Roland Weiger

Root canal irrigation: How much activation is necessary?

Introduction: Current systems for activating irrigation solutions mainly use sound, ultrasound or laser. The simple form of manual dynamic activation must be differentiated.

Methods: In comparison to the conventional irrigation technique, the described methods generally result in a greater cleaning effect under experimental conditions (removal of pulp tissue and debris, penetration depth into the root dentin, antibacterial effect, removal of calcium hydroxide). Gradual differences seem to be the result of the chosen experimental setup and the material used.

Result and Conclusion: Given that comparative clinical studies are largely lacking and the advantages of a defined irrigation protocol involving the activation of the irrigation solution have not been clinically proven so far, only a recommendation for their application can be derived from existing experimental studies. Also, with respect to the activation method, different approaches can be justified.

Keywords: activated root canal irrigation; laser; root canal preparation; root canal treatment; ultrasound

Departement of Periodontology, Cariology and Endodontology, University Center for Dental Medicine Basel (UZB), Basel, Switzerland: Prof. Dr. Roland Weiger
Translation from German: Cristian Miron
Citation: Weiger R: Root canal irrigation: How much activation is necessary? Dtsch Zahnärztl Z Int 2021; 3: 64–70
Peer-reviewed article: submitted: 01.10.2020, revised version accepted: 27.10.2020
DOI.org/10.3238/dzz-int.2021.0008

Figure 1 A new type of rotary root canal instrument (XP-endo Finisher, FKG Dentaire, La Chaux-de-Fonds, Switzerland)

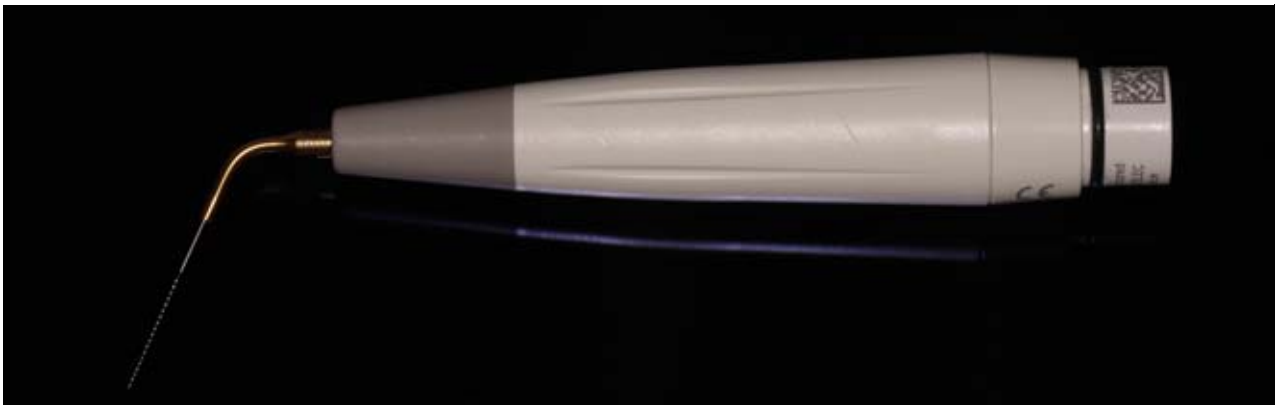

Figure 2 Ultrasound driven handpiece with Irri S file (VDW München, Germany)

Introduction

Besides the mechanical preparation of the main root canals, a sufficient chemical disinfection of the root canal system by means of root canal irrigation is required. In this manner, the term chemo-mechanical preparation is derived. The reason for this lies in the limitations of mechanical preparation and the complexity of the root canal system. Hand instruments as well as rotary root canal instruments do not prepare the canal walls of the main root canals entirely and do not reach the side canals of the root canal system. Despite careful preparation, at least 35 % of the inner surfaces of root canals usually remain untouched [11, 21]. This is why efficient root canal irrigation is required to clean isthmi, side canals and open dentinal tubules in addition to the main root canals, and depending on microbial colonization, for disinfection.

