Irrigation in endodontics—new needle for better results

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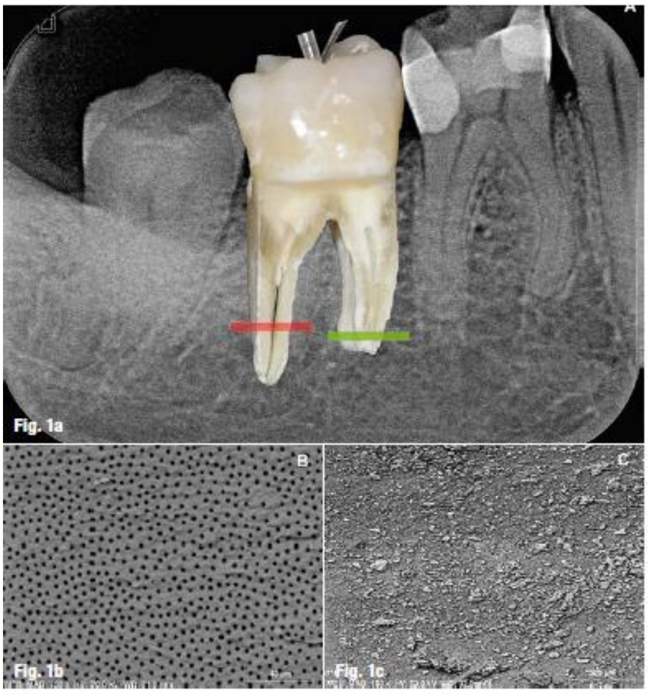


Figs. 1a–c: Radiograph and superimposed photograph of a mandibular molar showing the insertion of a metallic Endoneedle 27G and plastic IrriFlex 30G needle **(a)**. Scanning electron microscopy (SEM) image of a clean root-canal wall **(b)**, and one covered with dentine slurry and pulp debris **(c)**.

Root canal preparation is an essential step in endodontic treatment aimed at removing the current content of the root canal and preparing the canal or canals for filling. The objective is to prevent the onset or recurrence of apical periodontitis.[1] The use of rotary instruments with continuous rotation has made treatments faster, more comfortable and more predictable over the past 20 years.[2] Many developments in the instrument realm have helped improve endodontic preparation systems. But despite all these advances, the complexity found in root canal systems results in residual unprepared or unpreparable areas that require the complementary use of chemicals.[1, 3]

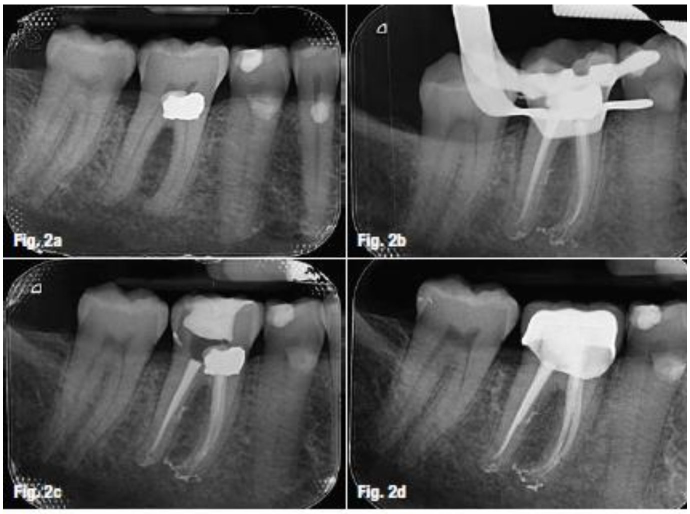
While most of the bacterial flora is eliminated by mechanical preparation, only endodontic irrigation can ensure intraoperative endodontic antisepsis. Used regularly and copiously, root canal irrigation can effectively remove organic and mineral debris in addition to providing bacterial decontamination.[4] Root canal preparation must therefore be considered a combined chemical and mechanical procedure where the limits of the mechanical instruments are overcome by irrigation solutions.[5]

The market is full of different irrigation systems designed to further enhance this step. Many studies have been carried out to find the ‘perfect’ irrigation solution, one that would meet all the criteria in terms of both efficiency and biocompatibility.[6–9] Unfortunately, there simply is no such solution at this point. Sodium hypochlorite remains the gold standard of antiseptic solutions, while EDTA or citric acid remain the gold standard among chelating agents, required at the end of the preparation process. However, a needle recently developed by Produits Dentaires SA has given us a new choice of irrigation needle.

