Studies on the Root Canal Filling Method

— Basic Considerations of Spiral Canal Root Filler and Canal Root Filling Agent —

by

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Introduction

The significance of root canal filling is found, in our procedures, in shutting off external stimuli to the infected root canal by closing its aperture and thus making it possible for the periapical tissues to heal favorably through the protection thus furnished [1, 2, 3].

In the root canal therapy today, the combination of points with various pastes or even paste alone serves commonly as the filling materials [5, 6, 7, 8]. With pastes alone, we can assume a higher incidence of overfilling or underfilling will occur, as compared with the combination of points with paste which is the most highly controlled condition to seal the canal aperture. However, since paste alone is widely used by a number of dental clinicians, this study was conducted to check how those materials could be inserted efficiently with the most consistent accuracy.

In the present studies, the authors are concerned with the viscosity of this paste, its changes in the passage of time, dimensions of the spiral portion of a common root canal filler (Lentulo's filler), transporting capability of this filler inside various model canals root and possible influence of the inside air on the movement of the paste within the model root canals. Our result suggests a favorable method of root canal filling which is clinically effective.

Materials and Method

1. *Kinds of Root Canal Agents and their Viscosities.*

For experimental purposes, AH 26, Topdain, N₂, Triozinc and calcium hydroxide were chosen from those on the commercial market. With these agents, effort was made to compare changes in their respective viscosities in the passage of time after they are mixed. AH 26, N₂, Triozinc and calcium hydroxide were respectively mixed in a powder-to-liquid (or paste) ratio of 5g : 2cc, while Topdain was mixed in 1cc : 1cc paste. All the triturations were finished within a minute and the materials were subjected to our experiment at a minute from the beginning of trituration. Respective viscosities were measured by the use of Vibration-reed viscometer at a natural resonance frequency of 28 KC with a maximum amplitude of motion of 0.5 μ . The viscometer is given in Fig. 1.

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Fig. 1.

Fig. 2.

2. Dimensions of Lentulo's Fillers.

Lentulo's fillers, Nos. 1 to 4 products of C. W. Z. Company, were selected. On these, distances between a point 1mm from the tip of the spiral portion (D_1) and a point 14mm apart (D_2) were measured by an industrial microscope with a precision of 5/1000 mm (Fig. 2).

3. Transporting Capabilities by Lentulo's Fillers of Filling Paste inside Model Root Canals.

By way of model root canals, glass tubes having a diameter of 0.640-0.690 mm were used after being carefully measured to check on the diameter. These glass tubes

Fig. 3.

were classed in 4 groups according to their lengths : 50 mm, 30 mm, 20 mm and 15 mm. As indicated in Fig. 3, the glass tubes were fixed on the scale that was horizontally placed.

In all the experiments, the root canal filler was inserted into a glass tube to a distance of 15 mm and was revolved at 1585 r. p. m. at the contra-angle. Root canal paste was prepared under the identical conditions as was the case with measurement of viscosities and it was placed into the tube after a minute of trituration. A distance of 15 mm from the entrance of tube was taken as 0 and the movement of paste beyond this bench mark was measured at intervals of 5, 10 and 15 seconds, a longer interval being used when necessary.

a. Glass tube 50 mm in length with an open one-end was used, in which different sizes of root canal fillers were inserted so as to ascertain difference in the movement of paste.

b. Glass tube 50 mm in length with an open one-end was used in conjunction with No. 1 Lentulos filler, in which the movement of 5 kinds of root canal filling agents were observed and compared.

c. Glass tube 30 mm in length with an open one-end was used. When root canal filling agent was pushed to the point 0 by a filler, an open end was closed, the purpose being to investigate possible influence of the inside air on the movement of paste.

d. On the assumption that it is clinically possible that the tip of filler is not fully inserted to the apical point, this part of our experiment was concerned with a tube 20 mm in length to 15 mm of which the paste was pushed. Thus possible influence of air remaining in 5 mm portion of the tube was observed. As in other cases, difference beyond the point 0 was expressed as positive and that on this side of 0 was taken as negative.

e. On the other hand, it was assumed that the tip of filler was fully inserted to the apical point. Therefore, paste was packed into a glass tube 15 mm in length with one end previously sealed (Fig. 4).

Fig. 4.

Experimental Results

1. Kinds of Root Canal Agents and their Viscosities.

Fig. 5 gives changes in the viscosities of various root canal agents from 1 to 10 minutes after trituration. N₂, Triozinc and calcium hydroxide were compared in two powder-to-liquid ratios of 5 : 2 and 4 : 2.