In the best case, the contribution of a particular irrigation technique to the clinical success of endodontic treatment can be evaluated [4]. The prerequisite for a comparative clinical study would be that all other relevant and currently known influencing variables are largely identical or equally distributed within the comparison groups. In view of the large number of variables that can influence the prognosis of a tooth after root canal treatment, unequivocal evidence for a single parameter in prospective, randomized clinical studies seems extremely difficult. The number of cases and recall rates required for this are so high that, depending on the question being addressed, the implementation would be associated with very great effort.

What potential could lie in the activation of irrigation solutions is answered mostly by older clinical studies, among others, that managed without the aid of modern irrigation techniques. As early as 1961, Grahnen and Hansen [10] reported a high success rate of 81 % four to five years after root canal treatment. The work of Sjögren et al. which was published 30 years later [23] and a review by Ng et al. from 2011 [19] likewise confirm that the healing rates – using conventional irrigation methods – are in a similarly high range. From this point of view, the potential for activation of irrigation solutions can be classified as limited. If, on the other hand, the lower root canal treatment success rates that are achieved in ordinary practice conditions [5, 31] are used as a reference point, the table turns, and the question arises of whether methods for activating irrigation solutions under these conditions could make a significant contribution, provided that they are efficient and easy to implement. On the basis of these considerations, this paper outlines the most important methods for the activation of irrigation solutions, and it summarizes the findings, which have primarily been published in the last 5 years in the context of in vitro and in vivo studies.

Goals of activated root canal irrigation

The activation of an irrigation solution is intended to increase the well-known and positive effects of conventional irrigation techniques when combined with conventional irrigation solutions such as sodium hypochlorite – especially in those areas

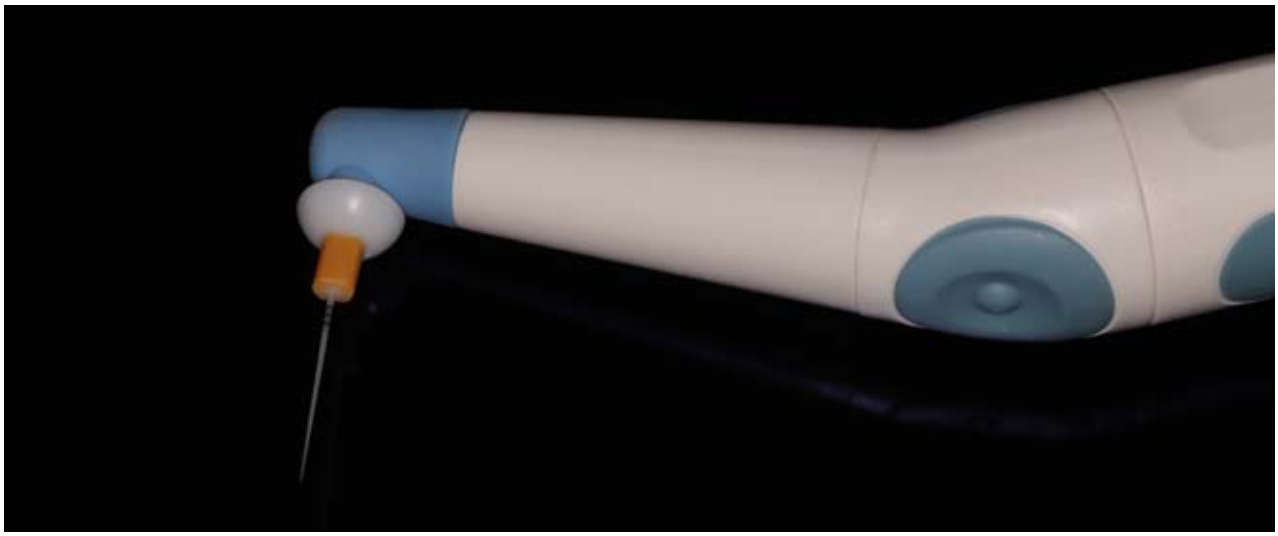

Figure 3 Special sound-activated tips for the EndoActivator (Dentsply Sirona York, PA, USA)

Figure 4 Special sound-activated tips from Eddy (VDW, München, Germany)

of the root canal system that are not accessible to root canal instruments. Essentially these are:

a. Removal of pulp tissue, tissue residues as well as microorganisms, fungi and viruses
b. Dissolving and removal of dentin debris (including the smear layer)
c. Destruction and removal of biofilm
d. Antibacterial effect and neutralization of bacterial toxins
e. Removal of intracanal deposits (e.g. calcium hydroxide) as well as of sealer and remnants of guttapercha.

