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Research Article

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Investigation of a Calcium Hydroxide Overflowing From Root Apex during Calcium Hydroxide Removal

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Abstract

Calcium hydroxide has been widely used as intracanal medicament recently. However, removing calcium hydroxide accumulated in the apical foramen was difficult, and there is a risk of overflowing outside of the apical foramen during removing procedure. In this study, we investigated (1) the status of overflow from root apex foramen in each removal method using hand file or ultrasonic scaler, (2) possibility of reducing overflow in combination with citric acid solution or EDTA solution.

Twenty-four maxillary premolar artificial teeth were performed root canal enlargement using K-fail until No.25 or No.30 size of thickness in each 12 teeth. After finishing root canal enlargement, calcium hydroxide was filled within root canal apex completely. Then calcium hydroxide was removed using ultrasonic scaler or hand file. Furthermore purified water, citric acid solution or EDTA solution was prepared as auxiliary agents respectively. After removing calcium hydroxide from each root canal was finished, the condition of calcium hydroxide overflowing from root apex was observed using stereomicroscope.

Calcium hydroxide in the root canal was sufficiently removed from root canals in the groups using ultrasonic scaler. However slighted calcium hydroxide was remained around root apex in the groups using hand file. Overflow of calcium hydroxide to outside around root apex was observed both using ultrasonic scaler and hand file. The tendency of calcium hydroxide overflowing was higher in the case of using ultrasonic scaler than using hand file. In the groups of using hand file, no significant difference was observed for the different size of root canal enlargement, however overflow of calcium hydroxide was clearly higher in 30 size of root canal enlargement using ultrasonic scaler. The use of citric acid solution and EDTA solution as auxiliary agents showed that overflow of calcium hydroxide was decreased compared without using them. In particular, the decrease of overflowing was more clearly using citric acid solution than using EDTA solution.

It is recommended that using hand file on removal apex areas of calcium hydroxide to reduce amount of overflowing and improve the removal efficiency. Moreover reducing the risk of calcium hydroxide overflowing are expected using citric acid solution or EDTA solution.

Keywords: Calcium hydroxide overflowing, Ultrasonic scaler, Citric acid solution, EDTA solution

Introduction

For successful root canal treatment, it is necessary to eliminate bacteria in the root canal as much as possible. Therefore, mechanical root canal cleaning as root canal enlargement and chemical root canal cleaning as root canal irrigation are exceedingly important. It is known that, bacteria in root canals can be reduced up to 50-70% if this procedure is performed correctly [1-3]. Therefore intracanal medication should be also an important factor, and calcium hydroxide have been widely used as intracanal medicament recently. It has been reported that 90% to 100% of bacteria in the root canal were reduced by performing calcium hydroxide medication to the root canal for over 1 week after completion of mechanical and chemical root canal cleaning [1,2]. Calcium hydroxide was first used by Hermann in 1920 for pulp protection, and has sustainable bactericidal effect since its high alkaline property with around pH 12.5 [4,5].

It has also been reported that its other effectiveness such as dissolving organic matter, attenuating bacterial endotoxins, inducing hard tissue, and attenuating endogenous in flammatory mediators [5-10]. Ordinary intracanal medicament should be exchanged new medicament each endodontic treatment. Therefore calcium hydroxide as root canal medicating was necessary removed completely in each root canal treatment.

However, removing calcium hydroxide that was accumulated in the apical foramen was difficult [11]. Although calcium hydroxide has high antimicrobial activity, it must be removed completely before

final root canal filling. Otherwise inadequate removal of calcium hydroxide leads to failure of root canal treatment [12]. As a further problem, there is a risk of overflowing outside of the apical foramen during removing procedure.

Even if disinfection in the root canal is achieved, the possibility of a risk inducing serious tissues damages around root apex is occurred when plentiful contaminated calcium hydroxide are overflowing. In such cases, consequently the possibility will improve delayed healing or failure to heal after root canal filling.

Actually, serious problem through calcium hydroxide overflowing to outside of root apex has been reported [13]. However, despite these problems, only few reports of calcium hydroxide overflowing were informing. Therefore, in order to avoid the risk of excessive overflowing, it is important to comprehend how much the calcium hydroxide medicament will overflows outside of the apical foramen during removal procedure. In this study, we investigated (1) the status of overflow from root apex foramen in each removal method using ultrasonic scaler or hand file, (2) possibility of reducing overflow in combination with citric acid solution or EDTA (Disodium Edetate Hydrate) solution.

Materials and Methods

The morphology of natural teeth roots are wide variety, and then root canals show also similar complex form influenced with teeth root. Therefore, it is difficult to prepare the uniform conditions of root canals to perform comparative study.

To avoid heterogeneous experimental conditions, artificial teeth were selected in this study.

Twenty-four maxillary premolar artificial teeth (T6-HN.C.41, Nissin Dental Products INC) were prepared, and root canals of those teeth were performed root canal enlargement using K-fail until No.25 or No.30 size of thickness in each 12 teeth (Figure 1). After finishing root canal enlargement, intracanal medicament (Nippon Shika Yakuhin Co., Ltd) was filled within root canal apex completely in all samples. 20% citric acid solution (Ultradent Products, Inc) and 10% EDTA solution (© SHOWA YAKUHIN KAKO CO, LTD) were used as auxiliary agents for removing calcium hydroxide.

