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EFFECTS OF DIFFERENT TAPERS ROOT CANAL PREPARATION ON ROOT CANAL FILLING USING GUTTAFLOW2

Dental Science

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ABSTRACT

Study the effect of root canal preparation in three different tapers on the effect of root canal filling using the second generation novel cold flow root canal filling system in vitro. 60 extracted human premolars with single root canal were divided randomly into 3 groups(A:02taper, B:04taper, C:06taper and N=20). The root canals were prepared using NIC® Super File to 3 different tapers to get to 30#,and were obturated with GuttaFlow2 in single-cone obturation technique.Then the roots were sectioned at 3 and 6mm from apical foramen. All the sections were observed under a stereo-microscope.Then these images were collected and analyzed.The percentage of gutta-percha-filled area(PGFA) was calculated by the software.The filling effect of root canals were evaluated and recorded by X-ray. As the increasing of the root canal taper,at the 3mm level from apex, the PGFA of group C was significantly higher than that of the group A ($p<0.05$),and the PGFA between the three groups was statistical significance ($P<0.05$). At the 6mm level from apex,those of 3 groups have no statistical significance ($p>0.05$). As the increasing of taper, the number of under-filled root canal in the 3 groups decreased, but there was no statistical significance in the 3 groups. When the taper of NI-TI instrument increase up to 06, it can effectively improve the effect of sealing in root canal filling and reduce the under-filled with the GuttaFlow2.But the effect of resisting force of the tooth root remains to be studied.

KEYWORDS

GuttaFlow2; NI-TI instrument; root canal preparation; taper; effect of root canal filling

0 BACKGROUND

With our increasing understanding of the complexity of the root canal, it is a hot topic in recent years to be able to form a tightly integrated whole of the root canal filling material and the root canal to achieve a completely tight three-dimensional closure. GuttaFlow normal temperature flow gutta-percha is a root filling system in the form of micro-particle gutta-percha, in which the diameter of the gutta-percha particles (<0.9 um) is smaller than the diameter of the dentinal tubule (more > 1 um) [1], and the particles can enter the dentin. The tubules are bonded to the gutta-percha and the root canal wall. Conventional root canal sealants such as epoxy resins, calcium hydroxides, bio-ceramics, etc. do not combine the dentin, sealant and root canal wall. The micro-dental granules have a viscosity at room temperature of about 107 Pa·s [2] and are uniformly dispersed in the polydimethylsiloxane, so that the whole exhibits a good flowability at room temperature. GuttaFlow2 is an improved product of the first generation of normal temperature mobile gutta-percha. Because it reduces silicone oil and paraffin oil in its composition, it not only mixes more evenly, but is also easier to remove when performing root canal retreatment or post and core repair [1]. The capsules were upgraded on the package to an injection head with an automatic, bubble-free mixing in a 4:1 ratio. When the ingredients are mixed, the overall flow performance will reach a peak [1]. No mixer is needed in the operation, which is simpler and significantly shortens the clinical operation time. And the mixing head injection type can generate pressure in the root canal to help improve the compactness of the root filling. At present, root canal therapy is widely used in clinical practice, and the choice of root canal preparation equipment is an important factor affecting clinical efficacy[3]. In this study, in view of the superior fluidity characteristics of GuttaFlow2, the effects of root canal preparation on the quality of root canal filling after the same type of different taper instruments were compared. The effect of GuttaFlow2 root canal filling under three tapers was evaluated by PGFA (percentage of gutta-percha-filled area) at a distance of 3 mm and 6 mm from the root tip, in order to provide a theoretical basis for clinical practice.

1. Information and methods

1.1 Experimental equipment

GuttaFlow2 normal temperature mobile gutta (coltene, Switzerland), NIC SuperFile machine with nickel titanium (Shenzhen Speed Airlines), 15# stainless steel titanium (Dentsply, Switzerland), gutta percha (Dentsply, Switzerland) , low speed straight machine (Kavo, Germany), stereo microscope (Zeiss, Germany).

1.2 Selection of isolated teeth

Select fresh single mandibular premolars extracted by orthodontic and periodontal disease and the shape of the root canal is elliptical. The apical foramen can pass through 15# Ktitanium and 60 teeth with tightness. Exclude the roots of the roots from being undeveloped, deformed, deformed or damaged, and the root canal curvature is greater than 10 degrees. The ultrasonic cleaning device removes the attached soft tissue and calculus and stores it in normal temperature physiological saline for use.

