Clinical aspects of endodontic disinfection

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Root canal systems can often show complex anatomies, with great variations in number and shape, as recently summarized by Versiani and Ordinola-Zapata, which described almost all anatomical configurations possible to be observed in a single root (1).
Anatomic factors may pose a significantly challenge to root canal shaping: curvatures, oval/flattened canals and other pathologic or iatrogenic conditions may influence attainment of a proper continuous conical shape during instrumentation (Fig. 1-8).
Different preparation techniques leave from 10% to 50% of the root canal surface area untouched (2, 3). Moreover, several studies demonstrated the impossibility to obtain a complete mechanical debridement or chemical disinfection of the isthmuses and accessory or lateral canals with the current technology, mostly because, in canals with irregular cross section, the instrument may not reach all recesses, thus hard tissue debris remain packed into these areas during the mechanical preparation of the root canal system (4-6).
The main reasons for bacteria to persist after chemomechanical procedures are that they are

resistant to treatment or they are unaffected by instruments/irrigants. While some micro-organisms have been shown to be resistant to some endodontic antimicrobial agents (7, 8), resistance to debridement and to NaOCl is highly unlikely to occur (9).

Anatomic complexities represent a challenge to adequate disinfection, since, in general, the main canal lumen and minor irregularities are incorporated into the preparation and affected by NaOCl, but bacteria and organic tissue may remain in areas not reached by instruments and irrigants. Bacteria can spread through these pathways, reaching the periodontal ligament and causing disease (10), especially in the apical area, where accessory canals are likely to be present (according to De Deus and Vertucci) (11, 12). These areas are usually not affected because of the limitations of instruments and the short retention time of irrigants within the root canal (1) (Fig. 9 ad).

From the clinical point of view, the infection of the above mentioned complex anatomical configurations, with several portals of exit, can be the cause of failure of primary and secondary non-surgical endodontic treatments; for this reason, an adequate infection control is necessary not only in the main canal lumen, but also in the entire root canal system (6).

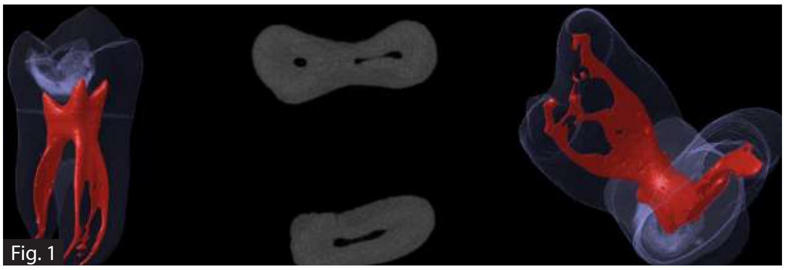
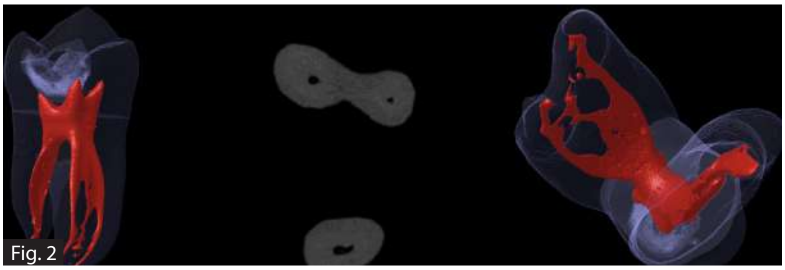