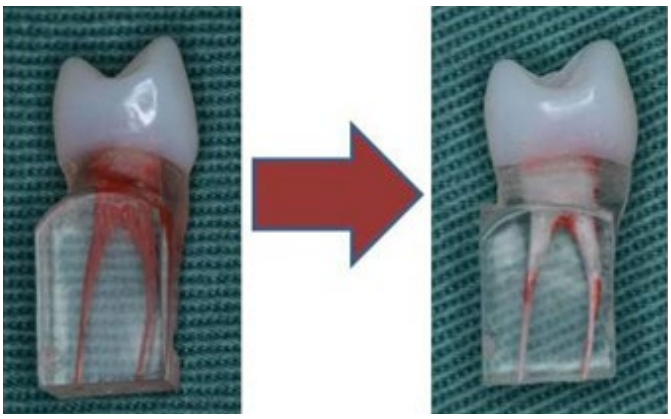

Figure 1

All samples were divided into several groups according to the different removal method (Table 1). First, divided into two groups by the difference of removing equipment (Group 1: ultrasonic scaler, Group 2: hand file) both in No.25 and No.30 size thickness root canal. Then they were further classified into tree sub groups by the difference of auxiliary agents in each group respectively. Group 1-A (G1-A:removed the calcium hydroxide by ultrasonic scaler with water), Group1-B (G1-B: The citric acid solution was injected suitably then using ultrasonic scaler without water), Group1-C (G1-C) The EDTA solution was injected suitably hen using ultrasonic scaler without water), Group 2-A (G2-A: Removal using hand file with purified water), Group 2-B (G2-B: The citric acid solution was injected suitably then removal using hand file), Group 2-C (G2-C: The EDTA solution was injected suitably then removal using hand file).

Table 1: Classification of each gropes by removal methods

(Group 1:G1) Calcium hydroxide was Removed by ultrasonic scaler
(G1·A) Performed removal with water injection.
(G1·B) Citric acid solution was injected suitably
(G1·C) EDTA solution was injected suitably
(Group 2: G2) Removal by hand file with same thickness as final enlargement size
(G2·A) Performed removal with purified water
(G2·B) Citric acid solution was injected suitably
(G2·C) EDTA solution was injected suitably

In G1 groups, scaler tip (ET-25: SATELEC ®) was connected ultrasonic scaler (P-MAX2: SATELEC ®), and performed removing the calcium hydroxide while light touch to the apical foramen. In Group 2, K file (MANI, INC) with the same thickness as the final enlarged size was used as the hand file. The groups using citric acid solution or EDTA solution as auxiliaries, calcium hydroxide was removed by using an ultrasonic scaler under anhydrous conditions (G1-B,C) or using hand file (G2-B,C) after injected appropriate agents into root canals.

After removal of calcium hydroxide in the root canal was considered to be finished in all samples, these root canals were dried using a paper point, then the overflow of calcium hydroxide from the root apex were observed under a stereomicroscope.

Results

Calcium hydroxide in the root canal was completely removed in the groups using ultrasonic scaler (G1). In the groups using the hand file (G2), calcium hydroxide was mostly removed from root canal, however slightly calcium hydroxide was remained around root apex.

In particular, the tendency of remained calcium hydroxide around root apex in G2-A (Using purified water) was more notable than G2-B and G2-C (using citric acid solution or EDTA solution). The results of calcium hydroxide extravasation outside the root apex are shown in Figure 2 and Table 2.

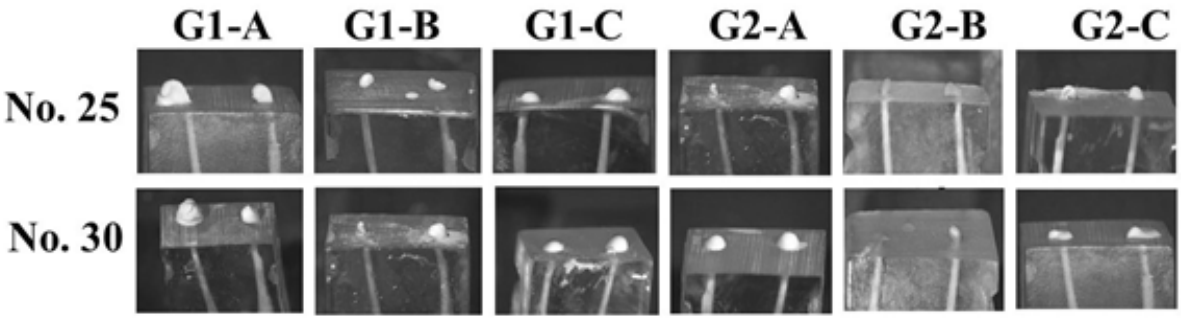

Figure 2: Overflowing condition of calcium hydroxide

Table 2: The results of overflowing level in each groups

	Group number					
Hand file number	G1-A	G1-B	G1-C	G2-A	G2-B	G2-C
number 25	+	+	+	+	±	+
number 30	+ +	+	+ +	+	+	+

-: no leakge, ±: leakage until 0.5nnm, +: leakage from0.5mm to 1mm
++: leakage from 1mm to 2mm, +++: leakage over 2mm

Calcium hydroxide overflowing to outside the root apex was observed both all groups of using ultrasonic scalers and hand file. The tendency of calcium hydroxide overflowing was higher in the groups using the ultrasonic scaler than in the groups using the hand file.

