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Letter to the editor

Evaluating dentinal crack formation after root canal preparation using nickel-titanium rotary file systems

Chemo-mechanical preparation of the root canal system, including maintaining the original path of the root canal system, cleaning, and shaping, is a major factor in root canal therapy. However, improper instrumentation techniques in the root canal system can cause rotational stress on the root canal walls. This can cause craze lines or micro-cracks, which can later lead to vertical or horizontal root fractures.[1,2] Therefore, this brief letter was focused on dentinal crack formation in the root canal system during endodontic therapy.

To evaluate dentinal crack formation, a systematic review based on 54 studies investigated the influence of root canal preparation in forming dentinal crack during root canal therapy. The review study highlighted the following three points: First, there was no evidence of dentinal crack formation in most of these studies evaluated by micro-computed tomography. Second, regardless of the kinematic movements, crack formation was high in the destructive techniques. Third, the risk of micro-crack formation in the apical region was reduced by adjusting the working length by subtracting 1 mm from the root canal length. Based on the result of this study, selecting the proper methodology is a prerequisite to avoid damage to the dentinal crack during root canal preparation.[3]

Maximum torque may cause a dentinal crack during root canal preparation. In this context, Katkam et al. evaluated the effect of different torque settings on dentinal crack formation. A total of 45 extracted human premolars were divided into three groups and prepared as follows: Group 1) using One Curve with min and max torque of 1.5 N cm and 2.5 N cm, Group 2) using ProTaper Next with min and max torque of 2.5 N cm and 5 N cm, and Group 3) unprepared as a control group. After preparing root canals, each sample was sectioned horizontally at 3, 6, and 9 mm. The result showed that the maximum torque setting was associated with a higher incidence of dentinal crack formation. Thus, minimum torque should be considered for root canal preparation.[4]

Branawal et al. evaluated the effect of dentinal defect development after root canal preparation using four systems. In this study, 105 extracted oval human teeth were selected and divided into five groups (n = 21). Groups were prepared as follows: Group 1) H-Files, Group 2) XP-Shaper, Group 3) TruNatomy, and Group 4) Reciproc Blue. Group 5 was unprepared as a control group. Microscopic examination of the sections at 3, 6, and 9 mm from the apex revealed the following percentages of dentinal cracks: 1) XP-Shaper 4.7 %, 2) H-Files 19 %, 3) TruNatomy 19 %, and 4) RC Blue 23.8 %. As a result, using XP-Shaper is recommended during root canal therapy.[1]

In line with the previous study, another study investigated the incidence of dentin micro-cracks following biomechanical preparation using four Ni–Ti rotary file systems. In this study, 80 extracted mandibular premolars were included and divided into four groups (n = 20). The sample preparation was performed as follows: Group 1) TruNatomy, Group 2) Neoendo Flex, Group 3) ProTaper Gold, and Group 4) 2Shape. The incidence of dentin micro-cracks, under microscopic examination of the samples' slices, was 65 %, 45 %, 20 %, and 20 % for ProTaper Gold, Neoendo Flex, TruNatomy, and 2Shape, respectively. According to the obtained results, since the 2Shape and TruNatomy systems produced satisfactory results, they could be considered for use during root canal preparation.[5]

Ozlek and Gunduz evaluated the effect of single-file systems on dentinal crack formation. In this study, 40 extracted mandibular premolars were posed and divided into four groups (n = 10) and prepared as follows: Group 1) Reciproc Blue, Group 2) One Curve, Group 3) HyFlex EDM, and Group 4) Control group, i.e., hand files. After root canal preparation, the percentage of dentinal crack formation on samples' slices was 30 % for Reciproc Blue, 26.7 % for One Curve, and 13.3 % for HyFlex EDM. Accordingly, applying HyFlex EDM, i.e., size 25, is recommended.[6]

In another investigation, an in vitro study was conducted on four rotary files to evaluate the occurrence of dentinal

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cracks during root canal preparation. To achive this objective, 36 extracted mandibular premolars were enrolled in the experimental study. The samples were divided into four groups (n = 9) for root canal preparation: Group 1) XP-endo Shaper, Group 2) TRUShape, Group 3) ProTaper Next, and Group 4) ProTaper Universal. Before and after root canal preparation, the micro-CT scan was performed. The results showed no new dentinal cracks in the other groups except for the ProTaper Universal group. Therefore, heat-treated nickel-titanium files could reduce the tensile stress on the root canal wall during root canal preparation.[7]

Another challenge during root canal therapy is using ultrasonic vibration protocols followed by the subsequent occurrence of dentinal crack formation. In this regard, Barakat et al. evaluated the incidence of dentinal crack using diode laser and ultrasonic activation during root canal retreatment. For this purpose, 30 extracted single-canal teeth were selected. After root canal preparation and root canal filling, the samples were retreated using the D-Race system and divided into three groups (n = 10) for additional root canal cleaning as follows: Group 1) untreated as a control, Group 2) underwent ultrasonic activation of irrigations, and Group 3) underwent active irrigations with a diode laser (980 nm wavelength). Micro-CT analysis was used to evaluate the dentinal crack. The results showed that the retreatment system was more associated with a significant increase in dentinal micro-cracks compared to ultrasonic activation and laser use.[8]

To prevent dentinal crack formation during endodontic treatment, a study evaluated the effect of three systems on dentinal crack formation. For this purpose, 70 extracted first mandibular molars were selected for this in vitro study. Of these samples, 10 were selected as a control group, and the remainder were divided into three groups (n = 20), and root canal preparation was performed as follows: Group 1) RaCe system, Group 2) ProTaper, and Group 3) V-Taper. Although all three systems produced dentinal cracks, the V-Taper system produced the least amount of dentinal cracks, particularly in the middle third ($P < 0.05$), which is recommended for root canal preparation.[9]

Based on the information provided in this letter, the following procedures should be considered to reduce the incidence of dentinal crack during endodontic therapy: 1) accurate determination of working length during instrumentation, 2) setting the correct torque on endomotors, and 3) applying proper Ni—Ti rotary file systems (e.g., XP-Shaper, 2Shape, TruNatomy, HyFlex EDM, and V-Taper) during root canal preparation. Consequently, precise selection of a particular system must depend solely upon the clinical decision, e.g., the shape of the root canal system and the requirements to avoid dentinal crack formation during endodontic therapy.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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