Conservative shaping combined with three-dimensional cleaning can be a powerful tool: Case series

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Abstract
Conservative endodontics has been introduced about a decade ago. Since then, it has been demonstrated that less canal preparations lead to more dentin preservation resulted in decreased stress on tooth structure, mainly in the coronal third of the root, and potentially a higher resistance to fracture. In addition, smaller and larger canal preparations were comparable with regard to the cleanliness of the root canal. The purpose of this case series was to report on the outcome of root canal treatments following a conservative canal preparation, followed by three-dimensional cleaning technique (intracanal heating and ultrasonic activation of NaOCl).

Keywords: Conservative endodontics; conservative shaping; internal heating; three‑dimensional cleaning; ultrasonic activation

INTRODUCTION
Minimally invasive endodontics has been introduced a decade ago.[1-3] Since then, it has been well established that smaller canal preparations preserving more dentin resulted in decreased stress on tooth structure, mainly in the coronal third of the root, and potentially a higher resistance to fracture.[4-7] In addition, smaller and larger canal preparations were comparable with regard to the cleanliness of the root canal.[7-9] The interest in minimally invasive endodontics was renewed based on these findings.[10] However, it is still unclear if conservative canal preparations will adversely affect the outcome of the root canal treatment, especially that it has been recently shown that smaller tapered instruments resulted in more untouched root canal walls which could result in a reduced ability to remove biofilm attached to the root canal walls.[10] However, a recent study cast doubt on the importance to touch root canal walls during instrumentation.[11] Bacteria remained in oval-shaped canals following conventional preparation and passive ultrasonic irrigation. On the other hand, a noninstrumentation protocol based on intracanal heating and ultrasonic agitation of sodium hypochlorite rendered all the canals bacteria free.[11]

The purpose of this case series was to report on the outcome of root canal treatments following a conservative canal preparation and intracanal heating and ultrasonic activation of NaOCl.

CASE REPORTS
Case report 1
A 50-year-old female patient presented to our private practice complaining of mild discomfort to biting on tooth #2.5, which was confirmed with a biting test. A preoperative intraoral periapical radiograph revealed an incomplete endodontic treatment and the presence of a periapical radiolucency associated with tooth #2.5 [Figure 1a]. The diagnosis of incomplete root canal treatment and symptomatic apical periodontitis was established.

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The bridge was removed, and a nonsurgical endodontic retreatment was performed. The operating field was isolated with rubber dam and the access cavity was performed under a dental operative microscope (DOM) (Kaps, Som 32 operative microscope, Karl Kaps GmbH and Co. KG, Germany). The old root canal filling material was removed using a HyFlex EDM 20/05 rotary nickel–titanium (NiTi) file (Coltene/Whaledent, Altstatten, Switzerland). Small stainless-steel hand files were then used to obtain patency to the working length. However, the canal was blocked, and the desired working length could not be reached. Canal instrumentation was then continued with HyFlex EDM 20/05 to the newly established working length, at the level of canal blockage. The canal was irrigated with 5.25% NaOCl (CanalProTM 5.25%, Coltene/Whaledent, Altstatten, Switzerland) at room temperature each time the instrument was removed out of the canal. NaOCl was delivered with a NaviTip 30G side-vented needle (CanalPro, Coltene/Whaledent, Altstatten, Switzerland) placed at working length. At the end of the preparation, the canal was irrigated with 17% ethylenediaminetetraacetic acid (EDTA) kept in the canal for 60 s, followed by 5 mL of saline. Finally, the canal was filled with room temperature 5.25% NaOCl which was heated in the canal for 8 s using a Touch’n Heat XF (size 0.30 mm and 0.04 mm/mm taper) electric heat carrier (Analytic Endodontics, Orange, CA, USA), attached to a System B unit (Analytic Endodontics). The temperature was set at 150°C. The heat carrier was inserted to the working length. During the heating procedure, the heat carrier was moved with small, in-and-out-movements in the canal. Care was taken to avoid wedging the heat carrier in the canal. Then, an ultrasonic file/tip (Titanium activator tip 20/02, Coltene-Micro-Mega, Whaledent, Altstatten, Switzerland) mounted in a cordless ultrasonic generator (EndoUltra, Coltene-Micro-Mega, Whaledent, Altstatten, Switzerland) was inserted to WL and activated for 30 s. The cycle of intracanal heating and ultrasonic activation of NaOCl (three-dimensional [3D] cleaning) was repeated 5 times. The canal was flushed with 3 mL room temperature 5.25% NaOCl after each 3D cleaning cycle to refresh the solution. The root canal was dried with absorbent paper points. The obturation was performed with gutta-percha and sealer using a modified continuous wave of condensation[12] and sealer (GuttaFlow Bioseal, Coltene/Whaledent, Altstatten, Switzerland) [Figure 1b]. At 6- and 12-month follow-ups, the tooth was asymptomatic. Radiographic examination revealed complete healing [Figures 1c and d].

