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Comparative *in vitro* evaluation of the amount of apically extruded debris using different root canal instrumentation

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Abstract
Background: To compare and evaluate the amount of apically extruded debris using root canal instrumentation.
Materials and methods: A total of 15 mandibular first premolars were enrolled. They were divided into 3 groups (n = 5 teeth/group). The root canals were instrumented according to the manufacturers' instructions using the Reciprocating single-file system Wave One™ and full-sequence rotary Hyflex CM™ and ProTaper™ instruments. The p- value less than 0.05 was considered significant.
Results: The mean apically extruded weight of debris in Wave One (0.0075 g) was more when compared with the Hyflex (0.0020 g). Wave One™ and Pro Taper™ (0.0070 g) was significantly more when compared to Hyflex™ (p<0.05).
Conclusion: The WaveOne™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments (p<0.05).

Keywords: Hyflex, protaper, debris

Introduction
Root canal therapy incorporates both cleaning and shaping of the root canal, with the help of instruments and the use of irrigants up to the controlled working length. In spite of maintaining strict working length during root canal preparation, dentin filings, microorganisms, fragments of pulp, necrotic tissue and canal irrigants are extruded beyond the apical foramen [1, 2]. This apical extrusion of debris sometimes results in a foreign body reaction and inflammation of periapical region, leading to intra-appointment or postoperative pain [2-4]. Apical extrusion of debris has been associated with all types of instruments and instrumentation techniques, even when preparation is maintained short of the apical terminus, with some instrumentation techniques extruding less material than others [5-8].
The cleaning of the root canal system and the removal of inflamed and/or necrotic tissue remain one of the most important steps in endodontic therapy [9]. Dentine chips, pulp tissue fragments, necrotic tissue, microorganisms, and intracanal irrigants may be extruded from the apical foramen during the canal instrumentation, which may cause pain or flare-up [10]. The interappointment flare-up is a true complication characterized by the development of pain, swelling, or both, which commences within a few hours or days after root canal procedures and is of sufficient severity to require an unscheduled visit for emergency treatment [11]. The causative factors of interappointment flare-ups comprise mechanical, chemical, and/or microbial injury to the pulp or periradicular tissues [2, 10]. In asymptomatic chronic periradicular lesions associated with infected teeth, there is a balance between microbial aggression and host defense in the periradicular tissues. Microorganisms that are extruded apically during chemomechanical preparation cause the host to be challenged by a larger number of irritants than before. Consequently, the transient disruption in the balance between aggression and defense will cause the host to mobilize an acute inflammation to reestablish the equilibrium [11].
Hyflex™ CM nickel-titanium (NiTi) Files (Coltene-Whaledent, Allstetten, Switzerland) is produced by an innovative methodology (patent pending) which uses a unique process that controls the material's memory (a complex heating and cooling treatment).

The cross-sectional design of Hyflex™ files is very much similar to EndoSequence [12]. WaveOne™ (Dentsply Maillefer, Ballaigues, Switzerland), the recently introduced single-file NiTi system is claimed to complete root canal preparation with only one instrument in reciprocating motion with adequate size and taper. These files are made of a special NiTi alloy called M-Wire that is created by an innovative thermal treatment process [13]. Hence, this study was conducted to compare and evaluate the amount of apically extruded debris using root canal instrumentation.

Materials and Methods

A total of 15 mandibular first premolars were enrolled. They were divided into 3 groups (n = 5 teeth/group). The root canals were instrumented according to the manufacturers' instructions using the Reciprocating single-file system WaveOne™ and full-sequence rotary Hyflex CM™ and ProTaper™ instruments. The canals were also irrigated. The debris that was extruded apically was collected and comparison was done. The debris extrusion was compared and statistically analyzed using SPSS software. The p- value less than 0.05 was considered significant.

Results

A total of 15 teeth were enrolled. The mean extruded debris weight of the 3 groups was included. The mean apically extruded weight of debris in WaveOne (0.0075 g) was more when compared with the Hyflex (0.0020 g). WaveOne™ and ProTaper™ (0.0070 g) was significantly more when compared to Hyflex™ (p<0.05). There was no statistical significant difference obtained between WaveOne™ and ProTaper™ (p>0.05).

