Preparation of model of simulated retromolar root canal

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ABSTRACT Objcetive: To set up a model of simulated retromolar root canal. Methods: According to the Brinell hardness values of dentin and resin obtained from the preliminary experiments, (HB72, HB54), the pure copper with a Brinell hardness value HB58 was chosen as the material of the model. Three different angles of artificial root canals were designed, with the parameters of those of resin canal models: the length was 16 mm and the radius of curvature was 5 mm, and the inner diameter was 0.7 mm. Twenty sets of ProTaper Nickel-Titanium rotary-instruments were randomly divided into four groups with 5 sets each. Group A prepared 50 pure copper artificial root canals with an angle of curvature of 70 degrees, Group B 64 degrees and Group C 60 degrees. Group D prepared 50 retromolars. After preparation, Fatigue tests of all files were carried out in a bench device. Results: The similarity rate of Group A, B, C and Group D were 33%, 67%, 33% respectively. Conclusion: The pure copper artificial root canal with an angle of curvature of 64 degrees was an ideal model for the research of Nickel-Titanium rotary-instruments in vitro.

Key words: Root canal instruments; Nickel-Titanium files; Simulation root canal; Root canal preparation; Model

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Introduction

Recent advances in the field of endodontics had led to the widely use of nickel titanium (Ni-Ti) rotary instruments in dental practice. During the last few years the number of users had increased significantly and many new systems were on the market. The unexpected fracture of Ni-Ti rotary instruments inside the root canal during root canal treatment is a matter of serious concern. Several factors contributed to instrument fractures [1-4], and the correct clinical use was important. There are plenty of researches on the mechanical functions of Ni-Ti rotary instruments in root canal models, however, there are few reports on the set up of artificial root canal models. At present, the models could be divided into two types: extracted teeth and resin root canal models. In vitro, the structure of extracted teeth tends to be changed easily, and the variation of root canals is large and hard to Standardize, which could impact the result. The resin is expensive. So, this study designed a pure copper artificial root canal model to solve these problems.

1 Materials and Methods

According to the Brinell hardness values of dentin and resin obtained from the preliminary experiments, (HB72, HB54), the pure copper with a Brinell hardness value HB58 was chosen as the material of the model. In the preliminary experiments, the range of the curvature angle of the root canal model was between 60 degrees and 70 degrees. Three different kinds of pure copper artificial canals were made, the angles of curvature were 70°, 64° and 60° respectively. The length was 16 mm and the radius of curvature was 5 mm, and the inner diameter was 0.7 mm (Figure 1).

Figure 1 The artificial root canal model :A picture of the artificial canal made of pure copper.

Twenty sets of ProTaper Nickel-Titanium rotary-instruments (Dentsply Mailler, Ballaigues, Switzerland) were randomly divided into four groups with 5 sets in each. Each set included files Sx, S1, S2, F1, F2, F3. The instruments of group A had 50 pure copper artificial root canals with an angle of curvature of 70° and radius of curvature of 5 mm, inner diameter of 0.7 mm. The instruments of group B had 50 pure copper artificial root canals with an angle of curvature of 64° and radius of curvature of 5 mm, inner diameter of 0.7 mm, while the instruments of group C had 50 pure copper artificial root canals with an angle of curvature of 60° and radius of curvature of 5 mm, inner diameter of 0.7 mm. The instruments of group D had 50 retromolars. Schneider method was used

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to detected the degree of mesiobuccal root in the first permanent mandibular molars [5]. The curvature angle of these molars was between 15 degrees to 25 degrees. The crown-down method was used to prepare the canals [6], using Glyde (Dentsply Maillefer, Swizerland) as a lubricant. After preparation, fatigue tests were carried out in a bench device that allows the files to rotate freely inside an artificial canal made of glass [7-8], consisting of an arch whose angle of curvature was 60 degrees, with a radius of 5mm, inner diameter of 2.1 mm (Figure 2).

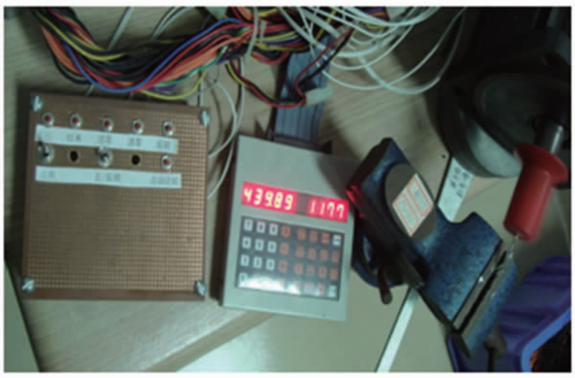

Figure 2 A picture of the fatigue testing device

The rotation speed was 352.8 rpm in this device. The number of cycles to failure (NCF) was recorded by a digital chronometer (OMRON,Japan), which started at the beginning of the test and stopped at the moment when the operator detected instrument separation by observing the displacement of the tip protruding from the artificial canal. The data were shown by mean values ± standard deviation, the one-way ANOVA test was used to analyse the data by SPSS WIN (release 17.0; SPSS, Munich, Germany).

