ORIGINAL RESEARCH

Histological evaluation of Multisonic technology for debridement of vital and necrotic pulp tissues from premolar teeth

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ABSTRACT

Background: To study the histological evaluation of multisonic technology for debridement of vital and necrotic pulp tissues from premolar teeth.

Materials & Methods: A total of 20 teeth were enrolled. 10 teeth identified with symptomatic irreversible pulpitis (SIP) and another 10 teeth diagnosed with pulp necrosis accompanied by symptomatic apical periodontitis (SAP) were removed. The eosin hematoxylin staining was done and gram stain for evaluating the necrotic tissue by presence of bacteria was done. The results were analysed using SPSS software.

Results: A total of 20 teeth were enrolled. Among the 7 teeth with symptomatic irreversible pulpitis (SIP), no pulpal debris was identified in any part of the canals in 6 of them.

Conclusion: Multisonic technology demonstrated its effectiveness in the thorough removal of both vital and necrotic pulp tissue, along with the eradication of bacteria from the root canal system, even in hard-to-reach areas.

Keywords: multisonic, bacteria, debris, premolar.

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INTRODUCTION

The primary goal of root canal treatment is to eliminate and prevent re-infection of the root canal system. [1] In necrotic teeth, microorganisms can colonize anatomical complexities, such as isthmuses, ramifications and dentinal tubules.[2] Instrumentation can reduce the bacterial load by approximately 80%. [3] However, the microorganisms cannot be completely eliminated, because the instruments are unable to fully reach the anatomical complexities of the root canal system. [2] For this reason, irrigation is the key to successful treatment, since it is the only way to reach areas left untouched by instrumentation. [4] Many techniques for cleaning and preparing root canals have been recommended, along with the use of chemical solutions for disinfection, tissue dissolution, and removal of the smear layer. [5] Sodium hypochlorite (NaOCl) is commonly used in root canal therapy for disinfection and tissue dissolution. [6]

Recently, a new system that combines multisonic and negative apical pressure (GentleWave, Sonendo Inc.) was introduced for cleaning and disinfecting root canals using minimal

preparation sizes, i.e., using small files with sizes #15 or #20 tip. [7,8] This system creates hydrodynamic cavitation in the root canal space, and the implosion of microbubbles creates an acoustic field of broadband frequencies that travels through the fluid to the entire root canal system. [9] The GentleWave system (GW) (Sonendo, Laguna Hills, CA, USA) was introduced on the US market in 2014, and represents a type of endodontic device developed for cleaning and disinfection of the root canal. [7] According to its manufacturer, GW can be used in situations that need only minimal instrumentation, instead of using conventional instrumentation, which may contribute to maintain tooth resistance. [10] That is because the widening of the root canal can lower the fracture resistance of the root; however, there is still no consensus that minimal instrumentation has this effect. [11] The GW system consists of a console, a handpiece similar to a conventional dental handpiece, and a trash container. A prerequisite for using GW is making sure that the pulp chamber is sealed to prevent communication with the oral cavity, thus preventing NaOCl mist from spreading to the work area. The handpiece tip should be positioned 1mm above the pulp chamber floor when used, to ensure that it does not enter the canal orifices. A touchscreen control panel on the console allows high speed flow regulation of the irrigant to the handpiece, where the irrigant strikes a metal strike plate at the end of the tip, thereby triggering the release of a spray from the tip. [7] The irrigants undergo a degassing process to eliminate the dissolved gas present in the solution, thus optimizing the energy supply through the root canal, and eliminating the vapor-lock effect. [12] When the solution passes from the handpiece into stagnant fluids in the pulp chamber, hydrodynamic cavitation is triggered by shear forces, forming thousands of microbubbles called cavitation clouds. These bubbles implode and create sound waves that cover a wide spectrum of frequencies (Multisonic Ultracleaning spectra) and reverberate throughout the root canal system to achieve more thorough cleaning. [13] The handpiece has a 5-point vented suction system that collects excess NaOCl from the pulp chamber. [7] Hence, this study was conducted for histological evaluation of multisonic technology for debridement of vital and necrotic pulp tissues from premolar teeth.

