The Endodontic Study for the Control of Resorption on Outer Root Surface with Dental Trauma

Yasutaka Yawaka, Yuki Toyota, Akina Hisada, Toshihiro Yoshihara

Department of Dentistry for Children and Disabled Person,
Division of Oral Functional Science,
Hokkaido University Graduate School of Dental Medicine,
Sapporo/Hokkaido, Japan

Introduction

The outer root resorption with dental trauma affects the life of the tooth (Fig. 1). However, it is difficult to control/stop the outer root resorption adequately.

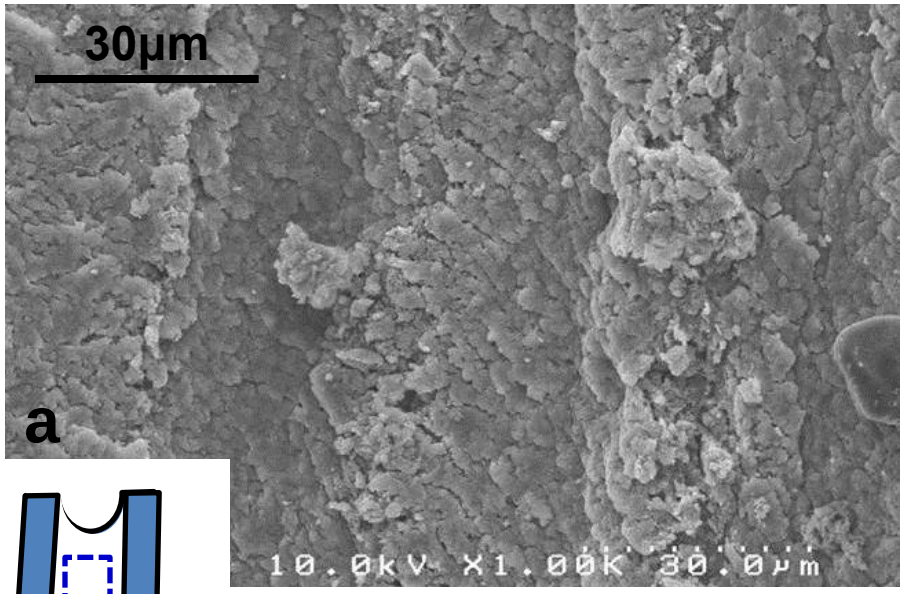
Clinically, the treatment of the outer root resorption is consisted of root canal cleaning and root canal dressing with calcium hydroxide [1]. The alkaline diffusion of calcium hydroxide from root canal to outer root surface neutralizes acid that is secreted by odontoclasts [2]. Therefore, it is thought that this procedure control the outer root resorption. On the other hand, root canal enlargement and preparation makes the smear layer on the root canal wall (Fig. 2). The smear layer blocks dentinal tubules. It is thought that the smear layer obstructs the diffusion of root canal dressing materials [3].

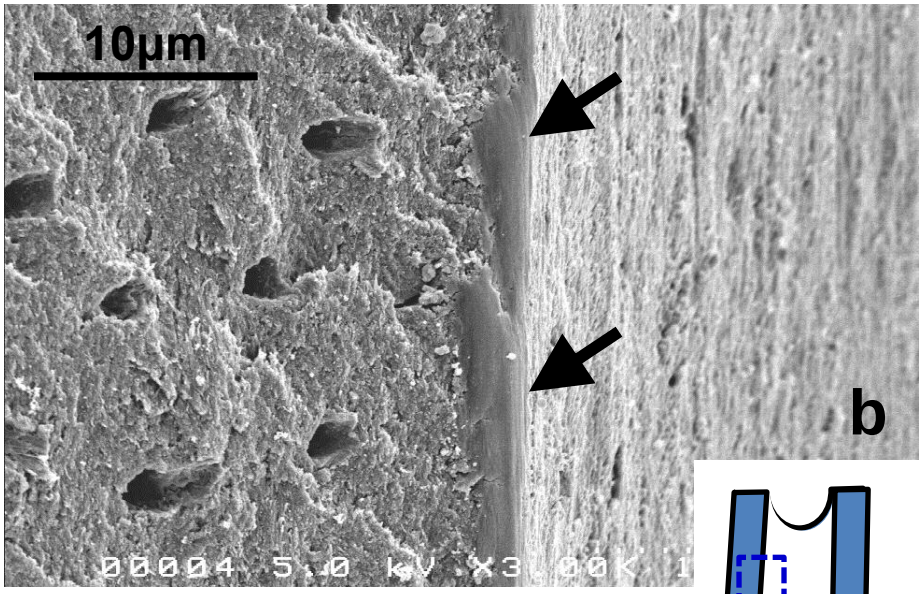
The aim of this study was to evaluate the influence of endodontic irrigation associated with removal of the smear layer and alkaline diffusion through the dentin of extracted human permanent teeth.

