregate. J Endod. 2005;31(2):97-100.
22. Camilleri J, Sorrentino F, Damidot D. Characterization of un-hydrated and hydrated BioAggregateTM and MTA AngelusTM. Clin Oral Investig. 2015;19(3):689-98.
23. Yang Q, Lu D. Premixed biological hydraulic cement paste composition and using the same. U.S. Patent 8,475,811, 2013.
24. Reyes-Carmona JF, Felippe MS, Felippe WT. Biomineralization ability and interaction of mineral trioxide aggregate and white portland cement with dentin in a phosphate-containing fluid. J Endod. 2009;35(5):731-6.
25. Sagsen B, Ustün Y, Demirbuga S, Pala K. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. Int Endod J. 2011;44(12):1088-91.

Original Article

Effects of various root canal sealers on tooth discoloration and internal bleaching

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There are several causes of tooth discoloration following root canal treatment. In this study, we evaluated the effects of sealers on tooth discoloration and internal bleaching. Twenty-four teeth were divided into 4 groups: control group, AH plus, Endosequece BC, and MTA fillapex group. Root canal filling was performed using each sealer conventionally and non-vital bleaching was performed with sodium perborate. The L, a, and b values were measured using Vita easyshade. Tooth discoloration after root canal treatment occurs irrespective of the type of sealers and may cause discoloration with only gutta-percha cone. The effect of non-vital bleaching following the use of calcium silicate-based sealers such as Endosequece BC and MTA fillapex was higher than that of AH plus. Therefore, it needs careful use of sealers in endodontics and calcium silicate-based sealers have advantages of bleaching in case of discolored tooth.

Key Words : Root canal sealer, Tooth discoloration, Non-vital bleaching