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Original Article

Effect of different torques on dentinal crack formation following canal preparation using neoniti rotary system

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Abstract

Introduction: The aim of this study was to determine the incidence of dentinal cracks in the mesial root of maxillary molar during canal preparation using Neoniti system in different torque settings.

Materials &Methods: In this in-vitro study, 60 maxillary molars extracted for various reasons were selected. The teeth were divided into 4 groups: one group(n=15) without preparation was considered as a control group (unprepared control group), the other 3 groups prepared with rotary neoniti system: group with standard torque (1.5 N/CM^2)(n=15), group with high torque ($2N/CM^2$)(n=15), and group with low torque (1N $/CM^2$)(n=15). After a canal preparation procedure, the teeth were horizontally sectioned at 3, 6 and 9 mm from the apex. All sections were examined for determining the presence of cracks using a stereomicroscope. Data were analyzed using chi-square test.

Results: There was no crack in the control group. The number of cracks was significantly higher in the high-torque group (80%) than standard- and low-torque groups (20%, 26.7%, respectively) ($p<0.001$). However, no significant difference was found between the standard-torque group and low-torque group ($p<0.001$).

Conclusion: According to this study result, to avoid crack formation in higher torques using motors with torque control option is suggested.

Keywords: Dentin, Root canal preparation, Torque

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بررسی تاثیر تورک های مختلف در ایجاد ترک های عاجی حین آماده سازی کانال با سیستم Neoniti

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چکیده

مقدمه: هدف از این مطالعه بررسی میزان شیوع ترک های عاجی در ریشه مزیال مولر ماگزیلا هنگام آماده سازی کانال با استفاده از سیستم Neoniti در تنظیمات مختلف Torqueمی باشد.

مواد و روش ها: در این مطالعه in vitro تعداد ۶۰ دندان مولر اول ماگزیلا که به دلایل مختلف کشیده شده بودند، انتخاب شدند. دندان ها در ۴ گروه تقسیم بندی شدند، که یکی از گروه ها بدون آماده سازی به عنوان گروه کنترل در نظر گرفته شد. تقسیم بندی گروه ها به این صورت انجام گرفت: گروه با Torqueاستاندارد($1.5\ N/CM^2$) ، گروه با Torqueبالا ($2\ N/CM^2$) و گروه با Torqueپایین. ($1\ N/CM^2$) بعد از پروسه ی آماده سازی کانال،دندان ها در مقاطع عرضی ۳،۶و ۹ میلیمتری نسبت به اپکس برش داده شدند. تمامی مقاطع برای تعیین وقوع ترک ها بوسیله استریو میکروسکوپ بررسی شده و تست Chi-Square برای آنالیز داده ها به کار رفت.

یافته ها: در گروه کنترل هیچ ترکی وجود نداشت. در گروه با تورک بالا تعداد ترک ها (۸۰٪) به طور معنی داری ($p<0.001$) بیشتر از گروه های تورک استاندارد(۲۰٪) و گروه با تورک پایین(۲۶/۷٪) بود. ولی تفاوت معنی داری بین گروه تورک استاندارد با گروه تورک پایین یافت نشد. ($p< 0.001$)

نتیجه گیری: با توجه به نتایج این مطالعه هنگام آماده سازی کانال ریشه دندان با سیستم Neoniti برای اجتناب از ترک در تورکهای بالا توصیه می شود از موتورهایی با قابلیت کنترل تورک استفاده شود.

واژگان کلیدی: عاج دندان ، آماده سازی کانال ریشه، تورک

Introduction

The preparation of the canal is one of the most important steps in the treatment of root canal. [1] The root canal preparation was carried out with manual stainless steel files over the years. [2] Nowadays, clinicians apply nickel-titanium (NiTi) rotary instruments. Since the use of them is easy and time-saving, and has better cutting efficiency, these systems are preferred to apply. [3, 4] However, the NiTi instruments can create many problems including transportation, perforation, and vertical root fracture. [5] In addition, the use of rotary NiTi instruments can potentially engender cracks in the root dentin. [6-9] It is essential to diagnose the factors involved in the development of the cracks and to reduce their incidence since the cracks have different types and their development can lead to endodontic treatment failure or loss of the tooth. [10] If the tensile stress exerted on the root canal wall is higher than on the dentin, the dentinal cracks or root fractures can be created. [11] NiTi files with large tapers can result in the increase of friction and stress on the canal wall and cracks in root dentin. [7]

Studies have shown that one of the reasons for the failure is torsional stress whose intensity can be decreased using different torque settings by clinicians. The torque enhancement leads to the lock of the instrument and finally its fractures. [12] Gambarini stated that the risk of intracanal fracture is probably increased when the torque of instrument gets beyond a certain limit. He suggested that there is a definite torque limit (close to the elastic limit) for each instrument of any size and type. Hence, different torque settings have been proposed for various files by the manufacturers. [13]

Various studies have compared different rotary NiTi systems in the area of dentinal crack formation. [7, 9, 11, 14] Recently, the Neoniti single-file system, which completes the canal preparation only with one instrument, has been developed. This file is made by Electric Discharge Machining (EDM) process that creates its unique properties including its special cutting, which shortens the rotation time of the rotary system. This system has two C1 and A1 files, C1 widens the canal orifices and A1 is used to shape canal

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to the apex. The proposed range of the manufacturer is 300-500rpm for speed and 1.5 N.cm^2 for the torque. [15]

In the present study, the effect of different torque settings on the formation of dentinal cracks was investigated. Therefore, the aim of this study was to determine the incidence of dentinal cracks during canal preparation using Neoniti system in different torque settings.