MATERIALS & METHODS

A total of 20 maxillary premolar teeth were enrolled. 10 teeth identified with symptomatic irreversible pulpitis (SIP) and another 10 teeth diagnosed with pulp necrosis accompanied by symptomatic apical periodontitis (SAP) were removed. Within each group, the GentleWave® procedure was administered to 7 teeth, while 6 untreated teeth were utilized as histological reference points. Subsequently, consecutive 5 µm sections were taken from the apical, middle, and coronal sections of the canals, and these sections were analyzed for the presence of debris and bacteria. All teeth were evaluated under microscope. The access cavities were prepared and working lengths were taken. Histological evaluation was done. The eosin hematoxylin staining was done and gram stain for evaluating the necrotic tissue by presence of bacteria was done. The results were analysed using SPSS software.

RESULTS

A total of 20 teeth were enrolled. Among the 7 teeth with symptomatic irreversible pulpitis (SIP), no pulpal debris was identified in any part of the canals in 6 of them. In the group with necrotic pulp, 5 out of the 7 specimens exhibited no observable pulpal debris within the canal spaces. While bacteria were not observed in the primary canals, or lateral canals, they were noticed deeply in dentinal tubules in all teeth.

Table 1: mean biofilm before and after treatment

Group	Pre	Post	Reduction (%)
GW	5.20	0.12	100

Table 2: mean percentage of teeth with bacteria inside dentinal tubules

	Root canal	Palatal	Buccal
Portions	Coronal	3.58	4.85
	Middle	2.5	0
	Apical	2.21	1.8

DISCUSSION

The main goal of endodontic treatment is to promote the healing of periapical tissues affected by apical periodontitis. To accomplish this goal, the operator needs to eradicate or at least reduce the bacterial concentration in the root canal system. [14] However, disinfection may be challenging when bacteria are organized in multispecies matrix-enclosed communities called biofilms, especially in teeth with complex anatomies. These bacterial structures can colonize the canal walls, ramifications and isthmuses. [15] Hence, this study was conducted for histological evaluation of multisonic technology for debridement of vital and necrotic pulp tissues from premolar teeth.

In the present study, a total of 20 teeth were enrolled. Among the 7 teeth with symptomatic irreversible pulpitis (SIP), no pulpal debris was identified in any part of the canals in 6 of them. A study by Siqueira JF et al, the efficacy of five instrumentation techniques for cleaning the apical third of curved root canals was assessed by histological examination. Mesial root canals of freshly extracted human mandibular molars were prepared by the following instrumentation methods: step-back technique using stainless steel files; step-back technique using nickel-titanium files; ultrasonic technique; balanced force technique; and Canal Master U technique and instruments. The apical portion of the root was histologically processed, and cross-sections were examined for remaining soft tissue, predentin, and debris. The results showed no significant differences among the techniques. Although the five instrumentation methods were effective in removal of major amounts of tissue from the canals, none totally debrided the entire root canal system, especially when variations in the internal anatomy were present. [16]

In the present study, in a group with necrotic pulp, 5 out of the 7 specimens exhibited no observable pulpal debris within the canal spaces. While bacteria were not observed in the primary canals, or lateral canals, they were noticed deeply in dentinal tubules in all teeth. Another study by Jaramillo DE et al, twelve teeth with a diagnosis of symptomatic irreversible pulpitis (SIP) and twelve teeth with a diagnosis of pulp necrosis with symptomatic apical periodontitis (SAP) were extracted. The GentleWave® procedure was performed on 10 teeth from each group. Four non-treated teeth served as histologic controls. Histological consecutive 5 µm sections were obtained from the apical, middle, and coronal portion of the canals. The canals were evaluated for the presence of pulpal debris and bacteria. In nine out of the ten specimens with SIP, no pulpal debris was detected in any portion of the canals. In the necrotic pulp group, eight out of the ten specimens had no detectable pulpal debris in any portion of the canal spaces. No bacteria were detected in the main canals, isthmuses, or lateral canals, but were detected deep within the dentinal tubules in 10 specimens. This study demonstrated that the multisonic technology was effective at removing vital and necrotic pulp tissue as well as bacteria from the root canal system, including inaccessible areas. [17] Coaguila-Llerena H et al, describe the outcomes of the GentleWave system (GW) (Sonendo) on root canal treatment. Published articles were collected from scientific databases (MEDLINE/PubMed platform, Web of Science, Scopus, Science Direct and Embase). A total of 24 studies were collected from August/2014 to July/2021, 20 in vitro and 4 clinical. GW System was not associated with extrusion of the irrigant, promoted faster organic dissolution than conventional syringe irrigation (CSI), passive ultrasonic irrigation (PUI) continuous ultrasonic irrigation (CUI) and EndoVac,