Fig. 1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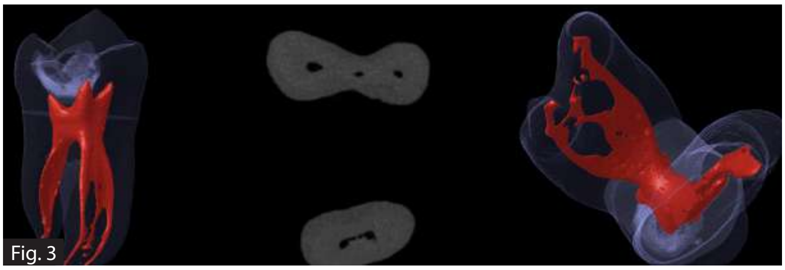
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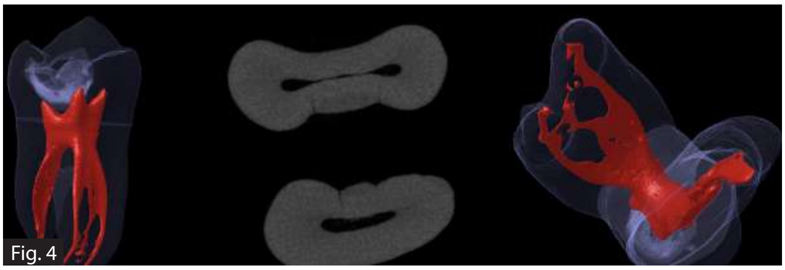
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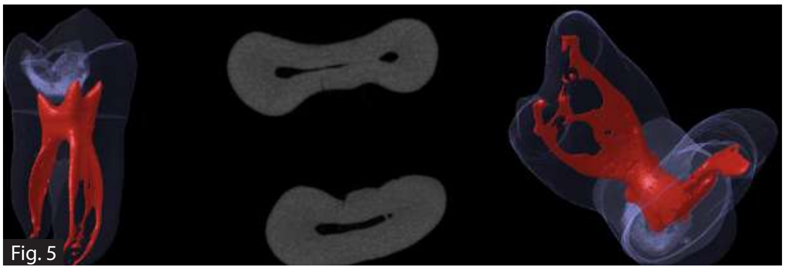
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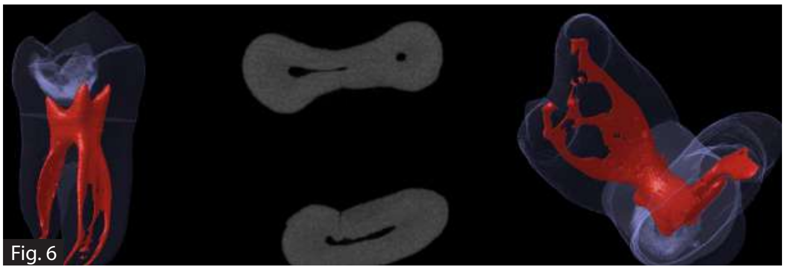
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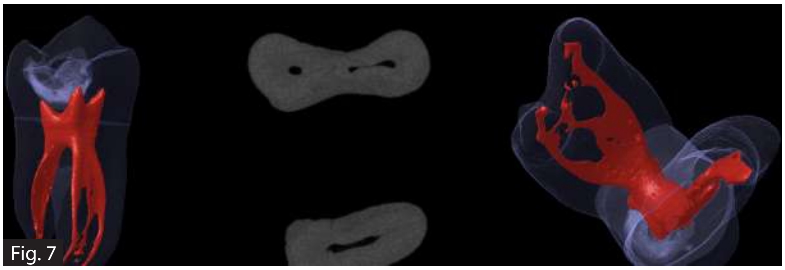
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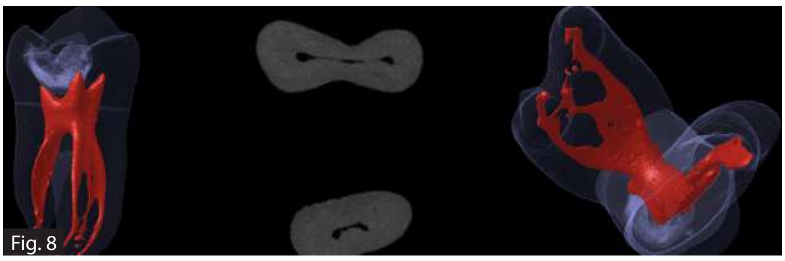
Fig. 8

Fig. 1-8: The tridimensional tomography sections show the anatomical complexity of a lower molar, underlining the difficulty to shape, clean and fill such and articulated root canal system. From Versiani et al. (2019) Root Canal Anatomy of Maxillary and Mandibular Teeth. In: The Root Canal Anatomy in Permanent Dentition. Ch. 7; Springer International Publishing. 425 p. DOI: 10.1007/978-3-319-73444-6