In the groups of using hand file, no significant difference of overflowing was observed for the different size of root canal enlargement, however overflow of calcium hydroxide was clearly higher in the groups using ultrasonic scaler with 30 size of enlargement root canal compared with 25 size enlargement root canal.

The use of citric acid solution and EDTA solution as auxiliary agents in removal of calcium hydroxide decreased the overflow of calcium hydroxide compared to the non-use of them. In particular, the decrease of overflow was clearly observed in the case of using citric acid solution more than using EDTA solution.

Discussion

Calcium hydroxide has been used not only for a intracanal medicament, also used for pulp capping and root canal sealer [4,14-16]. While Calcium hydroxide is indispensable material to success of endodontic treatment, removal from root canal has still remaining serious problem.

In this study, purified water, citric acid solution, and EDTA solution were used to remove calcium hydroxide. Generally Sodium hypochlorite is used as root canal irrigant for root canal treatment. Although sodium hypochlorite is known to have excellent antimicrobial activity, it has been reported that sodium hypochlorite and physiological saline were not able to remove calcium hydroxide from root canal completely [17].

In addition, sodium hypochlorite has high tissue irritation, and if discharged outside of the apical foramen, there is a danger of stirring up serious damage on periapical soft tissue, and there is a possibility that the sodium hypochlorite is leaked out with calcium hydroxide to outside of the root apex during removal procedure [18,19].

Whereas, citric acid solution and EDTA solution have been proven to be significantly higher effective in removing calcium hydroxide than NaOCl and water [20]. Though citric acid has a lower pH than purified water or EDTA solution, it has been reported that citric acid promotes wound healing of soft tissues [21,22].

Therefore, it is assumed that there is no serious problem in using the citric acid solution to remove calcium hydroxide in root canal treatment.

In the present study, calcium hydroxide remained in the vicinity of the root apex in the groups using hand file.

It is feared that remaining calcium hydroxide in the root canal induce the disturbance of intimate gutta-percha point filling as following root canal filling, consequently subsequent prognostic outcomes will be reduced [12].

Webber, et al. insisted that calcium hydroxide should be removed using a file one or two size larger than final root canal enlargement [23]. Therefore, it is recommended that using hand file which one size larger than the final root canal enlargement file number should be reduce the risk of calcium hydroxide remaining in root canals.

In the present study, it was assumed that most of calcium hydroxide was overflowed from root apex during the removal procedure. However, the situation of overflowing in the many cases of natural teeth might not be same as the results of this study, because mostly natural root canals have more complicated morphology such as curved root canal, having apical constriction and/or apical ramification compared with artificial teeth in this study.

In addition, periodontal tissues surrounding root apex may inhibit excessive overflowing from apical foramen, therefore it is inferred the state of overflowing less than in this results. However, even under such circumstances, mostly root canals seem to be inevitable overflowing of calcium hydroxide from apical foramen.

Therefore it should be strongly considered that calcium hydroxide overflowing might occur easily during removal procedure. Overflow of calcium hydroxide causes the possibility serious problem to surrounding periapical tissues and many accident cases like as tissue damage and neuroparalysis [13,24,25]. Then, it is necessary to have a consciousness that not pushed out from the root apex as much as possible constantly.

These results suggested that usage of citric acid solution as the auxiliary agent might be most effective to remove efficiently, because of the volume of overflow was the least with citric acid solution in this study. Nandini, et al. also insisted that citric acid was superior to EDTA solution to remove calcium hydroxide, and this study was confirmed it [17]. Considering the removing effectiveness of calcium hydroxide from root canals, usage of ultrasonic scaler is not only improving removal ability on the root canal wall, also is able to shorten the removing time.

However the tendency of overflowing was increased in using ultrasonic scaler, then it is recommended that using hand file on removal apex areas of calcium hydroxide to reduce amount of overflowing. Furthermore, improve the removal efficiency and reduce the risk of calcium hydroxide overflowing are expected using citric acid solution or EDTA solution on the calcium hydroxide removal.

Conclusion

The results of this study demonstrated that it is difficult to completely remove calcium hydroxide without overflowing from the apical foramen. Many of natural teeth have more complicated morphology than the artificial teeth which was used in this study. Therefore, the same results are not always showed from natural teeth. Even in such a natural tooth, it is considered that calcium hydroxide overflowing to out of apical foramen during removal procedure was inevitable in most root canals. Therefore, it is necessary to pay close attention to removal of calcium hydroxide in order to reduce overflow as much as possible.

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