2 Results

The average number of cycles to failure was shown in Table1. In Group A, the number of cycles to failure (NCF) of Sx, S2,F1, F2, was significantly different from those of Sx, S2,F1, F2 in Group D.(P<0.05). In group B, the number of cycles to failure (NCF) of Sx, F2, was significantly different from those of Sx, F2 in group D. (P<0.05). In Group C, the number of cycles to failure (NCF) of Sx, S1,S2,F2 were significantly different from those of Sx, S1,S2,F2 in Group D.(P<0.05). The similarity rate with group D was 33% (2/6), 67% (3/6), 33% (2/6) respectively. When the angle decreased, the NCF of the instruments extended.

Table 1 Mean number of cycles to failure (NCF) ± standard deviation

	n	Sx	S1	S2	F1	F2	F3
Group A 70°	50	367.2± 26.5	344.6± 27.3	286.2± 15.4	233.8± 21.9	239.2± 16.5	262.3± 14.6
Group B 64°	50	380.4± 27.6	375.5± 9.7	369.4± 23.3	303.0± 9.5	274.4± 28.3	328.2± 28.3
Group C 60°	50	391.3± 20.0	356.2± 7.2	372.4± 12.0	306.6± 12.4	285.8± 5.0	300.8± 34.2
Group D	50	464.6± 18.6	381.2± 15.0	342.0± 22.2	327.6± 22.9	314.8± 18.0	299.0± 40.0

3 Discussion

There is accumulating evidence suggesting that rotary Ni-Ti instruments facilitate root canal preparation with minimal or no canal transportation. However, instrument separation might occur more frequently with rotary systems than conventional hand instruments and there remains a clinical concern even after in-depth introductory courses [9]. Recently, More attention were paid to the safe use of rotary Ni-Ti instruments. However, no definite root canal model was used to study the performance of rotary Ni-Ti instruments. Canal anatomy was one of the key reasons for separation of rotary Ni-Ti instruments. The angle of curvature, radius, diameter can also affect the working life [10-13].

The fatigue life of rotary Ni-Ti instruments prepared the root canal models with the same angle of curvature decreased obviously with the increasing of diameter of the file, which is reported by Haikel Y [14]. The reason was that the large-size subjects had more stress than the small one in the same situation [15].

The degree of the root canal was often shown by the angle of curvature and radius of curvature [16]. The angle of curvature was one of the most important factors that affect the fatigue life of rotary Ni-Ti instruments[17]. Zelada G reported that the fracture of instruments generally won't happen when preparing mild curved root canals or relative straight ones[18]. When the angle of curvature was more than 30 degrees, the fracture rate could be 12.5%. In this study, three kinds of different angles of curvature (70°,64°,60°) were chosen according to the results of preliminary experiment and other root canal models. The radius of curvature kept invariable. The results revealed that when the angle decreased, the NCF of the instruments extended which was as the same of Li UM [19] reported.

The length, diameter, radius of root canals could impact the fatigue life of instruments [20-22], previous studies showed that increased severity in the angle and radius of the curves around which the instrument rotates decreases instrument lifespan, a possible explanation might be that these parameters could affect the flexibility of the instruments. And, if the artificial canal is not identical to the instruments, its trajectory will not respond to the established parameters, so, in this study, these parameters were set with unified standard to omit their influence. So far, the standardization of the parameters and devices used for cyclic fatigue testing of Ni-Ti rotary instruments is lacking, and according to the present study. The pure copper artificial root canal model with 64 degrees of curvature angle could be a possible ideal model for the study on the performances of rotary Ni-Ti instruments.

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后磨牙模拟根管模型制备与研究

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摘要 目的：制备后磨牙模拟根管模型。**方法：**依照预实验中测试的牙本质和树脂根管模型材料的布氏硬度值(牙本质 HB72，树脂块 HB54)选取纯铜质铜管为材料(纯铜 HB58)同时利用预实验中确认的后磨牙模拟根管模型弯曲角度的范围(70°-60°)并参照树脂根管模型相关数据，设计不同弯曲角度(70°，64°，60°)的纯铜质根管模型，将 20 套镍钛根管锉随机分为 4 组，其中 3 组根管锉分别预备相应角度的 10 个纯铜质后磨牙根管模型，另一组在临床预备 10 个后磨牙根管作为对照组。所有镍钛根管锉均在疲劳寿命测试装置中测试疲劳寿命。**结果：**选用根管长度为 16mm± 1mm，弯曲半径为 5mm，内径为 0.70mm 的纯铜质铜管制作后磨牙根管模型。其中在弯曲角度为 70°的后磨牙根管模型中有 33%(2/6)近似临床；在弯曲角度为 64°的后磨牙根管模型中有 67%(4/6)近似临床；在弯曲角度为 60°的后磨牙根管模型中有 33%(2/6)近似临床。**结论：**弯曲角度为 64°的纯铜制后磨牙模拟根管模型更接近于临床实际，可为体外研究镍钛根管锉各项指标提供一个较为理想的模型。

关键词：镍钛根管锉；模拟根管；根管预备；模型

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