Table 1: Amount of apically extruded debris after the use of the different instruments

Debris extrusion (g)	ProTaper	Hyflex	WaveOne
Mean	0.0070	0.0020	0.0075
Standard deviation	0.0020	0.0007	0.0016

Discussion

A major objective of root canal therapy is to obtain a clean root canal system. Debris such as dentine chips, necrotic pulp tissue, microorganisms and irrigants may be extruded into the periradicular tissue during canal instrumentation which leads to endodontic flare-up. Apical extrusion of infected debris to the periradicular tissues is possibly one of the principle cause of this post-operative pain [2]. Many factors affect the amount of extruded debris such as the instrumentation technique, instrument type and size, preparation endpoint and irrigation solution [14, 15]. Hence, this study was conducted to compare and evaluate the amount of apically extruded debris using root canal instrumentation.

In the present study, a total of 15 teeth were enrolled. The mean extruded debris weight of the 3 groups was included. The mean apically extruded weight of debris in WaveOne (0.0075 g) was more when compared with the Hyflex (0.0020 g). A study by Surakanti JR *et al*., 60 human mandibular first premolars were randomly assigned to 3 groups (n = 20 teeth/group). The root canals were instrumented according to the manufacturers' instructions using the Reciprocating single-file system WaveOne™ (Dentsply Maillefer, Ballaigues, Switzerland) and full-sequence rotary Hyflex CM™ (Coltene Whaledent, Allstetten, Switzerland) and ProTaper™ (Dentsply Maillefer, Ballaigues, Switzerland) instruments. The Wave One™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments (p<0.05). All systems that were used resulted in extrusion of apical debris. Full-sequence rotary instrumentation was associated with less debris extrusion compared with the use of reciprocating single-file systems [16]. In the present study, waveOne™ and ProTaper™ (0.0070 g) was significantly more when compared to Hyflex™ (p<0.05). There was no statistical significant difference obtained between WaveOne™ and ProTaper™ (p>0.05). Another study by Singbal K *et al*., thirty freshly extracted mandibular premolars with straight roots were sterilized and divided into two groups instrumented using: One Shape rotary Ni-Ti system with Endoflare orifice shaper (Group 1) and Neo-Niti rotary Ni-Ti system with C1 orifice shaper (Group 2). The difference between pre- and post-weights was significantly greater for the One Shape system. The Neolix Niti single file was associated with less extrusion compared to One Shape single file system [17]. A study by Shetty VP *et al*., thirty extracted human mandibular premolars were selected and randomly assigned to three groups (n = 10). The root canals were irrigated with conventional syringe, PUI, and EndoIrrigator Plus. The EndoIrrigator Plus group extruded significantly less debris than PUI and conventional syringe groups (p< 0.05). Furthermore, PUI group extruded significantly less debris than conventional syringe irrigation group (p< 0.05). All the three irrigation systems were associated with apical extrusion of debris. EndoIrrigator Plus system extruded significantly less debris than the PUI system and the conventional syringe irrigation system. PUI system extruded significantly less debris than the conventional syringe irrigation system [18]. Ruiz-Hubard *et al*. [19] found that extrusion of debris apically was less using a crown-down pressure less technique in curved and straight canals when compared with the step-back technique. Zarrabi *et al*. [20] compared ProFile, RaCe and Flex Master rotary instruments with the step-back technique using manual files and reported that the step-back technique extruded greater amounts of debris than the rotary instruments. Ghivari *et al*. found that step-back technique extruded a greater quantity of debris and irrigant in comparison to the other hand and rotary Ni-Ti systems [21, 22]. Garlapati *et al*. showed that K3 rotary instruments using crown down technique extruded less number of bacteria [23].

Conclusion

The WaveOne™ and ProTaper™ rotary instruments produced significantly more debris compared with Hyflex CM™ rotary instruments (p< 0.05).

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Author's Contribution

Not available

Conflict of Interest

Not available

Financial Support

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