Antibacterial efficacy of Sonicare CanalBrush irrigation after rotary instrumentation of infected root canals. A clinical study

Mohamed Ibrahim Salman

Department of Conservative Dentistry, Faculty of Dentistry, Mansoura University, Egypt.
dr.mohamed.ibrahim@qudent.org

Abstract: Introduction: This clinical study was conducted to assess the bacterial reduction of rotary instrumentation and the additive antibacterial effect of Sonicare CanalBrush irrigation. **Methods**: Fifteen mesial roots of mandibular molars with primary endodontic infections and chronic apical periodontitis were prepared with a combined ProTaper/GTX technique up to size 40/.04 taper followed by 30 s Sonicare CanalBrush agitation of 17% EDTA then 60 s 5.25% NaOCl. Canals were sampled before and after instrumentation and after Sonicare CanalBrush agitation of irrigats. Samples were incubated anaerobically for 7 days at 37˚C and colony forming units (CFUs) were counted and the number of bacteria in each sample was calculated. **Results**: All samples showed bacterial growth before treatment. 50% of samples showed negative cultures after rotary instrumentation alone while, 83.3% of samples were free of bacteria after the additional Sonicare CanalBrush irrigation. Furthermore, one minute Sonicare CanalBrush irrigation resulted in significant ($p<0.05$) reduction in CFU count. **Conclusions**: Bacterial counts and number of negative cultures were substantially reduced after Sonicare CanalBrush irrigation. This treatment protocol may be a valuable adjunct in the search for more effective antimicrobial treatment strategies to render the root canal system free of bacteria.
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Introduction

Optimal healing of apical periodontitis can be maximized by complete elimination of bacteria and their byproducts within the root canal system (1, 2).

In long standing endodontic infections, bacteria may propagate to the entire root canal system including; ramifications, isthmuses, fins, and dentinal tubules, the concern is primarily to disinfect beyond root canal instrumentation into these areas where increased numbers of bacteria settled. Current methods available for bacterial reduction in endodontic therapies including mechanical instrumentation, irrigation and intracanal medications are unable to render the root canal system bacterial free after the whole treatment protocol (3-5). This fact points to the need for developing more effective treatment strategies as well as searching for alternative or supplemental disinfecting procedures (6, 7).

Because routine bacterial monitoring of root canal during treatment using reliable anaerobic culturing techniques is not always practical, searching for ideal treatment protocol should be considered that has been shown to be effective in well-controlled studies so that a predictable outcome can be achieved (7).

Agitation of the irrigating solutions inside the root canal system using sonic or ultrasonic energy might be one of the promising alternative approaches to maximize disinfection in a single visit as well as better removal of debris and smear layer (8-12).

The Sonicare CanalBrush is a combination using the sonic energy of Philips Sonicare Elite toothbrush to activate a plastic brush of 0.25 mm diameter and 2% taper. The sonic toothbrush operates at a frequency of 50 Hz and performs 31 000 strokes per minute (8).

Some recent studies reported the ability of agitating irrigating solutions by CanalBrush either mounted on Sonicare elite tooth brush or conventional low speed handpiece to improve debris and smear layer removal within the root canal system (8, 13, 14).

In a previous publication (8), we reported better debris and smear layer removal after 30 s passive Sonicare CanalBrusg agitation of 17% EDTA.

It seems now of interest to study the efficacy of this protocol clinically on bacteria left after root canal instrumentation.

The present study was undertaken to investigate the possible antibacterial effect of agitating the irrigating solutions by Sonicare CanalBrush after rotary NiTi instrumentation of teeth with necrotic pulps and apical periodontitis.

Materials and Methods

Criteria for patient selection

A total of fifteen mesial roots of mandibular asymptomatic molars with necrotic pulps and apical

periodontitis as verified clinically and radiographically from patients attending dental clinics in the College of Dentistry, Qassim University were considered in the study. Approval for the project was obtained from the Dental Ethics Committee for research on human subjects. The study and associated risks were explained to the patients and consent obtained.

Endodontic treatment and bacterial sampling

Rubber dam and a strict aseptic technique were used throughout the endodontic treatment. Before isolation with rubber dam, caries and/or coronal restorations were removed with sterile high-speed burs. After rubber dam application, dental floss was securely tied around the neck of the tooth. The operative field, including the tooth, clamp, and surroundings, were cleaned with 3% hydrogen peroxide until no further bubbling of the peroxide occurred. All surfaces were then disinfected by 5.25% NaOCl solution. After completing the access with another sterile bur under sterile saline irrigation, ProTaper SX was used to open the orifice of the distal canal which was then sealed with Cavit. Sterile saline was used to flush debris within the chamber. The operative field, including the pulp chamber, was then cleaned and disinfected once again as mentioned above. NaOCl was neutralized with 5% sodium thiosulfate, and then sterility control samples were taken from the tooth surface with sterile cotton pellets. Control samples had to be uniformly negative to include the teeth in the study.