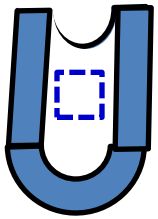
This study was recognized by Hokkaido University Graduate School of Dental Medicine, Research Ethics Committee (Number 2012-1).

Fig. 1 Outer root resorption

X-ray photograph of upper left lateral incisor showed outer root resorption with dental trauma.







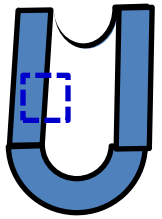


Fig. 2 Smear layer on root canal wall

SEM photographs of root canal wall after root preparation

a: Surface of root canal wall was covered with smear layer.
b: Smear layer (arrows) in 1~2μm thickness was observed on root canal surface.

Materials and Methods

Materials

Human permanent 58 teeth with single root and single root canal were used in this study. Teeth were cut off the crowns.

Root Canal Irrigation

The root canals of 28 teeth were enlarged by K file to size 80 (ISO). The teeth were classified into 4 groups with 7 teeth in each group and the root canals were irrigated by four kinds of method, respectively (Fig 3).

G1: 5%NaOCl, 31%H_2O_2
(alternate use with syringes)

G2: 5%NaOCl + Ultra sonic

G3: 5%EDTA + Ultra sonic

G4: 5%EDTA + Ultra sonic
→ 5%NaOCl + Ultra sonic

＊Ultra sonic : Osada ENAC10W (OSADA, Japan) with ENAC tip（ST19A + U file）at power 1（Fig. 4）

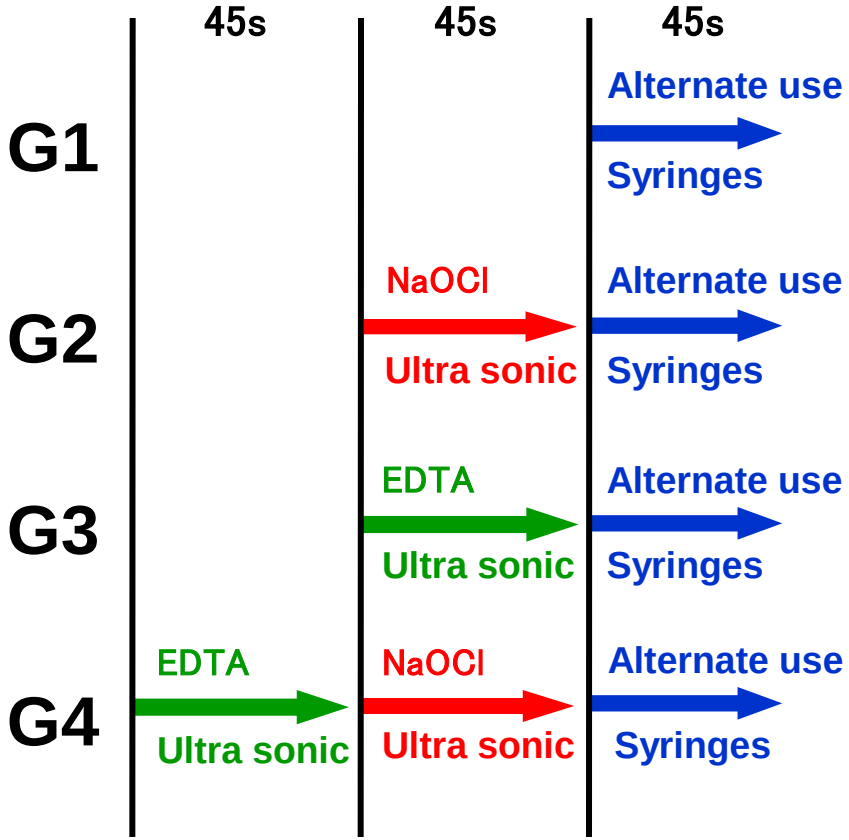


Fig. 3 Method of root canal irrigation

Observation of Root Canal Walls

Teeth were divided into 2 pieces in parallel with tooth axis, and fixed in glutaraldehyde in 0.1M sodium cacodylate buffer (pH 7.4) for 24 hours. They were dehydrated in a great series of ethanol, dried in a critical-point, and ion sputter coated. The irrigated root canal walls of specimens were observed with a scanning electron microscope (SEM: HITACHI S-4000, HITACHI, Japan), at an accelerated voltage of 10 kV, and taken photographs.