Irrigation in endodontics

Irrigation is an essential part in endodontic treatment. It is irrigation that allows us to prepare a root canal antiseptically. Irrigation is therefore required from the time of accessing the pulp chamber until the restorative material is introduced into the root canal. The anatomies of root canal systems are highly variable and can be very complex, so it will usually be impossible to mechanically prepare the entire system. However, it is still imperative to clean the entire root canal system to achieve effective cleaning and to perform a successful endodontic treatment. For this reason, irrigation is the mandatory complement to the preparation of canals with rotary instruments, which, while reducing the bacterial count in instrumented areas by up to 90 per cent, have no effect in areas that are not and cannot be instrumented areas.[5]

Various different irrigation systems are currently in use. Root canal irrigation with a syringe and a needle is still the most common procedure today.[4] Syringes are generally classified according to the design of their tips. Luer tips (which are not necessarily Luer-Lock tips) are conical, with a 6 per cent slope. Luer-Lock tips feature the same conical design but also provide a locking mechanism for the needle that prevents the needle from accidentally sliding off the syringe. All needles have some form of connector with which to attach them to the syringe. The length and thickness of the needle can vary greatly, depending on the procedure to be performed. Its diameter is measured in gauge numbers, which vary from 8 to 30, responding to 4.57 mm and 0.31 mm, respectively.4 The higher the gauge number, the slimmer the needle. It is quite possible to encounter two needles with the same lengths but different diameters.



Figs. 2a–d: First mandibular molar with acute pulpitis **(a)**, endodontically treated (Micro-Mega System 2-Shape for instrumentation and Produits Dentaires SA IrriFlex for irrigation). The obturation **(b & c)** demonstrates the excellent cleaning result by filling the apical delta of the mesial root and the accessory canal of the distal root. Control radiograph at 3 months with a peripheral cap **(d)**.

The needle can end in a bevel, it can feature one or several lateral openings. Being familiar with these different needles is particularly relevant in endodontics. It has been demonstrated that closed-ended needles must be used to prevent irrigation solution to invade the periapical space. The pertinent studies were based on visualising and examining the trajectories of irrigant particles of the irrigation solution at the root-canal level.4 Until now, there were three needles of particular interest to the practice of endodontics: — Irrigation needles with rounded foam tips and a lateral opening of the Irrigation Probe type (Kerr Hawe). The diameter of the needle opening is small enough for enough pressure to build to lift the dentine and pulp debris present.

— Irrigation needles with notched ends, of the Endoneedle type (Elsodent). These have the advantage that the passage of the needle is blocked 3 mm away from the apex, preventing the pressurised liquid from irritating the periodontal ligament with its 'water cannon' effect.

— Irrigation needles with two lateral openings at different levels and a foam tip, of the Endo Irrigation Needle type (Transcodent). These allow effective cleaning of the entire root canal in an atraumatic way. Like the others, they are available in several diameters, 27- and 30-gauge being the most suitable for endodontics depending on the width of the canal encountered.

The main limitation of this widespread irrigation method is irrigation in the apical third, as the irrigation solution does not reach any further than 1 mm from the tip of the needle.10 The latter must therefore be brought as close as possible to the apex (Fig. 1a) to be effective in the apical last few millimeters of the root canal. Thus, in order to increase the efficiency of irrigation, the forced protrusion of the solution by different methods presents good results.[1]

At present, we know that passive ultrasonic irrigation of the root canal is more effective than syringe/needle irrigation in removing residual pulp tissue and dentine debris and also allows a more significant reduction in the level of intra-canal bacteria.[13, 14] However, studies on the removal of dentine slurry have been inconclusive to date, although they tend to suggest a higher efficacy of passive ultrasonic irrigation.

The purpose of any endodontic treatment is to provide a good root canal filling (Fig. 2). Bolles et al. (2013) demonstrated the importance of root canal irrigation on the penetration of endodontic sealer cement. Sonic systems exhibited a slightly higher percentage of cement penetration compared to conventional irrigation.[15]

It is generally accepted that the oral environment is a complex ecosystem that comprises about 1010 bacterial species. In the root canal, 450 species have been identified, although any given root canal will generally not contain more than 5 to 30 species simultaneously.[3] The composition of the bacterial flora and the location of microorganisms in the root canal depend on several factors: the amount of oxygen available, bacterial access to nutrients, the status of the host defences, the prevailing pH level and others.[16] These bacteria readily organise themselves into a biofilm, a true 'endodontic plaque', and are considered to be the main cause of endodontic treatment failure.[17] According to Costerton, a biofilm is a community of bacteria aggregated into microcolonies, embedded in a gangue matrix that they have secreted, and adhere to an inert or biological surface. In this arrangement, bacterial species appear more resistant to root canal disinfection agents than bacteria with a plankton-like organisation. The irrigation solution must therefore be effective against isolated bacteria as well as bacteria grouped together in biofilm communities.[18]

The smear layer is a coating layer created by preparation instruments. This layer covers the surface of the root-canal walls and can reach a thickness of 5 µm and a depth of 40 µm in the dentinal tubuli. It consists of organic and inorganic substances (dentine slurry, pulp debris, microorganisms).[19]