First bacterial sample

This sample was taken from both root canals immediately before instrumentation. Sterile saline solution was placed in the pulp chamber, and files # 8 and #10 were used to carry the solution into the canal. The root canal walls were gently filed in order to suspend the canal contents in saline. Once each instrument was removed from the canal, the fluted part of the file was cut off with a sterile wire cutter and allowed to fall into a vial containing 1 ml of thioglycollate broth (Merck, Darmstadt, Germany). Sterile paper points were consecutively placed in the canal to a level approximately 1 mm short of the root apex and used to soak up the remaining fluid in the canal until obtaining a dry one. Paper points transferred to vials containing thioglycollate broth and sent immediately to the microbiology laboratory.

Second bacterial culture

Root canals were instrumented using ProTaper instrumentation technique till F3 and further apical canal enlargement was done using GTX rotary files till size 40/.04 taper. Patency of the apical foramen was checked with a #10 K-file after preparation. The irrigant used was 5.25% NaOCl solution. A 27-gauge needle was used to deliver 5 mL of NaOCl after each file. Each canal was dried by using sterile paper points and then flushed with 5 mL of 5% sodium thiosulfate to inactivate any residual NaOCl. Sterile saline solution was placed in the canals. The root canal walls were gently filed with a sterile GTX 40/.04 file, and the second sample was taken from the canal using sterile paper points as described earlier.

Third bacterial culture

Smear layer was removed from root canals as described by Salman et al (8) but with modification of the agitation time and the mode of activation as follows: canals were rinsed with 2 mL of 17% EDTA and then left filled with this solution for 90 seconds. During the last 30s, EDTA was agitated with the Sonicare CanalBrush, inserted to full working length and pumped vertically within 3 to 5 mm up and down movements. surplus EDTA was suctioned away with the 27-gauge needle. Each canal was then irrigated with 5 mL of 5.25% NaOCl using the 27-gauge needle. This solution was agitated by Sonicare CanalBrush for one minute. After activation, the action of the sodium hypochlorite was stopped by syringing in 5 mL of 5% sodium thiosulphate per canal. The third sample was taken from the canal as described above for the second sample.

Laboratory part

The laboratory procedures were performed at Microbiology Diagnostics and Infection Control Unit, Microbiology Department, Faculty of Medicine, Qassim University. Thioglycollate vials with samples were agitated 30 s on a vortex and 10 fold serial dilutions to 10^{-5} (for S1 samples) or 10^{-3} (for S2 and S3) was made in prereduced anaerobically sterilized buffered salt solution. Petri dishes with anaerobic sheep blood agar were inoculated with 0.1 ml of undiluted sample, as well as each of the other dilutions. Plates were incubated at 37°C for 7 days in an anaerobic glove box containing 5% hydrogen, 10% nitrogen, and 85% CO_2. After incubation, the total CFUs were counted, and actual counts were calculated on the basis of known dilution factors.

Results

Three teeth of the 15 teeth sampled showed bacterial growth for the sterility control of the working field and was excluded from the study.

Bacteria were found in all initial samples (S1). The median value of the number of CFUs in the initial samples was 3×10^5, ranging from 2.9×10^4 to 6×10^6. The mean number was 1.1×10^6. At S2 (after chemomechanical preparation using ProTaper and

GTX 40/.04 and 5.25% NaOCl as an irrigant), 6 of the 12 cases (50%) showed negative culture results. The median number of CFUs in postinstrumentation samples was 7.5×10^2 with a range from 0 to 9.2×10^4. The mean count in S2 samples was 2.1×10^4. After smear layer removal by 17% EDTA for 90 seconds, passive agitation of EDTA for 30 seconds and additional passive agitation of 5.25% NaOCl for 30 seconds (S3), 10 of the 12 (83.3%) cases yielded no cultivable bacteria. The mean count in S3 samples was 7.5×10^1.

Analysis of the quantitative data revealed that the number of CFUs in S2 and S3 was significantly reduced in comparison to S1 (p=0.002 for both comparisons). Significant bacterial reduction was also observed for comparisons involving S2 and S3 samples with regard to number of CFUs (p=0.028). The bacterial profile during treatment for each patient is seen in Table 1 and the mean number of CFUs in all samples are shown in Figure 1.