The percentage of opened dental tubules was used to evaluate the SEM photographs of the center and apex root canal walls.

The results were statistically analyzed using one-way factorial ANOVA.

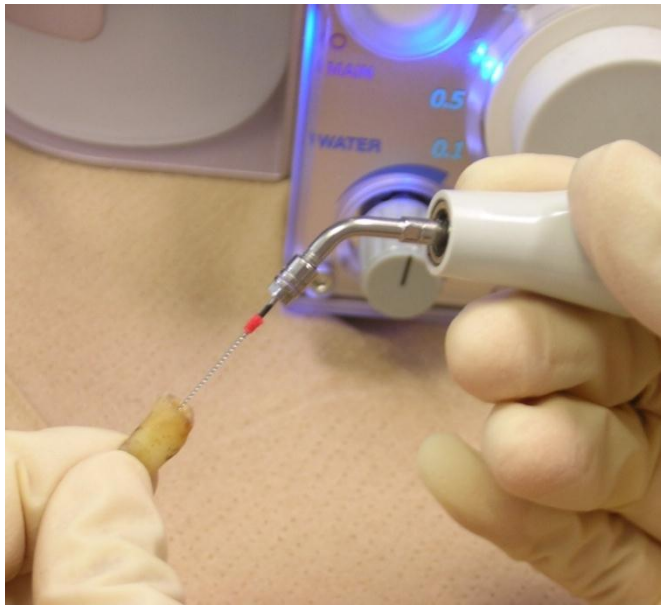


Fig. 4 Root irrigation with ultra sonic

Alkaline Diffusion of Outer Root Surface

The root canals of 30 teeth were enlarged by K file to size 80 (ISO). The teeth were classified into 3 groups with ten teeth in each group and the root canals were irrigated by G1 or G4 method, respectively. The root canal placement of three calcium hydroxide dressing materials; Calcipex II (Nippon Shika Yakuhin, Japan), Calvital (Neo Dental Chemical Products, Japan) and Vitapex (Neo Dental Chemical Products) (Fig. 5). Calcipex and Calvital are hydrophilic materials, and Vitapex is hydrophobic materials. And the root canal orifice and apical foramen of teeth were blocked by quick self-curing resin (Unifast II, GC, Japan). Then, two simulated resorptive defects were made on outer root surface by round bar. The teeth were embedded in ager culture medium with 1% phenolphthalein (Fig. 6). Phenolphthalein in alkaline region (more than pH 8.5) turns red. The color change of the medium as the alkaline diffusion from the part of resorptive defects was observed for 4 weeks.

