Germ reduction during endodontic treatment of a geminated tooth with a 970 nm laser

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ABSTRACT
Failures in the context of endodontic treatment can usually be attributed to inadequate germ reduction, including with untreated root canal sections. Therefore, effective germ elimination during endodontic therapy is absolutely necessary. The entirety of the preparatory procedures for the root canal prior to placement of a filling is referred to as chemomechanical preparation of the root canal. Root canal rinsing is an essential part of this treatment phase since mechanical preparation of the root canals alone does not normally result in adequate germ elimination. Since, up to now, it has usually not been possible to eliminate all germs in the root canal, adjunctive antimicrobial procedures can be expediently integrated in an endodontic treatment concept.
This case describes the endodontic treatment of a geminated tooth (12) with apical periodontitis and partial pulpal necrosis. A microbiological germ analysis shows the adjunctive antimicrobial effect of the 970 nm laser. Thanks to enhanced germ reduction, it can be assumed that the chances of preserving the tooth are improved. A planned surgical procedure within the scope of a treatment plan to improve the initial morphological situation for healing could possibly be avoided.

KEYWORDS
Diode laser, 970 nm, pulpal necrosis, apical periodontitis, microbiology, geminated tooth

Introduction

Effective germ elimination during endodontic treatment is absolutely necessary[1,2] because treatment failure can often be attributed to the inadequate reduction of germs. The bacterial flora in endodontic infections is related to the flora in the oral cavity and has a bacterial population of between 102 and 107 different germs per infected root canal.[3] Since mechanical preparation of the root canal alone usually does not result in the sufficient elimination of germs, chemical disinfection of the root canal is an essential part of the work phase to be carried out before the root canal filling, which is referred to as a whole as chemomechanical preparation of the root canal. In the process, over 95% of the microorganisms in the endodontium can be eliminated.[4] Even though many methods and rinse solutions for chemical preparation are available, sodium hypochlorite in a concentration of 0.5–5 % is still recommended as the first choice. In order to further improve germ reduction in the root canal, adjuvant antimicrobial procedures may also be used. This includes the use of laser energy, which can be performed athermally (e.g., as part of photodynamic therapy) or thermally. The antimicrobial properties of laser systems such as the diode laser are principally based on thermal effects. In this regard, a 980 nm laser is ascribed as having an antibacterial effect which can be demonstrated up to the depth of dental hard tissue.[5]

Fig. 1: X-ray of tooth 12 before treatment. A geminated tooth with two distinctive root structures is evident. Furthermore, internal resorption was suspected. – **Fig. 2:** Clinical picture of tooth 12 after systemic antibiosis by the previous dentist. The vestibular view does not show any signs of an endodontic-related acute inflammatory event. – **Fig. 3:** Clinical picture of tooth 12 from palatal. The partially irregular morphology of the tooth crown indicates the formation of a geminated tooth.

Case report

On May 6, 2013, a 12-years old-female patient came to the Department of Operative Dentistry and Endodontology at the Medical Center for Dental, Oral and Maxillofacial Sciences of the University Hospital of Gießen and Marburg in Marburg, Germany. She had been complaining of swelling on the right side of the face for four weeks, which subsided after being treated systemically with antibiotics by her regular dentist. Furthermore, the referring dental practitioner reported that tooth 12 exhibited grade II mobility and a distal probe depth of 7 mm with secretion discharge. The X-ray taken in the dental practice showed tooth 12 to be geminated with two distinctive root structures (Fig. 1).

Furthermore, internal resorption was suspected. There was no historical evidence to indicate a past trauma; however, the regular dentist reported that a mesiodens had been removed in 2007, without elaborating further on the surgery performed. In a follow-up appointment on April 9, 2013, no clinical symptoms or mobility of tooth 12 were reported (Figs. 2 and 3).