Materials & Methods

After ethics approval (MUBABOL.REC.1395.143), 60 human maxillary first molars extracted for various reasons (periodontal causes) were selected. After radiography, the teeth without obstruction, with a moderate curve in curved root canal (20-35 degrees) and with an obvious canal along the entire root were selected for the current study. To determine the working length, a k-file of size 15 (Dentsply, Maillefer) was put inside the canal till the file tip was visible at the apical foramen. Then, the working length was determined 1mm shorter than this size.

The removal of the coronal portion, and palatal and distobuccal roots of all teeth were performed to ensure the standardization and 13 millimeters of mesiobuccal root were remained. To simulate PDL, the roots were covered with a thin layer of silicon impression materials (Oranwash, Italy), and then mounted within an acrylic resin (Imicryl, turkey) to make them easy to use during work. Next, the teeth were randomly divided into 4 groups (N=15 in each group): a control group with no cleansing and shaping and the other three groups were prepared by single-file neoniti system (chatres-la-foret, france) in different torque settings. All preparations were done by one person.

The experimental groups divided in to 4 groups including: one control group without any preparation(n=15), group prepared by Neoniti system with the torque 1 N.Cm (n=15), group prepared by Neoniti system with the torque 1.5 N.cm. (n=15)and group prepared by Neoniti system with the torque 2 N.cm (n=15).

The NiTi C1 file (Chatres La Foret) (size 15, 12% taper, 15 mm length) as the general method of canal preparation in the groups was used to widen the canal orifices. This file was brushed against the canal walls opposite to the danger zone. Cleansing and shaping of the apical and middle thirds of the canal were performed using A1 file (size 25, taper 8%) with brushing action.

The root canals were irrigated with 2 ml of 2.5% sodium hypochlorite (NaOCl) solution during cleansing and shaping. After preparation, the teeth were taken from acrylic resin and kept in 0.5% basic fuchsine solution for 24 hours. Then, samples were horizontally sectioned at 3, 6, and 9 mm from the apex using low-speed diamond disc under water cooling. Stereomicroscope at 40X magnification (Dewinter, Milano, Italy) was used to observe and determine the incidence of cracks, horizontally. The cracks were examined by three endodontists. Data were divided into two categories: defect and no-defect. Defects were attributed to any craze line, microcrack and fracture, and in no-defect group, dentin had no crack or fracture at external or internal surfaces.

Craze line is a small crack extending from the outer surface into the inner surface of the dentin, but not reaching the inner wall. Microcrack is a small crack extending from the inner wall but not reaching the external wall. Finally, fracture involves both dentinal walls (Figure 1). Data were analyzed using chi-square and fisher exact test with bonferroni correction.

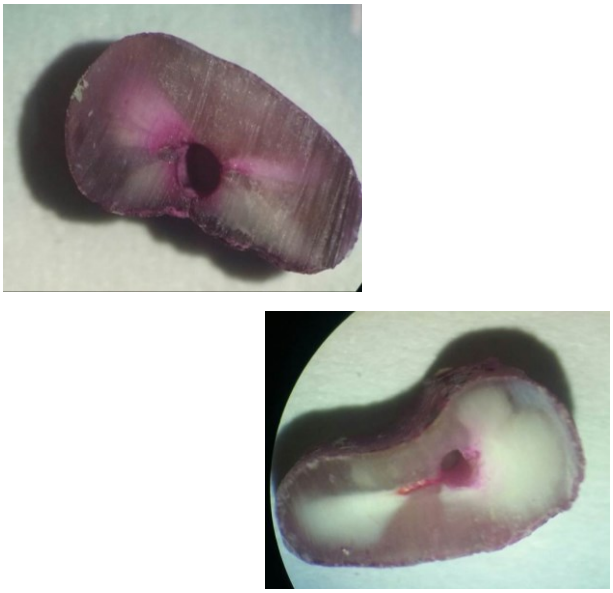

Figure1. 3-mm-cross-sectional slice without dentinal crack (right) and with dentinal complete crack (left)

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Results

The distribution of cracks is summarized in Table 1.

Table1. The number and percentage of dentinal cracks in different torque settings

	Coronal	Middle	Apical	Total
Control	0(0%)[a]	0(0%)[a]	0(0%)[a]	0(0%)[a]
Torque 1	3(20.0%)[a]	0(0%)[a]	1(6.7%)[a]	4(26.67%)[b]
Torque1.5	2(13.3%)[a]	0(0%)[a]	1(6.7%)[a]	3(20%)[ab]
Torque 2	5(33.3%)[a]	3(20%)[b]	4(26.7%)[a]	12(80%)[c]
P_value	0.10	0.02	0.08	<0.001

a/b/c: Groups with the same letters had no statistically significant difference.