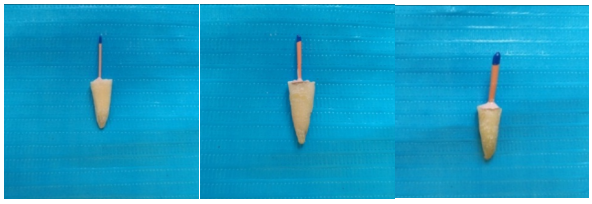
1.3 Experimental steps

1.3.1 Grouping and root canal preparation

All the isolated teeth are routinely opened and the pulp is removed. 15# titanium is reduced by 1mm as the working length by the length of the root canal just flushing the apical foramen. The above-mentioned isolated teeth were randomly divided into three groups: group A machine with nickel-titanium bismuth prepared to 02 taper 30# (n=20), group B: 04 taper 30# (n=20), group C: 06 taper 30# (n=20). All three groups were prepared by the Crown-down method, and the root canal was lubricated with 17% EDTA. The instrument was replaced with 15#K titanium , and 5.25% sodium hypochlorite and physiological saline were alternately washed to completely remove the stained layer.

1.3.2 Root canal filling

The prepared root canal was dried with paper, and the root canal was filled by a single-point method according to the GuttaFlow 2 product specification. That is, select the tip of the taper with the taper of the prepared root tube to carry out the test tip marking working length, insert the GuttaFlow2 syringe into the root canal and slowly inject it into the root 1/3 until the material overflows, and apply a small amount of normal temperature flowing gutta percha. Slowly insert and unify the lift three times. Then use a heat transfer device to cut off the root canal. The composite resin temporarily seals the root canal and is stored in an incubator at 37 degrees Celsius and 100% humidity for one week. The above operations are all done by the same person.



Group A: 02 taper Group B: 04 taper Group C: 06 taper

Figure 1 After filling the different taper root canals GuttaFlow2

1.4 X-ray evaluation of root canal filling quality

X-ray projections were performed on all the filled teeth, and the results were recorded for statistical analysis. According to the X-ray film to evaluate the root filling effect, the root filling material is ≤ 2 mm apart from the root tip and the root canal is closed and strictly determined as just filling; The distance between the root filling material and the root tip is >2 mm or the lack of tightness of the root canal closure is determined as underfilling; The root filling material is beyond the root tip for overcharging [4].

1.5 slice production and observation

The crown is embedded in a self-setting resin, and the long axis of the tooth is perpendicular to the self-setting resin.

The roots were cut with a low-speed corundum cutting disc at a distance of 3 mm and 6 mm from the root tip. The two sections were taken, and the stereo microscope was magnified 40 times to observe, collect and analyze the image. Two sections of PGFA were calculated using Photoshop 7.0, PGFA = (the area of the gutta perme on the section of the section root the root canal area of the section of the section) X 100%.

statistical processing

The collected data were input into SPSS 17.0 for processing, and the PGFA values were compared by one-way ANOVA. The SNK method was used to compare the two groups at the same level. The super- and under-filled conditions were tested by Fisher's exact probability method (P<0.05 for the test level).

2 Experiment Results

Percentage of gutta perme (PGFA)

A total of 60 cross sections were obtained at a distance of 3 mm from the apex, and images were collected under a stereo microscope as shown in Figs. 3 and 4. The PGFAs of groups A, B and C were (97.07±1.04)%, (97.28±1.13)%, and (98.33±1.00)%, respectively. Three-way analysis of variance was used to compare the PGFAs of the three groups. The SNK method was used to compare the three groups. It can be seen that the PGFA in the 06-taper group was significantly higher than that in the 02-taper group at 3 mm from the apex. P<0.05); 06 taper group was higher than 04 taper group, there was statistical difference (P<0.05); 04 taper group was higher than 02 taper group, but there was no statistical difference (P>0.05).