Since, despite a positive sensitivity test, an apical translucency in the apical area of the mesial part of the root was visible on the X-ray, pulpal necrosis in combination with chronic pulpitis of the distal part was diagnosed because it had to be assumed that the pulp chamber of the mesial and distal root canal opened into the same coronal pulp chamber.

Prior to the procedure, the different treatment options were discussed with the parents and the young patient. Due to the suspicion of internal resorption and the apical lesion on the mesial root, the prognosis following conventional root canal treatment was assessed as only partially successful. Root canal treatment with subsequent surgical resection of the mesial part of the root and curettage of the apical granulation tissue[6] was stated as the classic treatment recommendation in order to handle the chronic inflammatory event at this point. In addition, classic root canal treatment with adjunctive laser irradiation of the inner canal walls was addressed. The thermal effect of the laser could also have an impact on the large apical mesial lesion, so that the secondary surgical procedure may not be necessary. Given that with this treatment approach impairment of possible subsequent resection of the mesial root was not expected, the parents together with their daughter chose this option.

After infiltration anesthesia of tooth 12 with Ultracain D-S 1 : 200.000 (Sanofi-Aventis, Frankfurt/Main, Germany), trepanation and exposure of the coronal pulp cavity was performed employing a rubber dam. Tissue with a strong blood supply in the distal and necrotic tissue in the mesial root canal was ascertained as the trepanation finding (Fig. 4).

Thus, the suspected clinical diagnosis was confirmed. After removal of the root canals (Fig. 5), coronal enlargement of the canal openings was performed with Gates-Glidden drills using the step-down technique and endometric determination of the canal lengths.

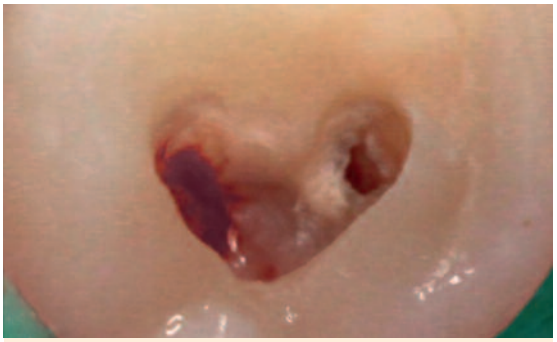

Fig. 4: Trepanation finding after opening the pulp cavity. Tissue with a strong blood supply in the distal and necrotic tissue in the mesial root canal.

Due to the suspicion of an irregular canal pathway, a silver point image was produced with the previously electronically determined lengths (Fig. 6).

Chemomechanical preparation of the root canals followed using hand instruments of up to ISO size 35 and the subsequent step-back technique with 1 mm increments up to ISO size 50 and regular rinsing with a 2.65 % solution of sodium hypochlorite. Afterwards, the canals were filled with a paste containing a glucocorticoid and an antibiotic (Ledermix, Riemser, Greifswald, Germany) since this compound is known to have antiresorptive properties.[7]

At the following treatment session, the two root canals looked different after removing the temporary protective filling. While there were no noticeable problems distally, mesially there was slight blood and secretion discharge. After rinsing the canal system with a 2.65 % solution of sodium hypochlorite, a microbiological sample was taken using sterile paper points. Laser irradiation of the inner canal walls was then carried out for one minute each by moving a laser fiber from an apical to coronal direction. For this, the class IV SIROLaser Advance (Sirona, Bensheim, Germany) 970 nm

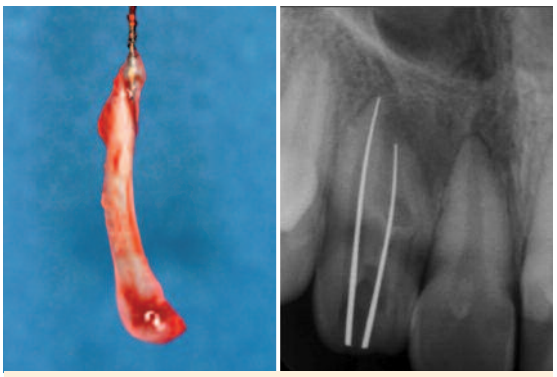

Fig. 5: Removed pulp tissue from the sensitive distal root canal of tooth 12. – **Fig. 6:** Silver point image for radiologically assisted determination of root length and canal pathway.