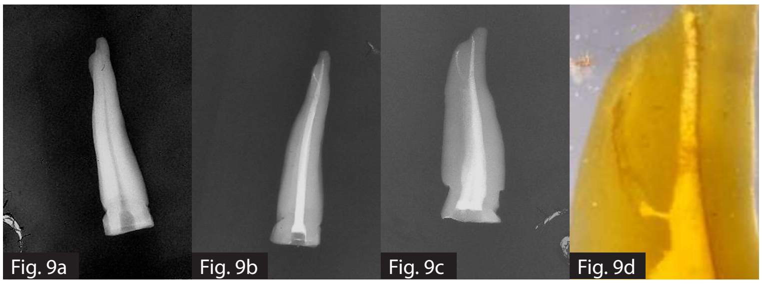
Fig. 9a Fig. 9b Fig. 9c Fig. 9d

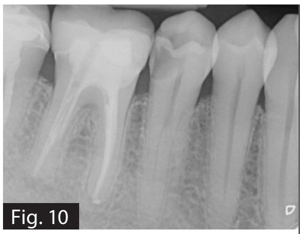
Fig. 10


Fig. 11


Fig. 12


Fig. 13


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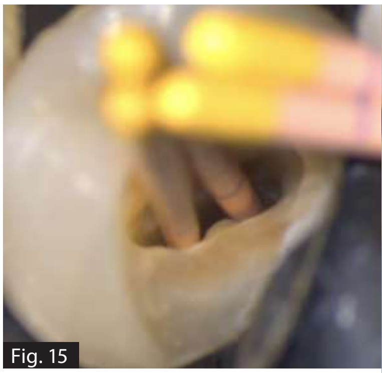
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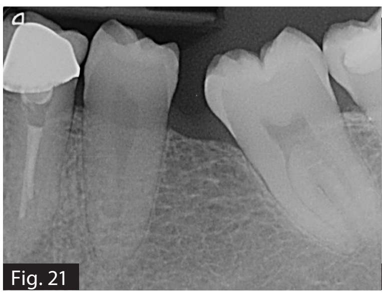
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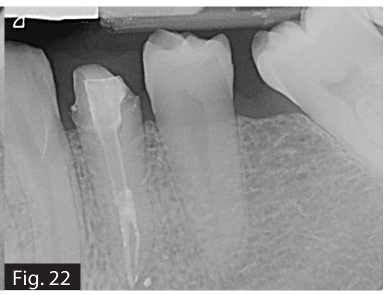


Fig. 22

Shaping does an important part in the endodontic treatment, but irrigants are in charge for the decontamination of the areas that cannot be reached by the files (2, 13, 14). Bringing the irrigating solution as close as possible to the apex and ensuring a good irrigant exchange, together with activating it, is extremely important to reach the success in endodontic treatments and retreatments (15, 16) (Fig. 10-20).

Irrigation is the step that is aimed to remove as many bacteria as possible from the root canal space, promoting apical healing (in case a lesion is present) and preventing reinfection (16).

Some clinical aspects of endodontic disinfection can be critical, as the scarce penetration of the irrigating solution and the irrigant exchange in complex anatomies, together with the biofilm resistance to the action of the irrigants (17) (Fig. 21 ,22).

Clinical and in vitro studies demonstrated that the combination of mechanical preparation and antibacterial irrigants significantly enhances disinfection when compared to irrigation with saline (18). The main requirement is to exchange frequently the irrigating solutions and use sufficient volumes in order to maintain the antibacterial effectiveness of the NaOCl solution, compensating for the effects of concentration (1) (Fig. 23-26).

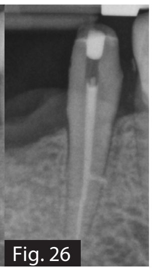
Fig. 10: A large decay on tooth 4.5 makes it necessary to plan an endodontic treatment.
Fig. 11: The anatomy of the tooth is similar to that described by Versiani et al.
Fig.12: The access cavity is designed after removing the decayed tissue.
Fig.13: The presence of notches on the shank of the irrigation cannula makes it easier to control the correspondence between the working length and the position of the cannula into the canal.
Fig. 14: Two thin root canals have been shaped and cleaned.
Fig. 15: The gutta percha points chosen for the vertical warm compaction filling are positioned into the root canals for the check.
Fig. 16: A final irrigation is performed using the push-pull technique.
Fig. 17: The root canals are dried and filled.
Fig. 18: The postoperative x-ray confirms the presence of an articulated anatomy that was treated thanks to the synergic use of shaping instruments and sodium hypochlorite, brought into the root canal system by means of IrriFlex, a polypropylene irrigation needle by Produits Dentaires SA, Vevey, Switzerland.
Fig. 19: The cavity is cleaned and prepared for the adhesive procedures.
Fig. 20: The tooth is restored with and indirect composite overlay.
Fig. 21: The tooth 3.4 shows and inadequate endodontic treatment and the patient refers pain while chewing. It is decided to perform a retreatment.
Fig. 22: The postoperative picture shows that the root canal system has been shaped, cleaned and filled correctly, evidencing the presence of a deep split.