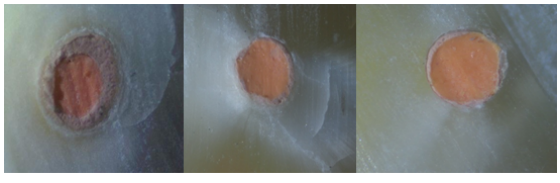
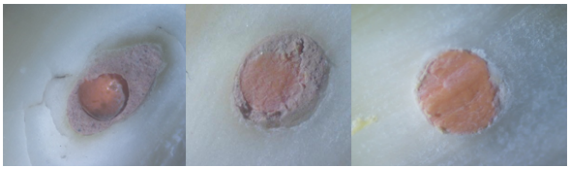


Figure 2-1 Group A：02 taper Figure 3-2 Group B：04 taper Figure 3-3 Group C：06 taper

Observe the proportion of the root canal area of the gutta-percha area in a cross section 3mm from the apex, ie PGFA (×40).

At 6 mm from the root tip, the PGFA of groups A, B, and C were (95.99±1.72)%, (96.19±1.30)%, and (97.14±1.78)%, respectively. One-way analysis of variance showed that there was no statistical difference between the groups (P>0.05).



Observe the proportion of the root canal area of the gutta-percha area in a cross section 6 mm from the apex, ie PGFA (×40)

Table 1 Comparison of two levels of PGFA after filling three kinds of taper root canals GuttaFlow2 (n=20)

Group	Distance from the apex（mm）	
	3	6
A	97.07±1.04	95.99±1.72
B	97.28±1.13	96.19±1.30
C	98.33±1.00	97.14±1.78

Table 2 Post-filling conditions of three taper root canals GuttaFlow2

Group	Number of root canals	Over-filling	Filling	Under-filling
A	20	0	16	4
B	20	2	17	1
C	20	2	18	0

3 DISCUSSION

Modern root canal therapy considers that the ideal root canal filling should be a dense three-dimensional filling that aligns with the apex of the root tip and maintains the natural morphology of the root canal. It includes not only good sealing and safe biocompatibility but also the compactness of root filling. In the 1980s, Eguchi etc. first used cross-sectional tissue sectioning to observe the compactness of root canal filling to evaluate the quality of root canal filling [5]. This method can visually observe the gap between the root filling agent and the root canal wall or between the gutta percha and the root filling agent in a three-dimensional direction. This experiment uses a stereo microscope to observe and measure the value of PGFA to evaluate the compactness of the roots. The higher the PGFA, the more dense the roots cannal are.

Due to the complexity of the anatomical structure of the root canal system, the quality of root canal filling is affected by many factors, such as root canal preparation, root canal filling method, and root canal filling material. Studies have shown that about 60% of failures in RCT are directly related to apical filling defects [6-7]. The normal temperature flow gutta-percha system combines the micro-dental gel and the sealant into one, so that it has the advantage of flowing at normal temperature, avoiding the poor compliance of the cold gutta-percha to the root canal wall and the large wedge force at the lateral pressure leading to the root fracture [8] and the disadvantages of shrinking the hot tooth gel after cooling, high temperature burns the periodontal tissue. With the development of large-tapered NiTi-preparatory instruments and the matching of large-tapered gutta-percha points, single-point root canal filling has been gradually applied clinically [9], and the characteristics of the normal-temperature flowing gutta-perchad system make it suitable for single use. It transmits pressure with a single gutta-percha point as a carrier, allowing the sealant to occupy all the space of the root canal, greatly reducing the technical sensitivity, shortening the treatment time and reducing the probability of overfilling. Studies have found that due to the continuous dissolution of the sealant, root canal leakage will continue to increase, so in the clinical treatment, root canal sealer should be used as little as possible. To ensure "as much as possible of the gelatin, as little as possible of the sealant" [10] This supports the conclusion of this experiment, the small taper root canal root tip sealant is more, the filling quality is not good. Although the proportion of sealants in the single-point method is large compared to the method of cold side pressure and hot gutta-percha, there is no statistically significant difference in the probability of void generation [11].