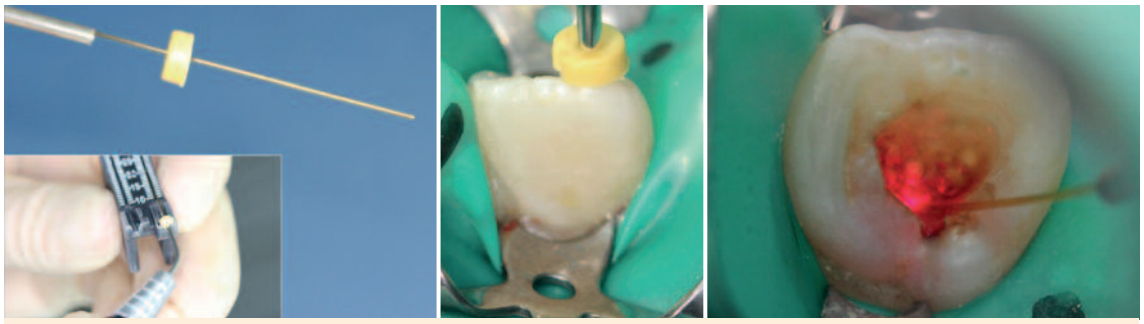

Fig. 7: Use of a silicone stopper to mark the working length of the laser fiber in the root canal. – **Fig. 8:** Clinical picture of the laser fiber inserted into the root canal along its complete working length. – **Fig. 9:** Laser irradiation of the inner canal walls for 1 minute per canal with a laser fiber from an apical to coronal direction.

diode laser was used with software version 2.0.6 and the dental team was equipped with the appropriate laser protective glasses for the 970 nm wavelength. The treatment room was designated as a laser workplace from the outside. In addition, a warning light was activated which was located at the entrance door to the treatment area. For the reduction of germs in the root canal, the manufacturer recommends a setting of 1.5 W with pulsed frequency (PF), a duty cycle of 50% and a frequency of 15 Hz. However, since in this case, an adjunctive effect on the healing of the apical lesion was intended, the presetting "gangrene treatment" was selected which has a setting of 3 W with a pulsed frequency (PF), a duty cycle of 50 % and a frequency of 20 Hz. The handpiece was used with a 200 µm (core diameter) fiber and was activated via the finger switch (Figs. 7–9).

Following final rinsing with a sterile physiological saline solution, another microbiological sample was taken with sterile paper points (Figs. 10 and 11).

In addition, another temporary obturation was carried out after filling the canal walls with the glucocorticoid/antibiotic paste and filling the canal lumen with a $Ca(OH)_2$ paste (Ultra-Cal, Ultradent, Cologne, Germany).

The microbiological analysis of the canals using a real-time PCR procedure resulted in a total bacterial count of 7.3×10^3 mesially and 4.2×10^3 distally after rinsing with sodium hypochlorite. After subsequent laser irradiation, no further bacteria could be detected in either of the two canals.

During the final treatment session, no blood or secretion discharge from the canal system was observed after removal of the temporary root canal dressing. A suspected resorption lacuna in the middle area of the mesial canal on the basis of the radiological image was not clinically evident during probing of the canal walls. Therefore, a gutta-percha root canal filling was carried out with vertical and horizontal condensation using the MTA Fillapex sealer based on a mineral trioxide aggregate (Angelus, Londrina, Brazil) without a thermoplastic root filling technique. After a radiological check-up of the root filling (Fig. 12), the root canal openings were sealed (SDR, DENTSPLY DeTrey, Constance, Germany) with an adhesive technique (AdheSE, Ivoclar Vivadent, Schaan,