At the same time, no side effects should occur due to the activation of irrigation solutions; this includes the extrusion of fluid and/or debris and occurrence of postoperative complaints.

If a narrow root canal has to initially be accessed, the effect of irrigation remains limited in this phase. Only in the final phase of mechanical preparation, and once the apical preparation size is sufficient, does the irrigation solution reach deeper apical areas and isthmi; in favorable cases, it penetrates into lateral canals and dentinal tubules. When a small irrigation cannula with a diameter of 0.30 mm (gauge 30) is used, apical preparation with instruments of at least size 25.06 (e.g. rotary file) or size ISO 30 (e.g. hand file) is required to ensure that the irrigation solution reaches the deep apical areas. Just in these conditions, once the preparation of the root canals is complete, is the final irrigation with or without activation particularly important.

Irrigation solution activation methods

Nowadays, the commonly used activation systems are based on the in-

Figure 5 Erbium-YAG Laser (Orcos, Medical, Küssnacht, Switzerland)

troduction of energy into the irrigation solution by means of sound, ultrasound or laser, which have the appropriate wavelengths, as well as, through the generation of mechanical vertical movements in the liquid (manual dynamic activation). In comparison to the classical irrigation technique, these various methods generally lead to an increase in the mechanical cleaning effect in vitro [29], although differences exist depending on the study design.

Mechanically-activated irrigation technique

In a simple way, the irrigation solution can be manually activated with a gutta-percha cone using rapid up and down movements in the root canal. This form of activation is, however, labor-intensive for the practitioner. In terms of penetration depth into the surrounding dentin, this procedure remains inferior to laser, sound and ultrasound-supported methods [8]. The reduction of debris in the mesial root canals and isthmus regions of lower molars does not show any advantage over conventional manual irrigation in vitro [20]. On the contrary, there is an increased risk of postoperative pain in cases of irreversible pulpitis when manual dynamic activation is used [25].

A new type of rotary root canal instrument (XP-endo Finisher, FKG Dentaire, La Chaux-de-Fonds, Switzerland) (Fig. 1) is particularly suitable for the activation of the irrigation solution, preferably at the end of preparation. The instrument is bent like a spoon and, using the corresponding rotation, it not only sets the irrigation solution in motion, but also reaches canal areas which conventional conical files cannot reach. According to two recent experimental studies, more debris could be removed when using the XP-endo Finisher together with passive ultrasonic activation than with conventional irrigation [7, 32]. This instrument is also suitable for the removal of calcium hydroxide from the root canal [15].

Ultrasonic-activated irrigation methods

Ultrasound-based irrigation techniques have been used in endodontics for over 10 years. The ultrasonic range starts at a frequency of about 20,000 Hz. With the aid of an ultrasonic handpiece, the energy can be transferred to a clamped file or a smooth-walled tapered instrument tip. With the latter, a so-called passive ultrasonic irrigation – without mechanical treatment of the canal wall – can be performed. This involves the insertion of the attachment tip into the root canal which is filled with irrigation solution, if possible, up to about 1–2 mm before the working length. The tip is then activated for 20 sec without any additional vertical movement. The greatest effect is achieved when the file can oscillate in the root canal as freely as possible. Limitations arise from the curvature and dimensions of the root canal. Passive ultrasonic activation of the irrigation solution is usually recommended as part of the final irrigation after the root canal has been shaped.

Under favorable conditions, the described effects, namely cavitation and "acoustic streaming", occur. Through the oscillation of the file in a plane with at least 20,000 Hz, so-called nodes and antinodes are created, which set the irrigation liquid in motion. Such high localized fluid movements are produced that these can contribute significantly to the removal of debris and pulp tissue. Another consequence, especially at the end of the freely oscillating instrument tip, is cavitation. This process produces small bubbles that increase in size in a very short time, which then immediately implode again. The resulting pressure waves accelerate the irrigation medium towards the root canal walls. Noteworthy is that the maximum input occurs in the plane of oscillation (parallel to the orientation of the contra-angle handpiece). This is a relevant consideration when cleaning the isthmus between the mesiobuccal and distobuccal root canals of lower molars for example. In this case, the tip should be rotated slowly during the activation phase. There can be clinical limitations to this, however, because the contra-angle handpiece cannot be rotated as desired in the patient's mouth.