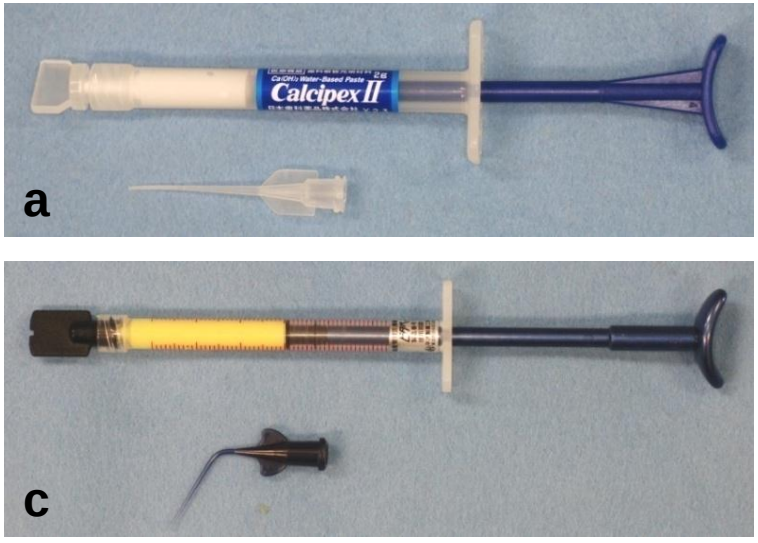


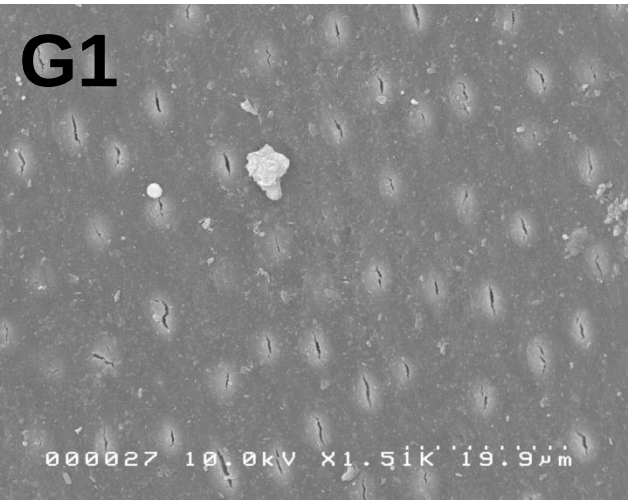
Fig. 5 Calcium hydroxide

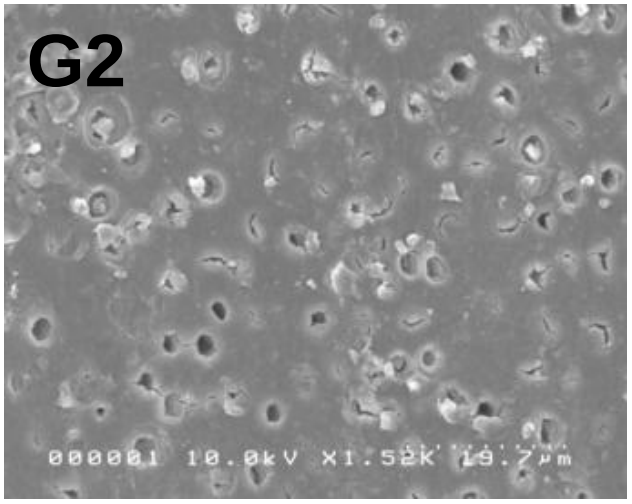
a: Calcipex II
b: Calvital
c: Vitapex

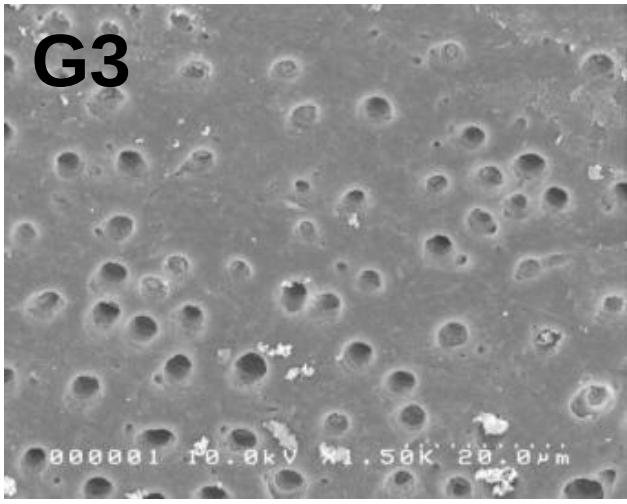
Fig. 6 Embedding of tooth in ager medium

