Introduction

Endodontic therapy is the treatment of choice for teeth with apical periodontitis and Internal Root Resorptions (IRR) as it aims to eliminate bacterial contamination, granulation tissue and blood supply of the clastic cells that are commonly reported to be involved with the process.1, 2

Sodium hypochlorite (NaOCl) is arguably chosen as primary endodontic disinfection solution. Nevertheless, the ideal concentration, temperature, contact period and extent of clinical effectiveness of NaOCl remains under discussion.3–6 Moreover, several clinical factors (e.g. root perforations, absence of apical constriction etc.) may accidentally induce NaOCl extrusion into periapical tissues with potentially severe and hazardous consequences.7–9

In spite of this, several clinical strategies were reported with regards to the management of root resorptions,10 their scientific evidence is limited to case reports and few present alternative disinfection techniques.11–14 Lasers have long been presented as promising alternatives to conventional endodontic procedures.15 Each laser wavelength has a specific absorption coefficient for every tissue16 and erbium lasers demonstrate a high absorption coefficient for both water/aqueous solutions and hydroxyapatite.17, 18 Thus, the rationale for using erbium lasers in endodontics may be briefly described as: (1) the ability of infrared light to interact with aqueous solutions and produce cavitation effects capable to remove smear layer, dentinal debris and filling materials from the root canal walls19–21 and (2) the ability of infrared light to propagate into the dentinal tubules, achieving significant bactericidal effects deeper than conventional chemical solutions.22, 23

Accordingly, the 2,780 nm Er,Cr:YSGG laser has been reported as an effective method for smear layer and debris removal in comparison with EDTA irrigation, hand activation or even ultrasonic activated irrigation,19, 24–27 resulting in a significant clearance of canals/isthmuses prior obturation28 and less microleakage of root canal filling materials.29 Moreover, it has also been shown to be suitable for deep...
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root canal system disinfection and to allow irriga-
tion solutions to travel apically.22, 30–32 In addition, 
Er,Cr:YSGG laser irradiation has been shown to pro-
duce clinically safe temperature increments along 
the root canal walls, 32–35 together with absence of 
molecular dentine changes, signs of melting or car-
bonisation.18, 34, 36

Previously, laser-assisted endodontic protocols 
consisted of using plain fibres (with a straightforward 
emission beam profile). Generally, these fibres were 
placed in the main canal and withdrawn from apical 
to coronal in a rotating motion. However, such tech-
nique is known to be sensitive and to produce incon-
sistent results.18, 35, 37

Designed to overcome such limitations, radial fir-
ing tips (RFT) present a beam expansion pattern—
promoted by the tip geometry—that favours a ho-
mogeneous energy distribution along the root canal 
wall. In contrast with plain fibres, RFT have been 
shown to produce consistently relevant in vitrro 
results. They are known to spread their energy in 
the direction of the dentinal tubules,22 to produce lower 
temperature increments,35 to increase cavitation ef-
facts towards the root canal walls without harming 
periapical tissues,36 to be highly efficient in bacterial 
and biofilm reduction39,40 and to allow irrigating 
solutions to travel apically by overcoming the airlock 
effect.41

Although some clinical studies have demonstrated 
the potential benefits and long-term outcomes after 
laser-assisted treatments,42, 43 there is no mention of 
any IRR case treated with a laser-assisted technique. 
The report of distinct clinical cases with long-term 
follow-ups may be an additional support for an evi-
dence-based proof of concept.

Case report

A 31-year-old female patient presented for con-
sultation, complaining of recurrent swelling and 
painful episodes related to tooth 11, which had been 
treated with antibiotic prescriptions over the past 
few years. The patient’s medical history was not con-
tributory. The patient reported trauma to her upper 
teeth when she was 20 years old. After performing 
clinical and radiographic examinations, tooth 11 was 
diagnosed with pulp necrosis with internal root re-
sorption and apical periodontitis. The tooth was 
slightly tender to percussion, periodontal probing 
depths were considered normal (< 3 mm), and there 
was no discoloration (Figs. 1 & 2).

Approval for the study protocol (N_682/068) was 
obtained. Treatment options were discussed and the 
required consent obtained (Helsinki Declaration, re-
vised in Edinburgh 2000). No financial incentive was 
offered (i.e., patient was responsible for the usual 
root canal treatment fee).

Under local anaesthesia (2% lidocaine with 
1:100,000 epinephrine, Scandonest, Saint Maur 
des Fossés, France) and rubber-dam isolation (Hy-
genic Non-Latex Rubber Dam, Coltène/Whaledent, 
Germany), an access cavity was prepared with a 
high-speed carbide bur (SS White, Lakewood, NJ) 
and Zekrya Endo burs (DENTSPLY Maillefer, Ballai-
gues, Switzerland). The working length (WL) was 
electronically established (Root Zx mini, Morita, 
USA) as 1 mm short of the biological apex of the root 
and confirmed by radiography. No bleeding was 
noted from the root canal. Patency was confirmed 
with an ISO#20 K-file and root canal preparation 
was performed with the Protaper system (DENTSPLY 
Maillefer, Ballaigues, Switzerland) up to an F5 (#50.05)
Instruments. Root canal irrigation was performed between each file with 3 ml of sterile saline solution (Monoject 27G, Kendall-Covidien, USA). No chemical irrigants or inter-appointment dressings were used.