This smear layer can interfere with the success of endodontic treatment [19, 20] by harbouring bacteria responsible for secondary or persistent infections, blocking the irrigation liquid from entering the dentinal tubuli (Fig. 1c), thus causing deep bacterial persistence and preventing a good definitive seal by inhibiting the penetration of the tubuli by the sealing cement. It is essential to remove the smear layer at the end of the instrumentation process and before the obturation step. Irrigation should therefore begin as soon as the pulp chamber is opened, using a 2.5 % sodium hypochlorite solution. Copious amounts of it should be introduced (up to 4 ml per canal have been recommended in the literature) and renewed between instrument passages. Some studies even state that the canals should always be filled with irrigation solution to prolong its action on the dentine walls.[1, 20]

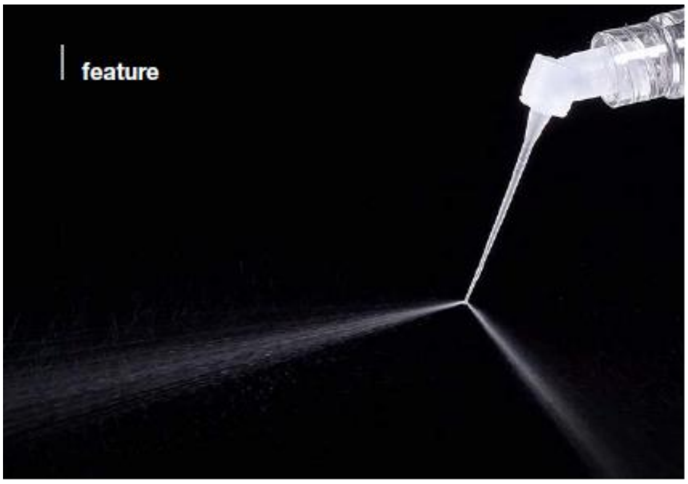


Fig. 3: IrriFlex 30G plastic needle with 2 lateral openings on the same level (Produits Dentaires SA).

Solutions can be introduced into the root canal by different methods. A needle recently developed by Produits Dentaires SA, the IrriFlex (Fig. 3), appears to be particularly interesting. This slightly conical 30-gauge needle is made of plastic and possesses two lateral vents arranged back to back just short of its closed end. This unique device facilitates an efficient lateral flow and reflux of the solution while controlling the extrusion risk. In effect, this means that the needle must never get stuck in the root canal (meaning that the preparation must be sufficient at all points) and that the liquid is ejected slowly and at low pressure, 1 to 2 mm from the working length (Fig. 1a). The lateral flow is conducive to the cleaning of isthmus and root canal irregularities. Once the root canal preparation is complete, and before proceeding to obturation, it is necessary to remove the smear layer created by the instruments (Fig. 1c). For this purpose, a 17 % EDTA solution (or 5 % citric acid) is applied for 2 minutes, at a quantity of 2 ml per canal. A final copious 2.5 % NaOCl rinse (2 minutes, 3 to 5 ml per canal) provides additional disinfection and completes the opening of the dentinal tubuli (Fig. 1b).

A comparative scanning electron microscopic (SEM) study[21] on debris removal showed that the IrriFlex needle/syringe system was more effective than the conventional Endoneedle/syringe system. The IrriFlex needle displays interesting properties during root canal irrigation. This might be explained by its flexible nature that allows it to penetrate root canal network more easily without breaking, but also by the presence of several lateral openings at the same level, which balances the pressure and flow of the expelled irrigant. These openings ensure extra broad exposure of the entire root canal.

Endodontic treatment requires root canal preparation instruments that work in synergy with an irrigation solution. The complexity of root canal systems prevents sufficient cleaning by mechanical preparation alone, mandating the additional use of chemical agents. The IrriFlex needle appears to be a promising device, showing superior results to the traditional syringe/needle method. It is flexible and has a very small diameter (30-gauge), which allows simple and efficient access to the apical areas of curved roots.

Editorial note: List of references is available from the author.

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Dr Franck Diemer earned his dental surgery's doctorate in 1995 at the University of Toulouse. He also has a Master in Science and Medical Biology (1998), a postgraduate diploma in pedagogy (2001), and a PhD from the Paul Sabatier University (2006). He is full professor in the Toulouse Dental Surgery's University, at the head of Endodontics department. He is a member of the French National College of Teachers in Dentistry (CNEOC) and the vice-president of the French Society of Endodontics (SFE). He is member of the scientific committee of Toulouse Dental Surgery's University, CNEOC and SFE. Dr Diemer has full hospital practice and is attached to the Clement Ader Institute (Surface, Machining, Materials and Tools team – UMR CNRS 5312). He has presented numerous lectures and continuing education, and published many national and international articles.