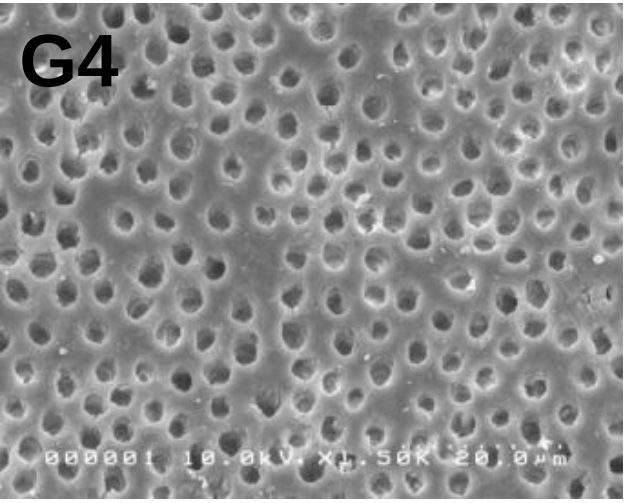
Results

Observation of Root Canal Walls





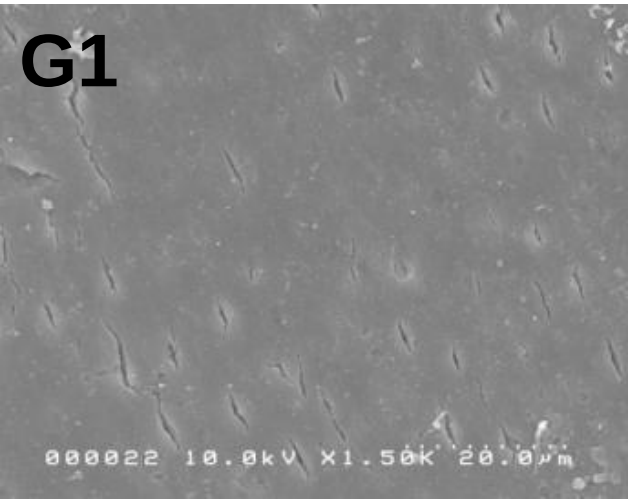


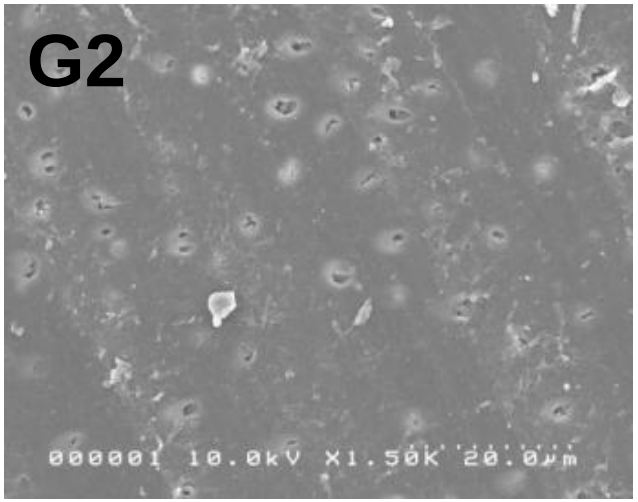


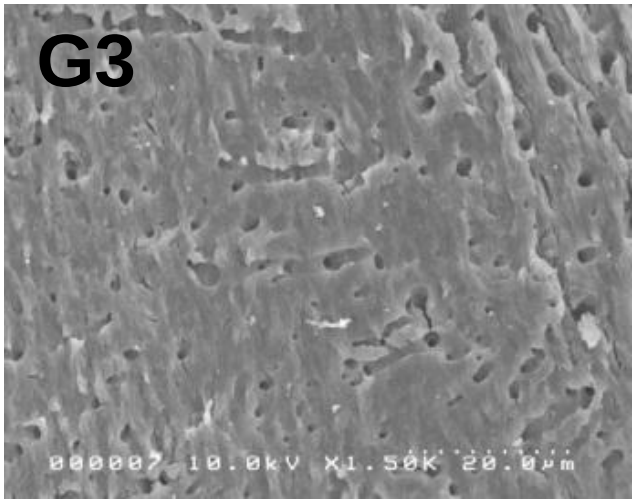
SEM photographs of root canal wall after root irrigation

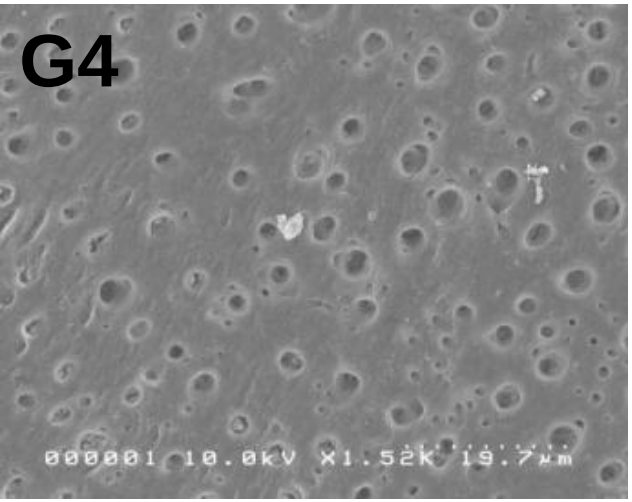
G1: Dentinal tubules were not clear by survived smear layer.
G2: Dentinal tubules were clear, but there were few opened dentinal tubules.
G3: Many dentinal tubules were opened.
G4: Most of dentinal tubules were opened.