For smear layer removal and root canal disinfection, a previously reported laser-assisted protocol was adopted. Following root canal preparation, the main canal was filled with distilled water and laser irradiation was performed with the 2,780 nm Er,Cr:YSGG laser (Waterlase MD; Biolase Technology, San Clemente, CA) and radial firing tip (RFT2 Endolase, Biolase Technology; calibration factor of 0.55) which was 270 µm in diameter, with panel settings of 0.75 W, 20 Hz (37.5 mJ), 140 µs pulse, 0% water and 0% air. The tip was placed at the working length and irradiation was performed, approximately, at the speed of 2 mm/s until it reached the most coronal part of the canal. The irradiation procedure was repeated four times: 2x with the canal filled with distilled water (for smear layer and granulation/pulp tissue removal) followed by 2x in dry conditions (to achieve deep dentine penetration and disinfection), with approximately 15 seconds between each irradiation. Afterward, a sterile cotton pellet was placed in the pulp chamber, and the access cavity was sealed with a reinforced zinc-oxide eugenol intermediate restorative material (IRM, DENTSPLY).

At the second appointment after seven days, the patient reported pain, tenderness to percussion and swelling upon questioning. Under local anaesthesia and rubber dam isolation, the canal was re-accessed. The main canal was filled with distilled water and laser irradiation was performed using a 320 µm radial firing tip (RFT3 Endolase, Biolase Technology; calibration factor of 0.85), with panel settings of 1.25 W, 20 Hz (62.5 mJ), 140 µs pulse, 0% water and 0% air. The tip was placed at the working length and irradiation was performed, approximately, at the speed of 2 mm/s until it reached the most coronal part of the canal. The irradiation procedure was repeated four times: 2x with the canal filled with distilled water (for smear layer and granulation/pulp tissue removal) followed by 2x in dry conditions (to achieve deep dentine penetration and disinfection), with approximately 15 seconds between each irradiation. After irradiation, a final rinsing of sterile saline solution (3 ml) was performed, and the canal was dried with sterile paper points, checking for the absence of any suppurating or exudate. Filling was performed with a #50.05 auto-fit gutta-percha cone (DENTSPLY Maillefer, Ballaigues, Switzerland) using a down pack-backfill technique (Calamus, DENTSPLY Maillefer) and a resin-based endodontic sealer (Topseal, DENTSPLY Maillefer). Both down pack motion and gutta-percha injection were performed with low pressure and extreme caution due to the root weakness. Radiographic images were taken immediately (Fig. 3) and after one (Fig. 4), two (Fig. 5) and three years (Figs. 6 and 7). Over this follow-up period, the tooth remained completely asymptomatic and periapical healing was noticed.

Discussion

Due to its insidious pathology, the following clinical findings enabled the establishment of the diagnosis of IRR: initial absence of bleeding from the root canal confirming a necrotic pulp, normal probing depth (< 3 mm) and the complete resolution of apical radiolucency after endodontic treatment, followed by the cessation of the progression of resorption.

Given that there is insufficient clinical data supporting the superiority of any chemical irrigation regimen and no guidelines for the management of low-occurrence pathologies such as IRR, case reports may be of special relevance while adequately reporting new disinfection techniques and their clinical outcomes. The present protocol adopted the use of an Er,Cr:YSGG laser and innocuous irrigants (e.g. saline solution as irrigation and distilled water for laser activation). The decision was primarily based on the assumption that IRR lesions may perforate external root surfaces without being detectable on conven-
While trying to achieve significant bacterial reductions, our protocol contrast with that recently reported by Christo et al. which used low concentrations of NaOCl and an Er:Cr:YSGG laser-activation technique. In fact, this protocol has been shown not to improve the antibacterial effects of NaOCl and, therefore, the activation of NaOCl may seem inadequate for the management of such conditions. In accordance, it was shown that the use of Er:Cr:YSGG laser with relatively high output powers to activate irrigants such as NaOCl or EDTA may result in a high magnitude of pressure changes capable to induce irrigants extrusion during laser-activated irrigation.

In order to obtain adequate microbial control calcium hydroxide (CH) is often recommended for the management of IRR lesions. However, the use of CH as an intra-canal medication consistently fails to present improved clinical outcomes. In the present report we may support that CH medication should not be considered crucial as antimicrobial agent and neither as essential to stop the IRR progression.

In fact, the decision process for not using CH as intra-canal medication during the endodontic treatment of IRR was also supported by the following criteria: (1) no irrigation technique is completely able to remove CH from simulated internal root resorption cavities and (2) the long-term exposure to CH can cause a significant reduction in the mechanical properties of radicular dentine.

Due to their biophysical properties, lasers have long been seen as a promising disinfection tool in endodontics. However, each wavelength demonstrates different biophysical interactions with the main radicular dentine components. The high absorption coefficients in both water and hydroxyapatite may justify the selection of the Er:Cr:YSGG laser (λ=2,780 nm) for both smear layer removal and disinfection purposes. Conflicting evidence while using other wavelengths can be found consistently.

In the present report, the laser protocol consisted in two irradiations with distilled water in the main canal followed by two irradiations in dry conditions, respectively for smear layer removal and disinfection purposes. The rationale was that in wet conditions the Er:Cr:YSGG laser can promote beneficial cavitation effects inside the main canal without increasing the extrusion of irrigants. Moreover, water-mediated cavitation has been shown to be highly effective for the removal of dentin debris in comparison with conventional or passive ultrasonic irrigation.