One simple method to improve the irrigant exchange and to activate the solution is the push pull technique. Most clinician consider irrigation as the extrusion of an irrigant from a syringe gripped by holding the index and middle fingers under the wings of the syringe and the thumb over the plunger. A simple yet effective method to improve the cleanliness of the root canal system, that does not require the use of special devices, consists in alternating positive and negative irrigation using the push pull technique. After extruding a small amount of irrigant, the clinician places the thumb under the plunger and pushes upwards, developing a negative pressure that opposes the pressure used to inject the irrigant into the canal: this causes a suction of fluids into the canals, improving the fluid dynamics within the root canal system (16). In this way, keeping the needle stationary and moving the plunger, the liquids have a better penetration into the canals, acting more effectively (as the buffer effect is decreased by a constant exchange of solutions) (19, 20). During the negative pressure phase, the fluids in the canal return to the syringe by capillarity and are reactivated, while any pathogens are eliminated thanks to the action of the irrigant solution.
This creates an ideal condition for the next


Fig. 23


Fig. 24


Fig. 25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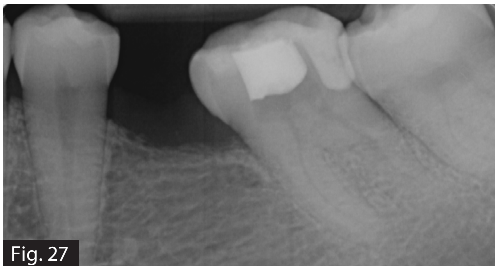
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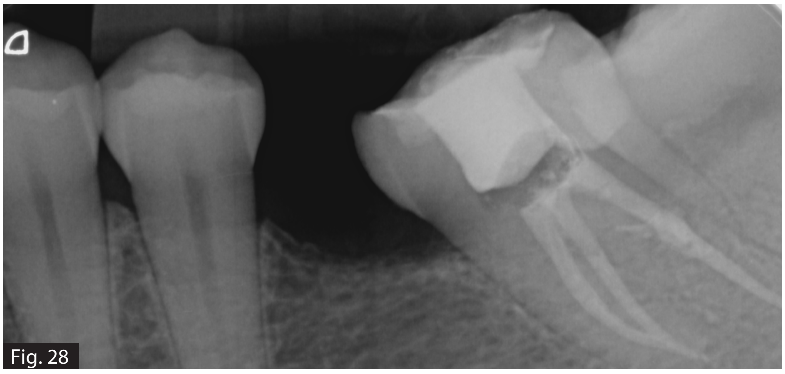
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Fig. 29


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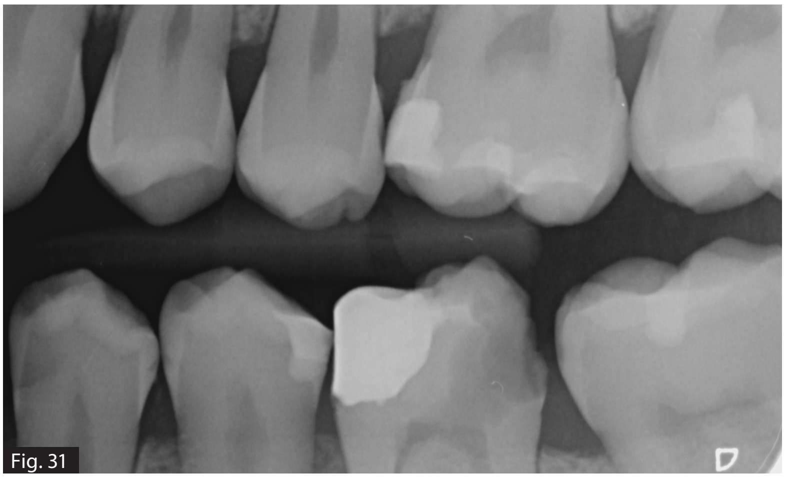
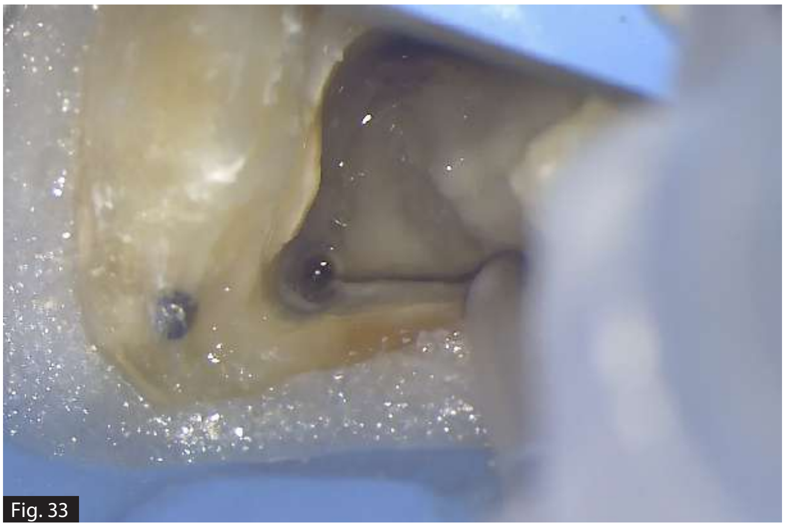