Fig. 7 Root canal walls in the center of root









SEM photographs of root canal wall after root irrigation

G1: Dentinal tubules were not clear by survived smear layer.
G2: Dentinal tubules were clear, but there were few opened dentinal tubules.
G3: Many dentinal tubules were opened.
G4: Most of dentinal tubules were opened.

Fig. 8 Root canal walls at root apex

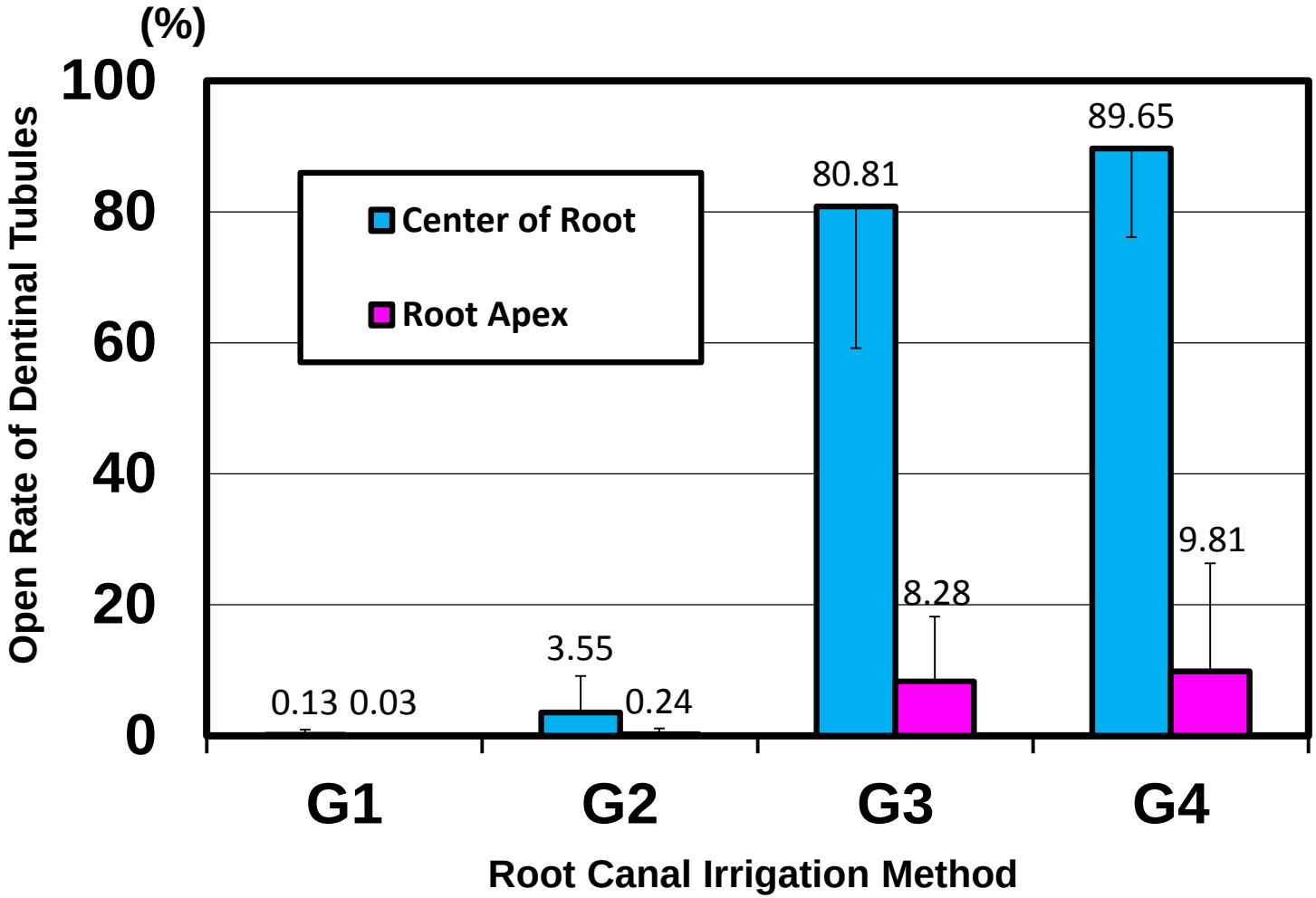


Fig. 9 Open rate of dentinal tubules

∗ **p< 0.01** Center of Root : G3 vs G1, G2
G4 vs G1, G2, G3

Root Apex : G3 vs G1, G2
G4 vs G1, G2

∗ using one-way factorial ANOVA

Alkaline Diffusion of Outer Root Surface