In principle, "non-cutting" tips are preferable (Fig. 2). Given that an

Standard irrigation medium	NaOCl (normally 1–3 %)	
during RC preparation:	using a 5 ml syringe and a conventional cannula (Luer-Lock-system)	at least 1 ml => after each hand instrument => for rotary instruments after 3 "pecks" or after retraction of the instrument due to "jamming" (increased resistance)
after final RC preparation:		
removal of the smear layer:	with EDTA (15–17 %) or citric acid (20 %)	
activation of NaOCl:	using an ultrasonic-activated tip or using Eddy: 3 x 20 sec (with renewal of the irrigation solution) or continuously 60 sec per canal	

Table 1 Possible irrigation protocol (RC = root canal)
(Fig. 1–5 and Tab. 1: R. Weiger)

intermittent contact between the tip and the canal wall is usually unavoidable in everyday clinical practice, these tips do not remove root dentin on contact with the wall and do not create legdes. Improper use can also lead to the fracture of the ultrasonic tip in the root canal. Only in very wide and straight root canals, e.g. in frontal teeth with wide open foramen, can the tip be placed "centrally" in the root canal – without contact with the canal wall; the tip can then swing freely with maximum energy input given that the practitioner's hand remains steady. However, even in root canals with a smaller apical preparation of 20/04, ultrasonic-activated irrigation has a beneficial effect on the removal of residual pulp, as shown in the study by Lee et al. [13].

The above mentioned explanations make it clear that the handling of the ultrasonic tip has an influence on the cleaning result. However, detailed information on this topic is rarely found in investigations that are performed mostly in vitro.

In a recent systematic review on the effect of ultrasonic-activated irrigation, a total of 45 in vitro studies and 3 clinical studies were analyzed [2]. The experimental work focused on the parameters of pulp tissue and debris removal as well as antimicrobial effect. With regard to the removal of pulp tissue and debris, ultrasonic-activated irrigation proved to be superior to conventional irrigation in the majority of the studies that were ultimately analyzed. Whether ultrasonic activation has an additional antibacterial effect on the microorganisms in the root canal system cannot be proven. The authors of this systematic review limit the evaluation of the summary results to a low evidence level [2]. The same conclusion was reached in another review published in 2018 which included 5 investigations in a meta-analysis [16]. In contrast, Nagendrababu et al. [17] conclude from their review that the reduction of the microbial load is more pronounced after the use of ultrasound compared to other methods. Recent in vitro studies from 2019 and 2020 confirm that positive effects are attributable to ultrasonic activation with regard to debris removal [7, 18, 22], penetration depth of the irrigation solution [8, 12] and pulp tissue removal [27]. Compared to manual irrigation, a higher chemical conversion rate of sodium hypochlorite by ultrasonic activation can be observed [9].

The GentleWave system (Sonendo Inc, Laguna Hills, CA, USA) was shown to be superior to ultrasound in terms of debris removal in the isthmus area [3]. GentleWave is not commercially available in Europe.

Only one clinical study which examined the healing of apical periodontitis in association with activated irrigation met the inclusion criteria from 2 reviews [2, 24]. This randomized study showed no significant differences between manual and ultrasonic-activated irrigation [14]. In the study, apical lesions of single-rooted teeth with mostly straight root canals were evaluated 10 to 19 months after root canal treatment based on DVT imaging. Although there was no statistically significant difference based on a significance level of alpha = 0.05, closer examination revealed evidence in favor of ultrasonic-activated irrigation with a healing rate of 95.1 % (39 of 41 teeth) vs. 88.4 % (38 of 43 teeth) with the conventional irrigation technique.

Sound-activated irrigation methods

The special sound-activated tips oscillate in the root canal with a frequency in the upper audible sound range (16–20,000 Hz). EndoActivator (Dentsply Sirona) (Fig. 3) and Eddy (VDW, Munich) (Fig. 4) are typical representatives of this group.