Table 1 Bacterial Counts for Root Canal Samples of 12 Teeth with Apical Periodontitis Lesions

Case	S1	S2	S3
1	7.3×10^5	1.5×10^3	0
2	2.98×10^5	1.11×10^4	5×10^2
3	6.31×10^4	0	0
4	2.2×10^5	4.6×10^3	0
5	2.9×10^4	0	0
6	3.15×10^6	9.2×10^4	0
7	7.3×10^5	0	0
8	6×10^6	8×10^4	0
9	3.02×10^5	0	0
10	1×10^5	0	0
11	2.1×10^6	7×10^4	4×10^2
12	2×10^5	0	0

Discussion

Our findings show that supplementing the chemomechanical preparation by the use of CanalBrush for 90 s resulted in both decrease of the number of CFUs (P<0.05) as well as the number of cases yielding positive cultures (2 out of 12).

These findings are in accordance with previous studies (9, 15, 16) where agitation of irrigating solution by sonic energy gave comparable bacterial reduction when compared to other supplementing techniques.

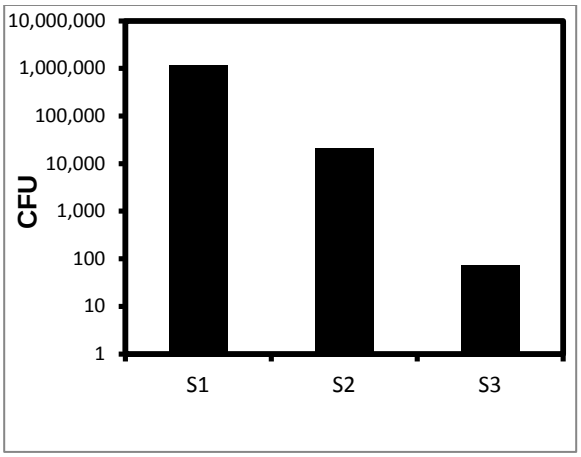

Figure 1 Mean number of CFUs before instrumentation (S1), after instrumentation (S2) and after 90 s Sonicare CanalBrush irrigation (S3).

A recent in vitro study by Pasqualini et al. 2010 (17) evaluated the efficacy of 15 and 30 seconds sonic agitation of NaOCl in reducing bacterial load in the root canal. Statistical analysis revealed that 30 seconds of NaOCl sonic agitation resulted in more bacterial reduction compared with NaOCl irrigation alone.

In contrary, Huffaker et al. 2010 (18) in vivo compared the ability of the EndoActivator (sonic energy) with that of standard syringe irrigation to eliminate cultivable bacteria from root canals and reported no significant differences in the ability of the sonic group and the control group to eliminate cultivable bacteria from root canals (P> .05). These differences may be attributed to differences in the size of apical preparation, design and size of activating instrument, type and concentration of the irrigating solution and the power delivering the sonic amplitude.

In a previous study, Salman et al. (8), found that passive agitation of 17% EDTA with the Sonicare CanalBrush for 30 seconds improved root canal cleanliness via debris removal and smear layer reduction. In this study the same protocol was used for debris and smear layer removal in order to create a favorable environment that might help for better supplemental disinfection by agitating NaOCl for another 60 seconds.

A very important factor in the effectiveness of a sonic device to produce an effective cavitation is size and taper of the apical preparation. Brunson et al. 2010 (19) documented that an apical enlargement to ISO #40 with a 0.04 taper will allow for tooth structure preservation and maximum volume of irrigation at the apical third. Arvaniti and Khabbaz (20) showed almost the same complete canal cleanliness with tapers 0.04, 0.06, or 0.08.

Our experimental model used a wide apical preparation with #40 .04 GTX file which enabled working motion of the CanalBrush (tip diameter 0.25 mm), which allowed free movement of the irrigant. In addition, a higher concentration of NaOCl (5.25%) was used that proved effective antimicrobial action (21).

The positive effect of sonically agitated irrigation may be explained by sonically induced acoustic cavitation, acoustic micro-streaming and heat that may remove and destroy the biofilm (22). An active mode of agitation (pumping) used in this study synergistically combined with mechanical agitation explains the better results achieved with the CanalBrush. Another contributing factor may be the removal of debris and smear layer effectively that resulted in more patent lateral canals and dentinal tubules, this may allow the agitated solution to reach deeply within the dentinal tubules and lateral canals to kill more bioburden bacteria(23).

Conclusions

In conclusion, bacterial counts and cases yielding positive cultures were clearly reduced after chemomechanical preparation and further supplementary effects of the Sonicare CanalBrush agitation of irrigation. Further clinical studies are required to confirm these results. Also, evaluating this supplementing protocol after single file endodontics is required.