Fig. 31


Fig. 32

Fig. 23: The presence of an endodontic lesion and of pain to the tooth 3.5 leads to the decision of doing an endodontic treatment.
Fig. 24: Even in this case, the postoperative radiography shows the presence of a particular anatomy in the apical third of the root, that has successfully been cleaned and filled thanks to the use of a rigid protocol of shaping and irrigating, followed by and adequate filling.
Fig. 25: The tooth 4.3 presents and irreversible pulpitis
Fig. 26: The postoperative x-ray shows a lateral canal in the middle third of the root
Fig. 27: The patient complained about spontaneous pain on the tooth 3.7
Fig. 28: The postoperative x-ray evidences the presence of a lateral canal in the middle third of the root.
Fig. 29: The tooth 3.4 presents a large decay and requires endodontic treatment
Fig. 30: The postoperative x-ray shows the presence of a loop in the root canal system
Fig. 31: The bite-wing shows an extensive hard tissue loss on the tooth 3.6
Fig. 32: The decayed tissue and the previous filling are removed, a pulpotomy is done and a temporary restoration is placed.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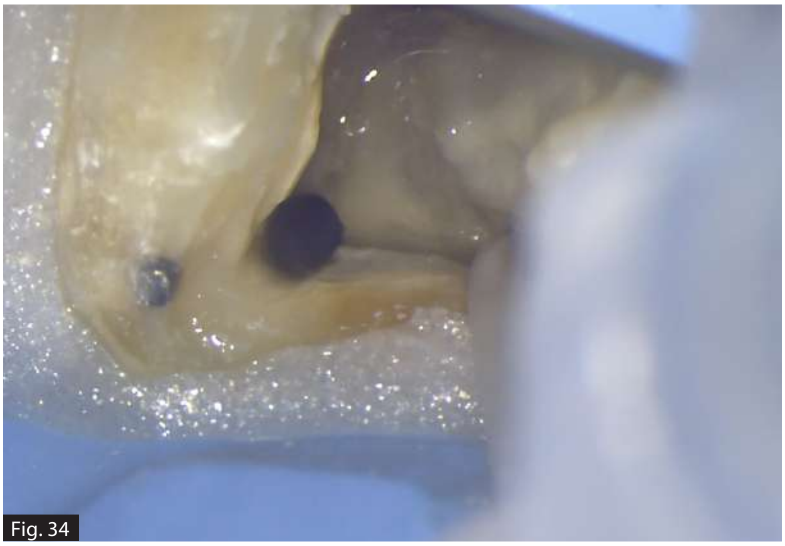
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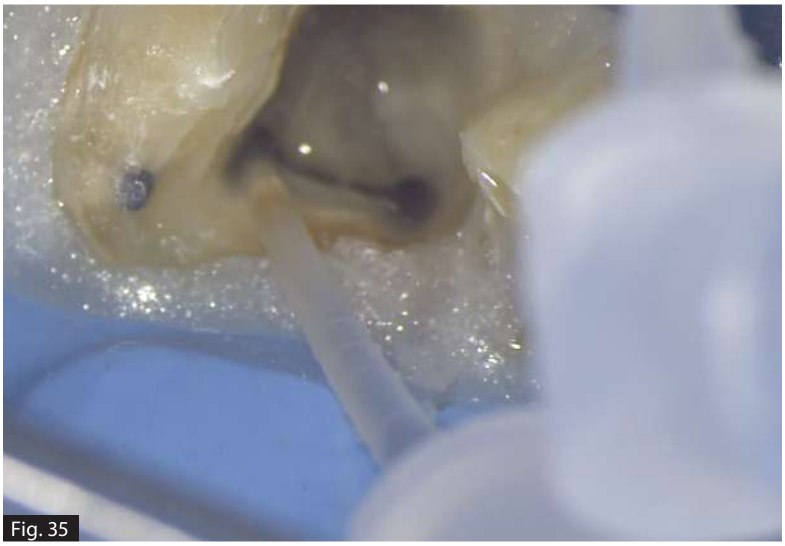