The alkaline diffusion from root canal to the outer surface cavity showed the color change of medium due to reaction of phenolphthalein. The specimens of G1 hardly changed medium color (not shown in Fig.). The color change of medium was observed in Calcipex II group and Calvital group of G4 with considerable frequency (Fig. 10a). However, Vitapex group of G4 showed the color change on the simulated resorptive defect surface only (Fig. 10b).

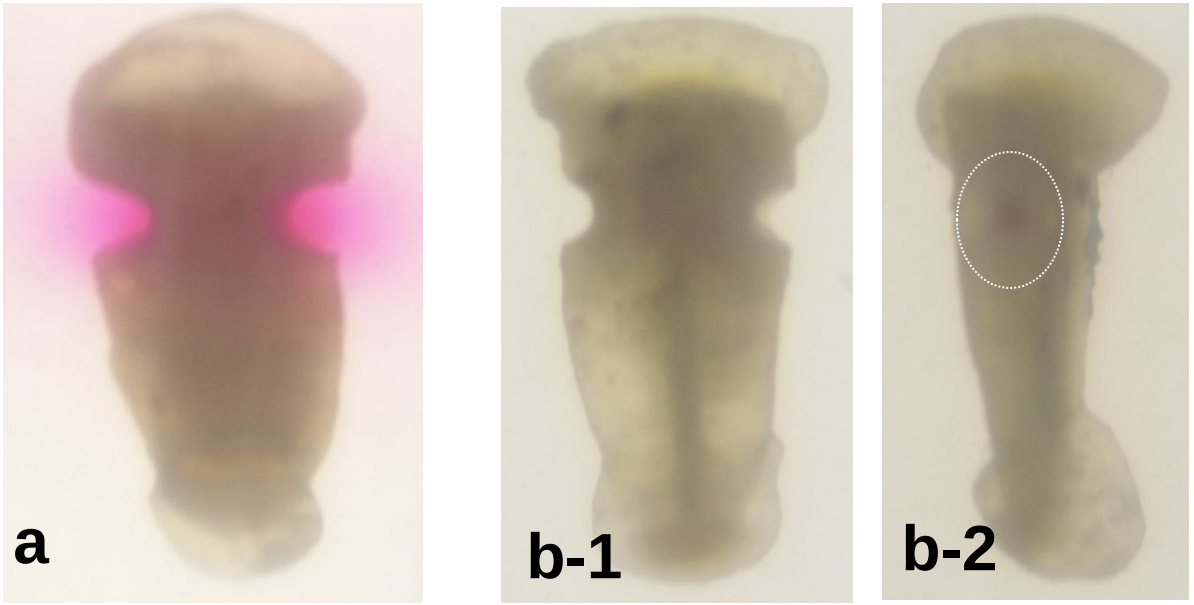


Fig.10 Color change of ager medium (G4)

a: Calcipex II : The color change of medium was clear.
b: Vitapex : The color change was shown on the defect surface only (oval).