An Eddy is a sound-activated polyamide tip that is screwed in an Airscaler attachment. In addition to being highly flexible, the narrow, flexible plastic tip can be pushed forward as far as possible into the root canal and can be used for cleaning in almost all phases of root canal preparation. When it comes in contact with a wall, no undesirable dentin removal occurs. It is questionable whether the effects, cavitation and "acoustic streaming", are actually achieved in the root canal with the maximum frequency of 6,000 Hz generated by the Eddy tip. The frequency range covered is clearly below the required frequency of at least 14,000 Hz (see ultrasound). Theoretically, the maximum amplitude of about 350 mm that is achieved by the plastic tip requires an apically prepared root canal up to ISO 100, so

that the tip can oscillate freely and the energy input into the irrigation solution is at its maximum. Nevertheless, current experimental studies on root canals that have been prepared up to an apical size of 40.06 show that the effect on adjacent dentin wall areas after sound activation with the Eddy tip corresponds to root canals that have been irrigated with ultrasound or laser [8].

Eddy proved to be as effective as the passive ultrasonic irrigation technique for removing the debris and smear layer [26]. Both methods have a comparable effect in terms of reducing the number of bacteria in the root canal [18]. Eddy also supports the removal of calcium hydroxide; it performed better than the Endoactivator (Dentsply Sirona, York, PA; USA) which is also based on the principle of sound activation [15]. The manufacturer of the Endoactivator, which provides flexible attachable polymer tips in sizes 15.02, 25.04 and 35.04, recommends additional pumping movements. In vitro, irrigation solutions penetrate into the surrounding apical dentin after application of the Endoactivator as far as laser or ultrasound-supported procedures [8]. In contrast, Varela et al. 2019 [27] report that, after rotary preparation with 25/08, the pulp tissue remains in the apical region to a greater extent when the Endoactivator is used as compared to passive ultrasound application.

Laser-activated irrigation methods

Laser light can be introduced into the liquid-filled root canal via narrow fiber optic light tips. The effect depends largely on the wavelength generated by the respective laser system, the energy density and the absorption of the hard and soft tissues that are being exposed.

The light emitted by an infrared laser is completely absorbed by water-based solutions. At the aperture of the laser tip, cavitation occurs in the irrigation medium. Pulsed lasers produce additional small bubbles through the cavitation process, which trigger "acoustic streaming" in the irrigation solution. The PIPS system (Photon Initiated Photoacoustic Streaming) represents a modern method for laser-induced activation which uses an Erbium-YAG laser with low pulse energy (10–20 mJ) and short pulse length (50 µs) (Fig. 5). A further development which makes use of an adaptive pulse mode is the SWEEPS system (Shock Wave Enhanced Emission Photoacoustic Streaming).

The tip is placed in the pulp chamber at the root canal entrance. The "primary" arising air bubbles collapse; this produces shock waves that strike against the canal wall at high speed as well as additional "secondary" bubbles. The shear forces that are generated act on tissue residues, biofilm and the smear layer and they should contribute to cleaning of the root canal system. With regard to the removal of debris in the isthmus area, PIPS proves to be equivalent to ultrasonic-activated irrigation and conventional laser-activated irrigation [28]. In the latter case, the tip is advanced into the root canal as deep as the dimensions of the optic fiber and the prepared root canal permit. PIPS completely removed calcium hydroxide from artificially created depressions in the root canal, whereas after the use of ultrasound and EndoActivator, there was evidence of residues [1]. In terms of the penetration depth of the irrigation solution and debris removal, no advantages of SWEEPS over PIPS could be demonstrated. However, in this respect, both methods were superior to conventional irrigation with a cannula [8, 20].

Photo-activated disinfection (PAD) requires the addition of a dye such as methylene blue. The dye adheres to cell walls and is apparently effective against Gram-positive and Gram-negative bacteria after activation in the red light range (diode laser). A reliable comparison with the other methods is not possible because valid studies are not currently available.

Closing considerations

The explanations found in literature regarding the possible "side effects" are limited. With regard to the frequency of postoperative pain, based on 6 clinical studies, Decurcio et al. [6] concluded that on days 1 and 2 after root canal treatment, symptoms occur less frequently when using "machine-supported" root canal irrigation as compared to conventional irrigation.