References

1. Sjogren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. International endodontic journal 1997;30(5):297-306.
2. Siqueira JF, Jr., Rocas IN. Clinical implications and microbiology of bacterial persistence after treatment procedures. Journal of endodontics 2008;34(11):1291-1301 e1293.
3. Neves MA, Rocas IN, Siqueira JF, Jr. Clinical antibacterial effectiveness of the self-adjusting file system. International endodontic journal 2014;47(4):356-365.
4. Law A, Messer H. An evidence-based analysis of the antibacterial effectiveness of intracanal medicaments. Journal of endodontics 2004;30(10):689-694.
5. Shuping GB, Orstavik D, Sigurdsson A, Trope M. Reduction of intracanal bacteria using nickel-titanium rotary instrumentation and various medications. Journal of endodontics 2000;26(12):751-755.
6. Paquette L, Legner M, Fillery ED, Friedman S. Antibacterial efficacy of chlorhexidine gluconate intracanal medication in vivo. Journal of endodontics 2007;33(7):788-795.
7. Siqueira JF, Jr., Magalhaes KM, Rocas IN. Bacterial reduction in infected root canals treated with 2.5% NaOCl as an irrigant and calcium hydroxide/camphorated paramonochlorophenol paste as an intracanal dressing. Journal of endodontics 2007;33(6):667-672.
8. Salman MI, Baumann MA, Hellmich M, Roggendorf MJ, Termaat S. SEM evaluation of root canal debridement with Sonicare CanalBrush irrigation. International endodontic journal 2010;43(5):363-369.
9. Bago I, Plecko V, Gabric Panduric D, Schauperl Z, Baraba A, Anic I. Antimicrobial efficacy of a high-power diode laser, photo-activated disinfection, conventional and sonic activated irrigation during root canal treatment. International endodontic journal 2013;46(4):339-347.
10. Caron G, Nham K, Bronnec F, Machtou P. Effectiveness of different final irrigant activation protocols on smear layer removal in curved canals. Journal of endodontics 2010;36(8):1361-1366.
11. Jiang LM, Verhaagen B, Versluis M, van der Sluis LW. Evaluation of a sonic device designed to activate irrigant in the root canal. Journal of endodontics 2010;36(1):143-146.
12. Paragliola R, Franco V, Fabiani C, Mazzoni A, Nato F, Tay FR, et al. Final rinse optimization: influence of different agitation protocols. Journal of endodontics 2010;36(2):282-285.
13. Al-Ali M, Sathorn C, Parashos P. Root canal debridement efficacy of different final irrigation protocols. International endodontic journal 2012;45(10):898-906.
14. Rodig T, Dollmann S, Konietschke F, Drebenstedt S, Hulsmann M. Effectiveness of different irrigant agitation techniques on debris and smear layer removal in curved root canals: a scanning electron microscopy study. Journal of endodontics 2010;36(12):1983-1987.
15. Halford A, Ohl CD, Azarpazhooh A, Basrani B, Friedman S, Kishen A. Synergistic effect of microbubble emulsion and sonic or ultrasonic agitation on endodontic biofilm in vitro. Journal of endodontics 2012;38(11):1530-1534.
16. Shen Y, Stojicic S, Qian W, Olsen I, Haapasalo M. The synergistic antimicrobial effect by mechanical agitation and two chlorhexidine preparations on biofilm bacteria. Journal of endodontics 2010;36(1):100-104.
17. Pasqualini D, Cuffini AM, Scotti N, Mandras N, Scalas D, Pera F, et al. Comparative evaluation of the antimicrobial efficacy of a 5% sodium

hypochlorite subsonic-activated solution. Journal of endodontics 2010;36(8):1358-1360.
18. Huffaker SK, Safavi K, Spangberg LS, Kaufman B. Influence of a passive sonic irrigation system on the elimination of bacteria from root canal systems: a clinical study. Journal of endodontics 2010;36(8):1315-1318.
19. Brunson M, Heilborn C, Johnson DJ, Cohenca N. Effect of apical preparation size and preparation taper on irrigant volume delivered by using negative pressure irrigation system. Journal of endodontics 2010;36(4):721-724.
20. Arvaniti IS, Khabbaz MG. Influence of root canal taper on its cleanliness: a scanning electron microscopic study. Journal of endodontics 2011;37(6):871-874.
21. Oliveira DP, Barbizam JV, Trope M, Teixeira FB. In vitro antibacterial efficacy of endodontic irrigants against Enterococcus faecalis. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 2007;103(5):702-706.
22. Ohl CD, Arora M, Ikink R, de Jong N, Versluis M, Delius M, et al. Sonoporation from jetting cavitation bubbles. Biophysical journal 2006;91(11):4285-4295.
23. Kanter V, Weldon E, Nair U, Varella C, Kanter K, Anusavice K, et al. A quantitative and qualitative analysis of ultrasonic versus sonic endodontic systems on canal cleanliness and obturation. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 2011;112(6):809-813.