reduced more bacterial DNA and biofilm than PUI and CUI, promoted higher penetration of sodium hypochlorite into dentinal tubules than PUI and CUI in vitro, and removed more intracanal medication than CSI and PUI. GW was able to remove pulp tissue and calcifications. Moreover, its ability to remove hard-tissue debris and smear layer was better than that of CSI, and its ability to remove root canal obturation residues was lower or similar to that of PUI, and similar to that of CSI and EndoVac. Regarding root canal obturation of minimally instrumented molar canals, GW was associated with high-quality obturation. Clinically, the success rate of endodontic treatment using GW was 97.3%, and the short-term postoperative pain in the GW group was not different from CSI. Further research, mainly clinical, is needed to establish whether GW has any advantages over other available irrigation methods. [8] The effect of GW on the final obturation after minimal instrumentation of root canals of maxillary molars (15.04, Vortex Blue) was evaluated using micro-CT images. [18] The root canals were filled using a modified single cone technique with 3 different sealers: GuttaFlow Bioseal, GuttaFlow 2 and MTA Fillapex. The sealers provided an 89.5%–98.9% filled canal, pointing out that GuttaFlow Bioseal (96.9%–98.9%) and GuttaFlow 2 (94.7%–97.5%) were higher than MTA Fillapex (89.4%–89.5%). It was concluded that the modified single cone technique using GuttaFlow 2 and GuttaFlow Bioseal sealers resulted in a high-quality obturation after using GW in minimally instrumented molar canals. Although the manufacturer suggests the use of GW in a single-visit, different impediments such as time constraints, presence of separated file, device availability make necessary to perform endodontic treatment in multiple visits. [9,12] The same studies that evaluated postoperative pain, success rate (clinical and radiographic) and healing of periapical lesions also took into consideration the number of visits. [12,19] After 6 months, a 93.3% success rate was observed in patients who were treated with GW in a single visit. A positive correlation was observed between single-visit and success. [20] However, after 12 months (84.3% recall rate), although the success rate remained high when single-visit was performed, 97.2%, there was no correlation between the number of visits and success. [12] A study that assessed healing of periapical lesions after 12 months (97.7% success rate) revealed that most of the patients (88.9%) were treated in a single visit. [12] Another study that evaluated postoperative pain revealed that 83.3% of patients were treated in 2 visits, with most of the pain eliminated between appointments. [19] Moreira et al. [21] performed a meta-analysis comparing passive ultrasonic irrigation to conventional irrigation techniques. The study demonstrated that there is no statistically significant difference in the presence of bacteria between the two techniques and there is bacteria remaining in the root canal system. Using histological evaluation of cleaning with ultrasonic irrigation, Gutarts et al. [22] showed that ultrasonic irrigation for 1 min in each canal after hand/rotary instrumentation cleaned the canals well 1–3 mm from the apex but the results for the isthmus region were not consistent over the same range. Varela et al. [23] showed that ultrasonic irrigation and hand irrigation removed more pulp debris from round-shaped canals compared to oval-shaped canals. This study shows that the multisonic technology with minimal instrumentation of 20/04 is sufficient to remove pulp tissue and disinfect the main canal, isthmuses, and lateral canals at all levels regardless of the shape of the canal.

The main limitation of GW is its cost, which would require a financial effort from the clinician. Additionally, GW uses a maximum of 3% NaOCl and 8% EDTA, which can be supplemented with water rinse. [12] This could be considered as a limitation since irrigants at higher concentrations, with different additives (such as surfactants) or alternative/experimental irrigants cannot be used. Regarding the handpiece, it needs vertical space to be attached to the tooth, therefore, structurally compromised teeth should be sufficiently restored to allow a proper attachment, i.e., 1 mm above the pulp chamber floor. [8]

CONCLUSION

Multisonic technology demonstrated its effectiveness in the thorough removal of both vital and necrotic pulp tissue, along with the eradication of bacteria from the root canal system, even in hard-to-reach areas.

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