Case report 2
A 52-year-old female was referred to our private practice for a root canal treatment on tooth #4.6 following the detection of apical disease on a cone-beam computed tomography (CBCT) image [Figure 2a]. The diagnosis of pulp necrosis and asymptomatic apical periodontitis was confirmed, and a root canal treatment was recommended. A preoperative radiograph was taken [Figure 2b]. The operating field was isolated with rubber dam and the access cavity was performed under a DOM (Kaps, Som 32). The canals were shaped with HyFlex EDM 20/05. Irrigation during the procedure, 3D cleaning, canals drying, and obturation [Figure 2c] were carried out as described in case report 1. At a 1-year follow-up, the tooth was asymptomatic, and a CBCT demonstrated complete healing [Figure 2d].

Case report 3
A 22-year-old male was referred to our private practice for a root canal treatment on tooth #3.4 following the detection of apical disease on a periapical radiograph [Figure 3a]. The diagnosis of pulp necrosis and asymptomatic periodontitis was confirmed, and a root canal treatment was recommended. The operating field was isolated with rubber dam, and the access cavity was performed under a DOM (Kaps, Som 32). It was not possible to reach the desired working length during the initial canal scouting due to the presence of a complex anatomy in the apical third [Figure 3b]. WL was established at 2–3 mm short of the radiographic apex. The canals were shaped with HyFlex EDM 20/05 as

![Figure 1:](image-url)
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Figure 2: (a) Preoperative cone-beam computed tomography showing tooth #4.6 associated with two periapical radiolucencies attached to mesial and distal roots and inflammatory apical resorption in the mesial root. (b) Preoperative intraoral periapical radiograph showing tooth #4.6 with a small periapical lesion attached to mesial root and also inflammatory apical resorption can be noted. (c) Postoperative intraoral periapical radiograph showing the obturation of the root canals after treatment. The conservative access can be seen and the presence of only one mesial and one distal canal. (d) A cone-beam computed tomography 1-year follow-up showing healing of both periapical lesions.

Figure 3: (a) Preoperative intraoral periapical radiograph showing tooth #3.4 with a periapical lesion. (b) Postoperative intraoral periapical radiograph showing the obturation of the root canals after treatment. The conservative access can be seen. (c) An intraoral periapical radiograph of 1-year follow-up showing the healing.

DISCUSSION

The outcome of endodontic therapy depends on the ability to kill and remove bacteria from infected root canals. Due to the challenges associated with microbiological studies, the cleaning ability of root canal preparations was considered as a surrogate endpoint to predict outcome. There is a concern that conservative canal preparations may not result in an adequate cleaning and disinfection. However, there is evidence that smaller and larger canal preparations are comparable with regard to their cleaning and disinfecting abilities. Therefore, the expected outcome should be similar.

This series of three cases reported on the clinical and radiographic outcomes of the endodontic treatment of infected root canals associated with apical disease. Conservative canal preparations were done using a NiTi rotary instrument with a diameter of 0.20 mm at the tip and a constant taper of 0.05 mm/mm. A final 3D cleaning was performed in all three cases following a protocol previously described. The protocol is safe with regard to heat generation and irrigant extrusion. Temperature rise on the surface of the root did not exceed 42°C which was below the temperature (47°C) at which damage to the periodontal tissues might occur. In addition, NaOCl extrusion was not observed during 3D cleaning despite a decreased viscosity of the irrigant when heated.

It was not surprising that healing and resolution of clinical signs and symptoms occurred in case report 2, in which the root canal treatment was performed to the desired length.