Since the advantages of a defined irrigation protocol with respect to the activation of the irrigation solution could not be proven in comparative clinical studies so far, at least from valid experimental investigations, different approaches regarding the activation methods can be justified. The author shares the view of Virdee et al. 2018 [29], which on the one hand, describes the 16 publications included in the meta-analysis as heterogeneous, while on the other hand, based on the results of the investigations, derives a recommendation for the use of activated irrigation techniques. An irrigation protocol which is widely applied in practice for activation is outlined in Table 1 for guidance. In principle, the recommendations of the device manufacturer should be respected when performing irrigation. In clinical use, the effect of an activated root canal irrigation depends on other factors such as the type and concentration of the irrigation medium, penetration depth, contact time and volume of the irrigation solution used [28].

Conflicts of Interest

The author declares that there is no conflict of interest within the meaning of the guidelines of the International Committee of Medical Journal Editors.

References

1. Arslan H, Akcay M, Capar ID, Saygili G, Gok T, Ertas H: An in vitro comparison of irrigation using photon-initiated photoacoustic streaming, ultrasonic, sonic and needle techniques in removing calcium hydroxide. Int Endod J 2015; 48: 246–251

2. Căpută PE, Retsas A, Kuijk L Chávez de Paz LE, Boutsioukis C: Ultrasonic irrigant activation during root canal treatment: a systematic review. J Endod 2019; 45: 31–44

3. Chan R, Versiani MA, Friedman S et al.: In vitro efficacy of 3 supplementary

irrigation protocols in the removal of hard tissue debris from the mesial root canal system of mandibular molars. J Endod 2019; 45: 923–929

4. Chubb DWR: A review of the prognostic value of irrigation on root canal treatment success. Aust Endod J 2019; 45: 5–11

5. Connert T, Truckenmüller M, ElAyouti A et al.: Changes in periapical status, quality of root fillings and estimated endodontic treatment need in a similar urban German population 20 years later. Clin Oral Investig 2019; 23: 1373–1382

6. Decurcio DA, Rossi-Fedele G, Estrela C, Pulikkotil SJ, Nagendrababu V: Machine-assisted agitation reduces postoperative pain during root canal treatment: a systematic review and meta-analysis from randomized clinical trials. J Endod 2019; 45: 387–393

7. De-Deus G, Belladonna FG, de Siqueira Zuolo A et al.: In vitro Micro-CT comparison of XP-endo Finisher and passive ultrasonic irrigation as final irrigation protocols on the removal of accumulated hard-tissue debris from oval shaped-canals. Clin Oral Invest 2019; 23: 3087–3093

8. Galler KM, Grubmüller V, Schlichting R et al.: In vitro penetration depth of irrigants into root dentine after sonic, ultrasonic and photoacoustic activation. Int Endod J 2019; 52: 1210–1217

9. Gołąbek H, Borys KM, Kohli MR, Brus-Sawczuk K, Strużycka I: In vitro chemical aspect of sodium hypochlorite activation in obtaining favorable outcomes of endodontic treatment: An in-vitro study. Adv Clin Exp Med 2019; 28: 1311–1319

10. Grahnén H, Hansen L: The prognosis of pulp and root canal therapy. Odontologisk Revy 1961; 12: 146–165

11. Hülsmann M, Peters OA, Dummer PHM: Mechanical preparation of root canals: shaping goals, techniques and means. Endodontic Topics 2005; 10: 30–76

12. Iandolo A, Abdellatif D, Amato M et al.: Dentinal tubule penetration and root canal cleanliness following ultrasonic activation of intracanal-heated sodium hypochlorite. Aust Endod J 2020; 46: 204–209

13. Lee OYS, Khan K, Li KY et al.: Influence of apical preparation size and irrigation technique on root canal debridement: a histological analysis of round and oval root canals. Int Endod J 2019; 52: 1366–1376

14. Liang YH, Jiang LM, Jiang L et al.: Radiographic healing after a root canal treatment performed in single-rooted teeth with and without ultrasonic activation of the irrigant: a randomized controlled trial. J Endod 2013; 39: 1218–1225

15. Marques-da-Silva B, Alberton CS, Tomazinho FSF et al.: In vitro effectiveness of five instruments when removing calcium hydroxide paste from simulated internal root resorption cavities in extracted maxillary central incisors. Int Endod J 2020; 53: 366–375