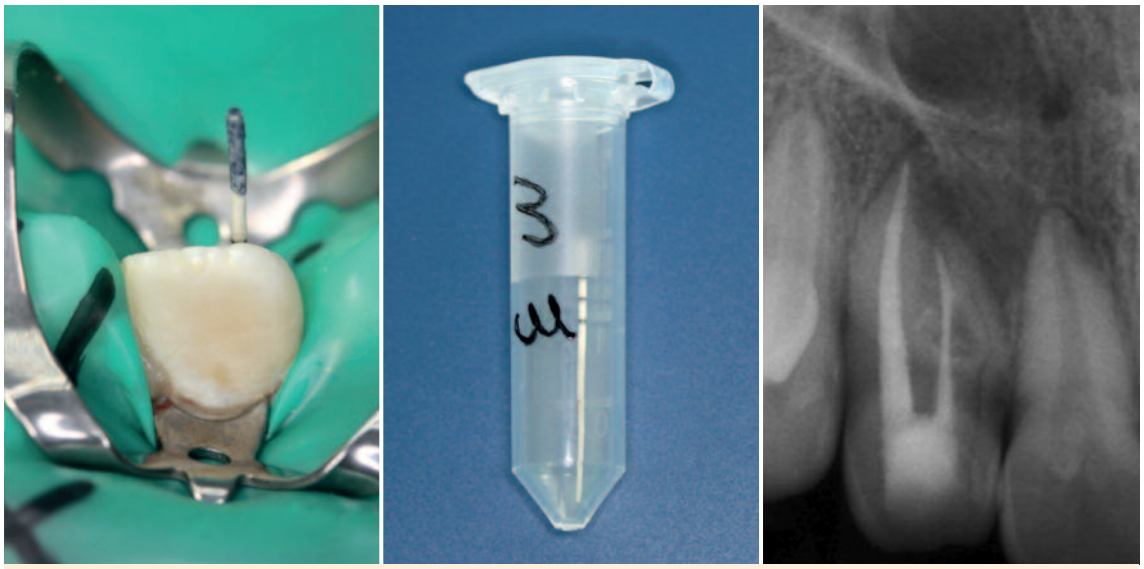

Fig. 10: Microbiological sampling after laser irradiation of the inner canal walls with a sterile paper point. – **Fig. 11:** Paper point prepared for transporting for real-time PCR analysis after removal from the treated root canal system. – **Fig. 12:** Follow-up X-ray image after root canal filling. Compared to the original image, a tendential decrease in the apical change is noticeable.

Liechtenstein) and the trepanation cavity was filled with a nano-filled composite resin (GrandioSO, VOCO, Cuxhaven, Germany).

A non-physiological mobility grade and increased probing depth could no longer be determined at this point. A comparison of the original X-ray image with the follow-up image after root canal filling showed a tendential decrease in size of the mesial apical change. However, additional follow-up check-ups are needed to assess the long-term success of the endodontic treatment carried out. If clinical symptoms of a chronic or acute inflammation appear or the radiological noticeable changes become larger in the course of follow-up sessions, implementation of the original treatment plan with surgical resection of the mesial part of the root should be considered. Under normal circumstances, the next follow-up is scheduled for three months time.

Concluding remarks

In addition to shaping the root canal system, the goal of chemomechanical root canal preparation is the extensive elimination of germs from the canal system. Conventional rinse protocols are effective; however, the elimination of germs can be further enhanced with a diode laser.[8] Based on this observation, adjunctive diode laser irradiation was used in this case to achieve extensive disinfection of the canal system and possibly also the adjacent structures involved in order to forego surgical intervention. To this end, additional germ reduction could be confirmed by means of a microbiological analysis. The absence of indications of chronic or acute signs of inflammation as well as the slight decrease in the radiologically identifiable apical lesion confirms the chosen treatment approach. Nevertheless, the findings are subject to the follow-up check-ups in order to assess the long-term success of the treatment.

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