No crack was found in the control group. The number of cracks was higher with a significant difference in high-torque group (2 N.cm) (80%) compared to standard and low-torque groups (1.5 N.cm) (20%) (1N.cm) (26.6%) and control group, respectively.

The number of cracks was higher in low-torque group (1N.cm) (26.6%) than the standard group, while this difference was not statistically significant. In addition, the cracks were higher in this group than control group with significant difference.

There was no significant difference between standard-torque group and control group in terms of the cracks (P<0.001).

There were two complete fractures in high-torque group (2 N.cm).

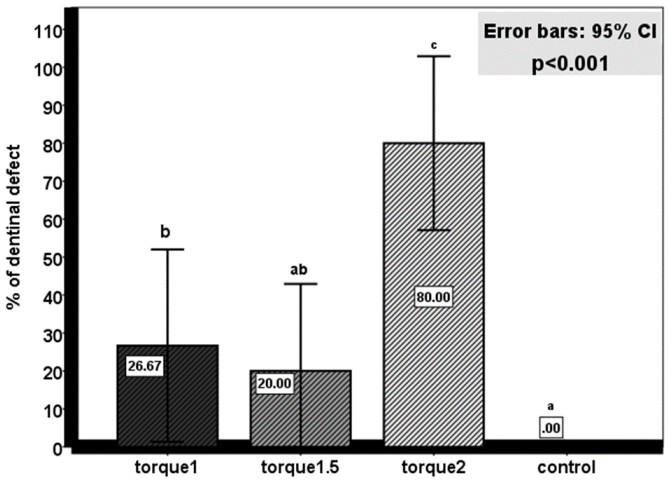

Figure2. The percentage of cracks after the preparation of the canal with different torque settings. Groups with the same letters had no statistically significant difference

Discussion

When rotary instruments are used, a torque force is exerted on the canal walls. Hence, it can lead to the formation of microcrack in the root dentin. [9] The development of these cracks is affected by a variety of factors including rotary file properties such as tip and taper design as well as the properties of the rotary engine-driven systems.

The aim of this study was to investigate the effect of rotary engine torque on dentin during tooth preparation using Neoniti rotary system. The Neoniti system made by EDM (Electric Discharge Machining) process has unique features such as progressive flexibility and sharp cutting edges. [16]

In the current study, 60 maxillary first molars were selected. Their mesiobuccal roots were used to evaluate the incidence of cracks created during the canal preparation using Neoniti Rotary File in different torques. This root had a favorable curvature for the study. In the present study, the highest dentinal cracks and defects were related to the second group (high-torque group). And the lowest ones were associated to standard-torque group (Torque: 1.5). The percentage of cracks was higher in Torque: 1 group (low-torque group) than standard-torque group, but no significant difference was found. The high number of cracks in the high-torque group can be associated with greater stress on the dentinal surfaces.

These results were similar to those of Dane et al. in 2016, who used 69 mandibular premolars to study the effect of different torque settings on dentinal crack formation during preparation using Protaper system. They concluded that the cracks were significantly higher in high-torque group than lower-torque group. [17]

Numerous studies have evaluated the effects of different rotary systems on dentinal crack formation and only one study has been investigated the effect of torque control on the dentin structure. [17]

Paul et al. compared the dentinal defects created by various files including K file, Protaper universal, Neoniti and iRace. Data analysis indicated that Neoniti Rotary file had the lowest incidence of cracks compared to other files. It was also observed that the number of cracks in the apical thirds and coronal of the canal was equal in Neoniti Rotary file, which is consistent with the result of the present study in the standard torque, and there was no statistically significant difference between the cracks of the apical and coronal sections (P <0.001). [16] In another study, Jain et al. examined the

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effects of different One Shape single-file rotary systems and Hero Shaper multiple rotary file systems on the incidence dentinal defects. Statistical analysis results represented that the number of dentinal defects was greater in Hero Shaper system than One Shape system (P value <0.05). According to these results, a single-file system causes fewer dentinal cracks. In the present study, the Neoniti single-file system produced the least number of cracks in the standard-torque group so that this group had no statistically significant difference with unprepared control group in the number of cracks (P<0.001). [18]

Considering the observations of the present study to reduce the incidence of cracks during the canal preparation using Neoniti system and the increased number of cracks in high-and low torque settings, it is suggested that the preparation process with the Neoniti system should be done in standard torque values with motors which control the torque.

Conclusion

The results of this study indicated that the incidence of cracks is increased through changes the torque (higher and lower than the standard level) during root canal preparation using Neoniti system.

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Conflict of interest :There was no conflict of interest.

Authors' Contributions

The study was designed by Akam Saeidi and Mahmoodreza Hamidi. The study data were collected by Mina Habibolahpour. Analysis and interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content were performed by Hemmat Gholinia and Akam Saeidi and Azadeh Harandi and Mahmoodreza Hamidi. Study supervision was conducted by Akam Saeidi and Mahmoodreza Hamidi.

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