2. Dimensions of Lentulo's Fillers.

Table 1 gives readings of D₁ and D₂ distances (spiral portions) on Nos. 1-4 Lentulo's fillers.

TABLE 1

Numbers	D ₁ (mm)	D ₂ (mm)	Taper
No. 1	0.308±0.007	0.615±0.028	0.021
No. 2	0.350±0.015	0.614±0.016	0.018
No. 3	0.362±0.007	0.663±0.026	0.021
No. 4	0.417±0.035	0.641±0.009	0.016

TABLE 2

(mm)

	Time	AH 26	Topdain	N ₂	Triozinc No. 2	Ca (OH) ₂
a. 50mm open Filler No. 1	5sec	11.3±2.04	9.8±0.54	8.3±2.21	5.5±1.96	5.7±2.28
	10	22.0±2.83	17.8±0.88	11.7±4.52	9.3±3.18	10.5±3.50
	15	21.8±3.32	24.6±2.21	16.7±5.98	12.1±2.15	13.2±3.63
	20					15.0±4.61
b. 50mm open Filler No. 4	5sec	19.3±1.00	14.5±1.79	10.3±1.25	7.5±0.50	11.6±1.20
	10	34.5±0.40	26.2±2.58	18.0±1.41	13.5±0.50	21.0±2.15
	15			23.8±0.59	20.3±0.24	26.0±2.15
	20					
c. 30mm closed Filler No. 1	5sec	9.3±0.52	5.3±0.25	3.0±1.00	2.3±0.74	1.3±0.74
	10	11.0±0.57	5.5±0.00	4.3±0.74	2.8±0.75	2.0±0.50
	15	11.2±0.53	5.5±0.00	5.0±0.00	3.8±0.25	2.1±0.55
	20	11.2±0.53	5.5±0.00	5.0±0.00	4.3±0.25	2.1±0.55
d. 20mm closed Filler No. 1	5sec	2.6±0.24	-1.0±0.93	-1.3±0.25	-1.3±0.83	-3.0±0.00
	10	3.5±0.40	0.0±0.35	-0.3±0.25	-0.1±0.87	-3.0±0.00
	15	4.0±0.40	0.5±0.50	0.2±0.15	0.1±0.57	-2.5±0.50
	20	4.0±0.40	0.8±0.56	0.3±0.25	0.3±0.60	-2.0±1.00
e. 15mm closed Filler No. 1	5sec	-1.0±0.00	-0.4±0.29	-1.8±0.74	-2.0±1.18	-2.7±0.43
	10	-0.2±0.15	-0.1±0.05	-0.6±0.55	-0.8±0.40	-2.0±0.78
	15	-0.2±0.15	-0.1±0.05	-0.3±0.37	-0.3±0.17	-0.4±0.41
	20	-0.2±0.15	-0.1±0.05	-0.1±0.10	-0.2±0.20	-0.3±0.30

Fig. 5.

Fig. 6.

3. Transporting Capability of Root Canal Filling Paste by the Model Root Canals.

Results of the experiments **a**, **b**, **c**, **d** and **e** above mentioned are given in Table 2 and Figure 6.

Discussions

1. As regards the kinds of various root canal rgents in current use. AH26 is found to have a high degree of viscosity in its initial stage which is supposed to be explained by a delayed setting on the part of this agent. Topdyne, which contains in it both the basic substance and and accelerator of chemical reaction, has a similar chemical composition like that of Cavitex and though it has a similar viscosity as AH26, its setting takes place in a very short while. The viscometer readings after its setting are excessively abnormal and, although no definite reason is found for this fact, the readings are dismissed as not representing the viscosity of Topdain,. N₂, Triozinc and calcium hydroxide were compared in two different powder-to-liquid ratios respectively. As a result, a tendency is established that the larger is the amount of liquid to powder the lower will become the viscosity of a paste in its initial phase, though a paste thus prepared is easy of manual trituration.

However, as regards calcium hydroxide it is not definite whether the viscometer is faithfully representative of its viscosity or it is influenced by the friction of powder particles in it. For similar reasons, this fact should be also taken into account when the viscosity of Triozine is measured.

2. Concerning D₁, there is a range from 0.308 ± 0.007 mm (No. 1) to 0.417 ± 0.035 mm (No. 4). In actual clinical practice, the root canal filler is used after the root canal has been sufficiently enlarged by either reamer or file and, for this reason, there must be correlation between the dimension of the blade of an enlarging instrument and the transporting part of root canal filler.