It was noteworthy that healing occurred in cases 1 and 3 where the root canal treatment could be considered incomplete, a working length being established at 3 mm from the radiographic apex. A working length shorter than 2 mm from the radiographic apex would result in a lower healing rate. In the opinion of the authors, the use of 17% EDTA followed by 3D cleaning contributed to an adequate root canal cleanliness and disinfection. This protocol has been recently shown to result in a significantly better
disinfection and cleanliness compared to passive ultrasonic irrigation.[11,13,20-22] The smear layer produced during instrumentation minimizes the penetration of disinfectants into the dentinal tubules and their antibacterial activity in dentin. Irrigation with 17% EDTA removes smear layer blocking dentinal tubules, resulting in cleaner canals and a better penetration of warm NaOCl in the dentinal tubules and lateral anatomies following a conservative canal preparation.[13] Amato et al. demonstrated that, in canals with a conservative shape (size 30 at the tip and a 4% taper), 3D cleaning was the only irrigation protocol allowing the dissolution of pulp tissue in artificial lateral canals.[20] In addition, 17% EDTA allows better biofilm elimination by breaking its attachment to the root canal walls.[21] Furthermore, the lower NaOCl viscosity caused by heating the irrigant to 150°C could cause a turbulent flow,[18] which might result in detaching microfilm off the canal walls.

A recent study has shown that canal cleanliness following conservative canal preparation with a 20/04 NiTi rotary instrument and passive ultrasonic irrigation was comparable to larger canal preparation (40/04) in oval-shaped canals.[15] 3D cleaning would improve the cleaning ability of root canal preparations, including conservative preparations, considering the additional benefits from irrigation with 17% EDTA, and intracanal heating and ultrasonic agitation of NaOCl.

It was recently shown that less root canal walls were touched with smaller taper instruments, which could result in a lower ability to remove biofilm.[10] However, a recent study showed that it was not necessary to touch root canal walls to kill bacteria.[11] It could be assumed that the sequential action of 17% EDTA and 3D cleaning compensated for the reduced percentage of untouched and noninstrumented root canal walls, resulting in an adequate disinfection.[11]

The long-term success of endodontic treatment (as mentioned above) is basically based on adequate 3D cleaning of the endodontic space after root canal shaping, followed by complete 3D obturation of the complex root canal system. The endodontic space is composed of areas that are easily accessible to hand and rotary instruments (the main canals) and as confirmed by many clinical and histological studies, some spaces that are difficult to access or even inaccessible (isthmuses, loops, lateral canals, ramifications, deltas, and dentinal tubules).

For that reason, mechanical shaping is not able to reach all areas of the complex root canal system, regardless of the technique used, leaving parts of the root canals untreated. Therefore, it is necessary to carry out endodontic biochemical cleaning (for the accessible and inaccessible areas). Once these areas have been cleaned, they can be filled and obturated with gutta-percha and sealer during the obturation phase.[24-26]

When it comes to obturation, there are different techniques, mainly warm and cold techniques. In the literature, there are no significant differences regarding whether warm obturation techniques are better than cold techniques, but it is logical and well demonstrated that the warm filling techniques can fill the endodontic space in a 3D way, as also well demonstrated in the cases presented in this work.

As already mentioned, it is not only the main canal that is present in the endodontic space, but there are different anatomical configurations. Therefore, if we use cold filling techniques, most of these spaces will not be filled. In brief, in the pursuit of excellence, we must try to clean almost all of the endodontic space and then fill it nearly completely.[12]

CONCLUSIONS

Healing of periapical disease was achieved in the above-reported cases following conservative root canal preparation, irrigation with 17% EDTA, and intracanal heating and ultrasonic activation of NaOCl. Previous evidence demonstrated that conservative canal preparation followed by irrigation with 17% EDTA and 3D cleaning resulted in better disinfection and cleanliness compared to conventional passive ultrasonic irrigation. Therefore, it was expected that healing of periapical disease occurred in the three reported cases. This protocol can be valuable in the endodontic treatment of infected teeth, especially for the management of root canals with complex anatomies and clinical challenges such as blocked canals.

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Conflicts of interest
There are no conflicts of interest.

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