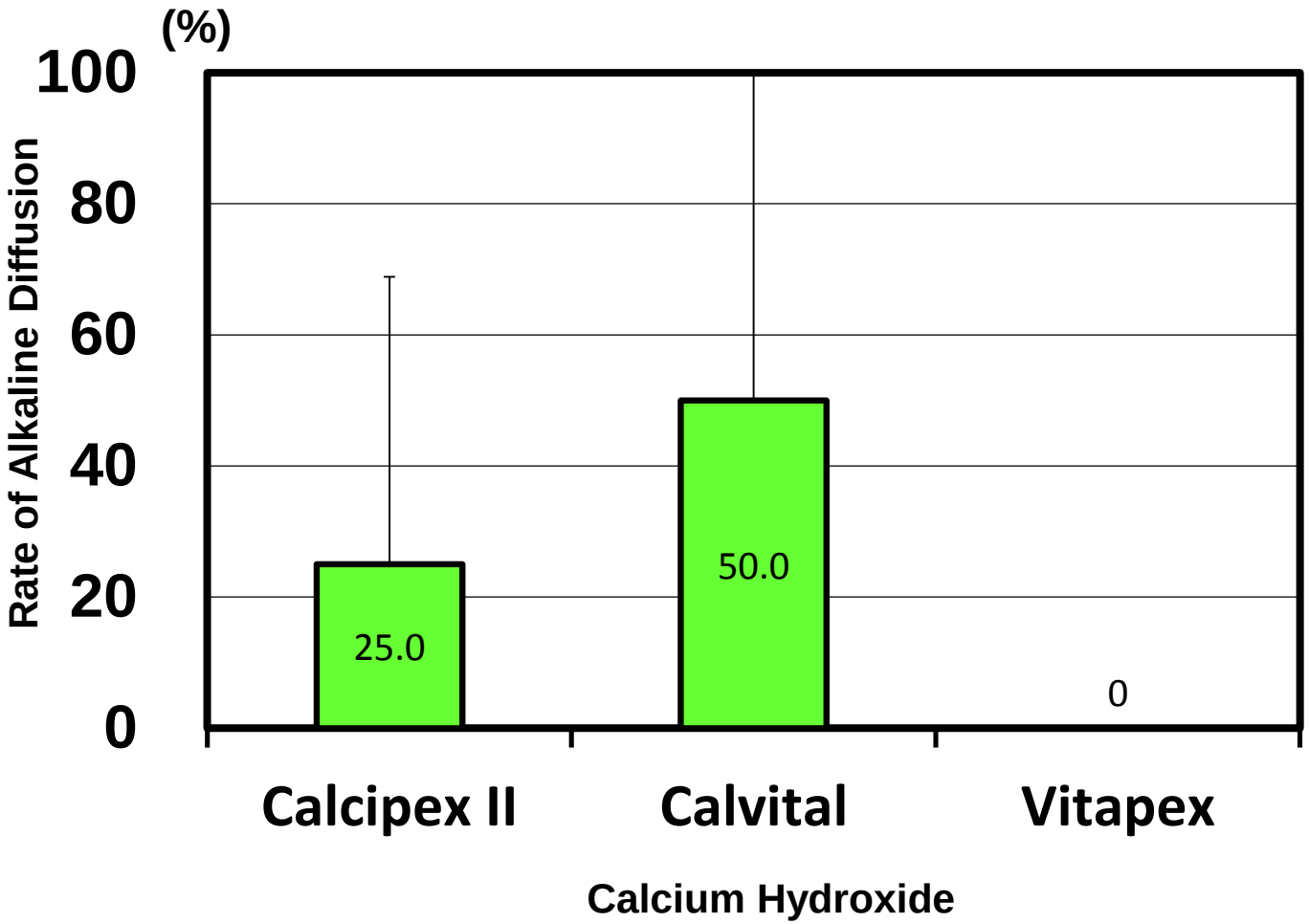


Fig. 11 Rate of alkaline diffusion (G4)

The root canal irrigation of G4 showed high diffusion rate. However, Vitapex group showed that the color changed on the defect surface only, accordingly, the rate of diffusion was “0”.

Discussion and Conclusion

EDTA with ultra sonic or combination of EDTA and NaOCl with ultra sonic was effective in removing the smear layer on permanent teeth. It was suggested that root canal irrigation with ultra sonic was valid for the alkaline diffusion from calcium hydroxide.

The diffusion type of Calcipex II and Calvital was different from the type of Vitapex. It was thought that the result depended on chemical behavior of materials as hydrophilic or hydrophobic.

The smear layer removal with ultra sonic facilitated hydroxide ion diffusion from the root canal to the root outer surface cavity.

References

1) American Association of Endodontists Recommended Guidelines: Treatment of the avulsed permanent tooth. Dent. Clin. North Am., 39: 221-225, 1995.
2) Tronstad, L., Andreasen, J.O., Hasselgren, G., Kristerson, L., Riis, I.: pH changes in dental tissues after root canal filling with calcium hydroxide. J. Endod., 7: 17-21, 1981.
3) McComb D, Smith D.C.: A preliminary scanning electron midroscopic study of root canals after endodontic procediures. J. Endod., 1: 238-242, 1975.