In this experiment, the mandibular premolars were selected, which ensured that the thickness of the root canal was as equal as possible. It can be seen that the shape of the root canal prepared to be 06 taper is smoother. From the microscope observation, the root canal from 06 taper to 02 taper can be seen. The proportion of post-filled gums tends to decrease. The proportion of root canals with 06 taper is significantly smaller than that of 02 and 04 tapers. Foreign studies have shown that in the case of ensuring contact between the sealant and the root canal, the teether The larger the proportion, the more it tends to form a perfect filling [12]. Therefore, it is consistent with the conclusions drawn from this experiment. In addition, the large taper gutta-percha point better conforms to the root canal wall, and the GuttaFlow2 is squeezed around to effectively reduce the generation of bubbles and gaps. This may be one of the reasons why GuttaFlow2 matches a large taper gutta-percha tip filling a large taper root can effectively reduce air bubbles and voids. It is observed that the proportion of GuttaFlow2 in the 02 taper root canal is relatively large, and the probability of occurrence of voids is large. The gap appears between the normal temperature flowing gutta-percha and the root canal wall, and the normal temperature flowing gutta-percha and the normal temperature flowing gutta-percha and gutta-percha between. Studies have shown that there is no chemical bond between the normal temperature flow gutta-percha and the gutta-percha point, so it is recommended to apply a layer of GuttaFlow2 before inserting the gutta-percha point to effectively reduce the invalid cavity [13]. At the level of 3mm, due to the narrow volume of the root tip 1/3, the PGFA difference between the 02 taper root canal and the 04 taper root canal is not obvious. When the root

canal is prepared to be 06 taper, the root canal wall has a high fluency and the shape is good. The adhesion is significantly better than the 02 taper. Because GuttaFlow2 has no volume shrinkage after curing, there is a slight expansion of 0.2%, and the filling of the apical region and the lateral accessory root canal is better, which may be one of the reasons for its better apical sealing performance [14]. At the 6mm level, the degree of fit between the gutta-percha and the GuttaFlow2 in the root canal of the 02 taper is significantly worse, so it is recommended to add a minor tip to the crown to compensate for the lack of GuttaFlow2 filling adhesion after preparation of the small taper device.

At the same time, the use of machine nickel-titanium large taper device preparation on the one hand to greatly improve the efficiency of the removal of infectious agents in the root canal, making the rough root canal smooth and smooth, and studies have shown that the greater the taper of the root canal, root canal irrigation and disinfection The better the effect, which is beneficial to the subsequent root canal filling; On the other hand, it has the function of matching with the large taper gutta-percha point, and it is important to improve the root tube compactness in combination with the 06 taper gutta-percha point. In this experiment, elliptical root canals were selected, and the effect of different taper machine nitinol root canals was different, and it was difficult to clean, shape and fill elliptical root canals [15]. In this experiment, the PGFA at the 6 mm level of the same taper root canal was significantly lower than the 3 mm level, which may be due to the reduced adaptability of the gutta-percha and the root canal wall. It is suggested that the superior fluidity of GuttaFlow2 can well conform to the shape of the root canal wall, thus better filling the space of the apex. The preparation of the large taper not only ensures the complete removal of the infected material, but also provides a strict root canal filling. Favorable conditions. The preparation of the large taper will inevitably cut more tooth tissue, and studies have suggested that this may weaken the root bending resistance. However, some studies have pointed out that the ProTaper and K3 large-tapered NiTi- instruments do not significantly reduce the maximum compressive load of the roots compared to the traditional step-back method [16]. Therefore, in clinical, appropriate preparatory instruments and preparation methods should be selected according to the thickness of dentin and the curvature of the root to avoid the occurrence of root fracture [17].

In summary, the results of this study suggest that the root tip filling quality of the 06 taper root canal GuttaFlow2 is the best. In this experiment, the isolated teeth were studied. The selected ones were straight and smooth root canals. For the thinner or curved root canals, whether there is an advantage in the preparation of large taper instruments requires further study. In clinical use, there are also clinical studies indicating that compared to AH-plus paste, GuttaFlow overfilled teeth suggest that good fluidity increases the risk of over-filling of the teeth, so it should be noted in clinical application [18]. While preserving the tooth tissue, achieving optimal root canal cleansing and root canal formation is a requirement for proper root canal preparation [19-20]. Therefore, to weigh the advantages and disadvantages of completely removing infectious agents and preserving dental tissues as much as possible. In this study, the influence of different taper root canals GuttaFlow2 on the root resistance remains to be further explored.

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