16. Moreira RN, Pinto EB, Galo R, Falci SGM, Mesquita AT: Passive ultrasonic irrigation in root canal: systematic review and meta-analysis. Acta Odontol Scand 2019; 77: 55–60

17. Venkateshbabu N, Jayakumar J, Anand S, Senthilnayagam K, Prasanna N: Effectiveness of ultrasonically activated irrigation on root canal disinfection: a systematic review of in vitro studies. Clin Oral Investig 2018; 22: 655–670

18. Neuhaus KW, Liebi M, Stauffacher S, Eick S, Lussi A: Antibacterial efficacy of a new sonic irrigation device for root canal disinfection. J Endod 2016; 42: 1799–1803

19. Ng YL, Mann V, Gulabivala K: A prospective study of the factors affecting outcomes of nonsurgical root canal treatment: part 1: periapical health. Int Endod J 2011; 44: 583–609

20. Passalidou S, Calberson F, De Bruyne M, De Moor R, Meire MA: In vitro debris removal from the mesial root canal system of mandibular molars with Laser-activated irrigation. J Endod 2018; 44: 1697–1701

21. Peters OA, Schönenberger K, Laib A: Effects of four Ni-Ti preparation techniques on root canal geometry assessed by micro computed tomography. Int Endod J 2001; 34: 221–230

22. Rödig T, Sedghi M, Konietschke F, Lange K, Ziebolz D, Hülsmann M: Efficacy of syringe irrigation, RinsEndo and passive ultrasonic irrigation in removing debris from irregularities in root canals with different apical sizes. Int Endod J 2010; 43: 581–589

23. Sjögren U, Hagglund B, Sundqvist G, Wing K: Factors affecting the long-term results of endodontic treatment. J Endod 1990; 16: 498–504

24. Silva EJN , Rover G, Belladonna FG, Herrera DR, De-Deus G, da Silva Fidalgo TK: Effectiveness of passive ultrasonic irrigation on periapical healing and root canal disinfection: a systematic review. Br Dent J 2019; 227: 228–234

25. Topçuoğlu HS, Topçuoğlu G, Arslan H: The effect of different irrigation agitation techniques on postoperative pain in mandibular molar teeth with symptomatic irreversible pulpitis: a randomized clinical trial. J Endod 2018; 44: 1451–1456

26. Urban K, Donnermeyer D, Schäfer E, Bürklein S: In vitro canal cleanliness using different irrigation activation systems: a SEM evaluation. Clin Oral Invest 2017; 21: 2681–2687

27. Varela P, Souza E, de Deus G, Duran-Sindreu F, Mercadé M: In vitro effectiveness of complementary irrigation routines in debriding pulp tissue from root canals instrumented with a single reciprocating file. Int Endod J 2019; 52: 475–483

28. Verstraeten J, Jacquet W, De Moor RJG, Meire MA: Hard tissue debris removal from the mesial root canal system of mandibular molars with ultrasonically and laser-activated irrigation: a micro-computed tomography study. Lasers Med Sci 2017; 32: 1965–1970

29. Virdee SS, Seymour DW, Farnell D, Bhamra G, Bhakta S: Efficacy of irrigant activation techniques in removing intracanal smear layer and debris from mature permanent teeth: a systematic review and meta-analysis. Int Endod J 2018; 51: 605–621

30. Virdee SS, Farnell DJJ, Silva MA, Camilleri J, Cooper PR, Tomson PL: The influence of irrigant activation, concentration and contact time on sodium hypochlorite penetration into root dentine: an ex vivo experiment. Int Endod J 2020; 53: 986–997

31. Weiger R, Hitzler S, Hermle G, Löst C: Periapical status, quality of root canal treatment and estimated endodontic treatment needs in an urban German population. Endod Dent Traumatol 1997; 13: 69–74

32. Zhao Y, Fan W, Xu T, Tay FR, Gutmann JL, Fan B: Evaluation of several instrumentation techniques and irrigation methods on the percentage of untouched canal wall and accumulated dentine debris in C-shaped canals. Int Endod J 2019; 52: 1354–1365

(Photo: Roland Weiger)

PROF. DR. ROLAND WEIGER
Departement of Periodontology, Cariology and Endodontology
University Center for Dental Medicine Basel (UZB)
Mattenstrasse 40; 4058 Basel
Switzerland
roland.weiger@unibas.ch