Fig. 35


Fig. 37

active irrigation phase, because the new irrigant can come into contact with the entire dentine surface (Fig. 27-30).

This simple technique is also able to reveal to the operator any confluence of apparently independent canals: in this case it will be sufficient to observe if, during the suction phase carried out in one canal, the irrigant disappears from the adjacent canal. The clinician, during the execution of the technique, should try not to introduce air into the root canal (16) (Fig. 31-37).

One significant improvement to this technique is represented by the introduction in the market of a polypropylene irrigation needle developed by Produits Dentaires SA (Switzerland) and named IrriFlex.

Thanks to an innovative back-to-back side vent design that improves the fluid dynamics into the canal, IrriFlex allows performing a safe and efficient cleaning of the root canal system, even in presence of challenging difficult anatomies.

Several articles described the superior adaptation of IrriFlex in curved canals, thanks to its 30G tip and superior flexibility with respect to steel or Ni-Ti, following the anatomy of the root until the working length, without the risk of blocking.

The possibility to bring the irrigant where it is most needed and to deliver a large vol-

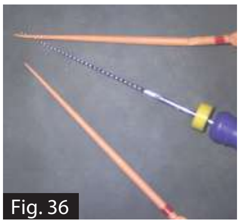


Fig. 36

Fig. 33: The push-pull technique is used while irrigation with IrriFlex.
Fig. 34: The push pull technique allows seeing a confluence between the two canals while sucking the irrigant.
Fig. 35: While extruding the irrigant in one canal, the other is filled as well.
Fig. 36: The confluence is confirmed by the k-file and the gutta-percha point.
Fig. 37: The postoperative x-ray shows the correct filling of the root canal system.

ume of solution with no effort, together with the possibility for the operator to control the depth at which the tip is (thanks to the millimetric notches printed on the shank of the cannula) (Fig. 13), helps improving the disinfection step of the root canal treatment, making it more ergonomic and safer.
IrriFlex improves fluid dynamics throughout the root canal system, retaining the safety features of closed tip needles: the irrigant, in fact, can only flow coronally and the two microscopic outlets induce atomization of the liquid, effective fluid dynamics turbulence for fluid replacement and improve the removal of dentine debris (Fig. 38). It also works perfectly with the push-pull technique, allowing an increased irrigant exchange in the apical third of the root (Fig. 39, 40).
The introduction of technological innovations in endodontics helps achieving more easily repeatable and predictable results, with benefits for the patient and the operator.

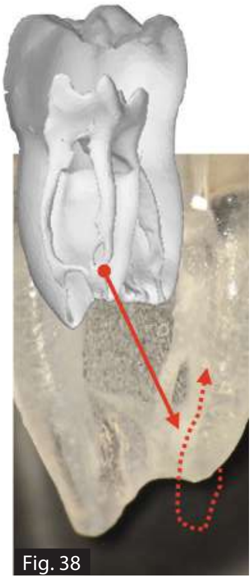
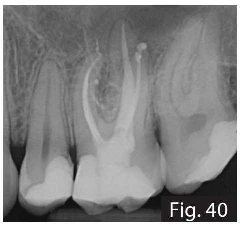


Fig. 38: Detail of the irrigant flow in the apical area
Fig. 39: The patient refers spontaneous pain to the tooth 2.6
Fig. 40: The postoperative x-ray shows the presence of multiple lateral canals



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