According to SHOJI[4], the dimensions of the maker's Nos. 4, 5 and 6 reamers and files are as indicated in Table 3.

Numbers	Reamers	Files
No. 4	0.291 ± 0.012	0.254 ± 0.026
No. 5	0.362 ± 0.017	0.269 ± 0.024
No. 6	0.392 ± 0.029	0.312 ± 0.086

3. Transportability of root canal paste by the use of medel root canals is discussed in the following 5 headings.

a. With a glass tube of the identical diameter, No. 4 filler is found to have more transporting capability than No. 1 filler in a given period of time.

b. In a similar test as the foregoing, various root canal pastes are observed to traverse different lengths even in the same space of time. It follows, therefore, that these differences are to be explained by different compositions of pastes used. Root canal agents such as AH 26 and Topdain which have the paste-like base material can traverse a longer distance than those otherwise which are prepared by mixing powder with liquid prior to use. It may be inferred that while the former works advantageously on the surface of the transporting part of the filler on account of its being in the paste state, the latter cannot be sent smoothly on its surface as the chemical bond of powder

particles is not so solid as in the former.

It has been quite difficult to establish definite correlation between the viscosity of a given paste and the distance it travers in a given space of time. But a comparison between the two paste-like agents, AH26 and Topdain, reveals that AH26 which has a higher viscosity than Topdain traverses much longer distance in the same space of time.

In a similar study to the present one, SAEKI[5] gave the following data of his experiment in which he prepared the various agents in the same powder-to-liquid ratios as were used by us, subjecting them to a weight between two glass plates with three measurement points of immediately after the trituration, 5 minutes and 10 minutes.

	After trituration	after 5 min	after 10 min
AH 26	21 mm	21 mm	21 mm
N ₂	22 mm	15 mm	14 mm
Triozinc	16 mm	16 mm	16 mm
Calcium hydroxide	12 mm	10 mm	10 mm

As seen above, SAEKI's findings are more or less in keeping with our own results in this study.

c. In this experiment, as the air inside the glass tube beyond 15mm from the tip has no outlet it can be assumed that it is compressed in proportion to the movement of paste beyond this point. Percentwise, the compression of air in connection with each of the five agents tested is 74.6 % (AH 26), 36.6 % (Topdain), 33.3 % (N₂), 28.5 % (Triozinc) and 14.0 % (calcium hydroxide) respectively. These data also indicate the fact that difference in the movement of a root canal agent inside the root canal can be accounted for by the manner of composition of an agent.

d. As has been made clear by the foregoing test, there was none of the cases in which the root canal agent was transported to the other end of tubes because of the presence of air. Clinical implication from this fact is that we should enlarge the root canal sufficiently wide so as to allow the root canal filler to reach the root-end for the purpose of filling it compactly enough.

e. On the other hand, experiment in this part of our study revealed that in all the glass tubes the root canal agent sufficiently reached the root-end with a little space because of the compressed air. Our supposition here is that the air inside the tube ejected itself through the rotation of incoming filler, thus being replaced by the root canal agent.

In terms of a given space of time, paste-like agents such as AH 26 and Topdain reached closer the root-end.

This fact is full of clinical significance. That is, when the root canal has been sufficiently enlarged, we can transport the agent to a distance of our desire by using a root canal filler whose diameter is much smaller than that of the root canal involved.

Root canal filling is usually classified into that of points[6, 7, 8] and that of paste agents. While the theoretical background of the former is relatively known, that of the latter has been indefinite and the present study may contribute toward the elucidation of matters connected with it.

Conclusions

As results of our endeavors with the measurements of viscosity of root canal agents, dimensions of transporting part of fillers, etc., the following conclusions were obtained.

1. The use of Vibration-reed viscometer is effective in determining changes in various root canal agents in the passage of time.
2. From the point of view of root canal instrumentation, the dimension of blade part of root canal enlarging instrument should correlate to that of its transporting part of Lentulo's filler.
3. Root canal filler which is equipped with a large transporting part sends in more root canal agent in a given space of time.
4. Ease or difficulty in the transportation of a root canal filling agent is influenced by its manner of chemical composition. In general, paste-like agents traverse a longer distance in a given space of time.
5. The tip of root canal filler should be sufficiently inserted into the root canal so that it may reach a point to which we intend to carry the root canal agent.

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