Endodontic accesses: what every endodontist should know

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ABSTRACT

Introduction: Minimally invasive access cavities emerged aiming to maintain the fracture resistance of endodontically treated teeth through the preservation of dental structure. Starting with the first study in 2010, several others were developed to evaluate the influence of minimally invasive access cavities in the fracture resistance of endodontically treated teeth. However, the coronal interference caused by those access cavities could impair the subsequent procedures of root canal treatment, such as the location, instrumentation, cleaning, disinfection and filling of the root canals. **Objective:** Based on this premise, the aim of the present review was to answer some questions so that the clinician knows the main modalities of minimally invasive access cavities, the impacts of this approach and the real role of endodontic treatment in the tooth loss. **Results:** Considering the available data, there is a lack of robust evidence in literature to support the claim that the minimally invasive access cavities preserve the fracture resistance of endodontically treated teeth better than the traditional one. In addition, these access cavities can interfere in other stages of endodontic treatment, making it unpredictable. **Conclusion:** Thus, it can be concluded that there is a lack of evidence to support the use of minimally invasive access cavities in routine clinical practice and/or in the process of training undergraduate and graduate students.

Keywords: Endodontic. Coronary access. Minimally invasive dentistry.

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Introduction

The logical thinking leads us to believe that the less wear of dental tissue, more resistant it would be to the occurrence of fractures. Following this reasoning, endodontic access cavities and root canal instrumentation were considered to be responsible for excessive wear and fracture of endodontically treated teeth.[1,2] In order to preserve the fracture resistance of teeth that require endodontic treatment, minimally invasive endodontic access cavities have been suggested as an alternative to traditional endodontic access (TradAC).[3,4]

Initially proposed without an in-depth scientific basis, this approach stimulate the interest of clinicians and researchers and different types of endodontic access cavities were quickly suggested, always searching to reduce more and more the loss of tooth structure. Such proposals emphasize tooth structure preservation including cingulate, the oblique crest, the pulp chamber roof and pericervical dentin,[3,4,5] which, according to the defenders of these accesses, would be the main responsible for transferring the occlusal load to the root of the teeth.

Due to possible advantages related to fracture resistance, this outcome was the main aim of studies in this regard.[6,7,8] However, the presence of coronal interferences caused by small access cavities could jeopardize the performance of subsequent endodontic procedures. These possible damages led the minimally invasive access cavities to be extensively evaluated, discussed and, even, rethought. Therefore, numerous studies were concerned not only with assessing the fracture resistance of teeth, but also evaluating the capacity of canal location, cleaning, shaping, disinfection, filling and the occurrence of iatrogenic complications, such as deviations and instrument fractures.[9-13] Thus, it is essential to understand the characteristics of the different types of minimally invasive access cavities and the possible impacts of this approach on endodontic treatment.

The main modalities of endodontic access proposed in the literature

» Traditional endodontic access cavity (TradAC): Endodontic access cavities are based on the anatomy of each dental group and individual variations of the tooth – i.e., the morphology of the pulp chamber that will determine the final design of each access cavity. Overall, the access cavities recommend maximum preservation of dental structure, with the complete removal of the pulp chamber roof and interferences, in order to identify the canal orifices and obtain an efficient debridement of the coronal portion of the root canals[14] (Fig 1). The adequate access cavities facilitate all subsequent procedures, minimizing the occurrence of fracture of endodontic instruments and the deviation from the original anatomy of the root canal during instrumentation.

» Conservative endodontic access cavity (ConsAC): In posterior teeth, this access cavity is performed in the central fossa and extended only the necessary to identify the root canals, preserving part of the pulp chamber roof (Fig 1).[9,11]

» Ultraconservative endodontic access cavity (UltraAC): this type of access is also popularly known as "ninja access". This name is due to the difficulty caused in performing all subsequent procedures of endodontic treatment. In this modality, the access is performed in a punctual way with spherical drills of small caliber towards the central fossa, without any extension of the cavity (Fig 1).[8,15]

» Truss access cavity (TrussAC): in this type of access, two or more cavities are prepared separately, in order to individualize the access to roots and/or root canals, preserving dentin and pulp chamber roof between the access cavities. For example, in mandibular molars, one cavity is prepared to access the mesial canals and another to access the distal canal(s). Another example is performing two cavities, one vestibular and one palatal, to visualize, respectively, the vestibular and palatal root canal of a maxillary molar (Fig 1).[10,11]

» Caries-Driven access cavity (CariesAC): in the presence of a carious lesion, the access is performed by removing caries and extending the necessary for the location of the root canals (Fig 2).[16,17]

» Restorative-Driven access cavity (RestoAC): the principle of this access cavity is similar to CariesAC, i.e., the access cavity is performed removing the restoration and extending enough to locate the root canals.[17]

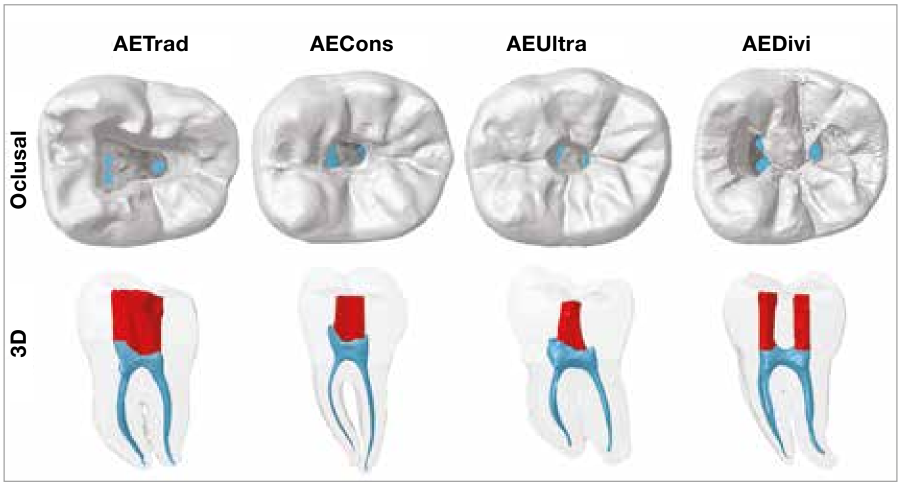

Figure 1. Images obtained by microcomputed tomography (micro-CT) of the different types of access cavities (TradAC, ConsAC, UltraAC and TrussAC) in occlusal view and in 3D models (red represents the access and blue, the root canals).

Are there any disadvantages when performing minimally invasive access cavities?

For the use of these types of access to be based on scientific evidence, they: 1) must have advantages over traditional access cavities and 2) should not present major disadvantages in the subsequent steps of endodontic treatment. In theory, if these types of access cavities improve fracture resistance, but impair disinfection, increase the risk of anatomical deviations, or even the risk of fracture of instruments, they should not, ideally, be recommended. However, do these risks and disadvantages really exist (Tab 1)?

Root canal detection

A great unanswered question is whether it is possible to locate, in a predictable way, all root canals in teeth with restricted access cavities. However, it has been shown that the association of cone beam computed tomography exams, operative microscopy and selective wear with ultrasonic tips allows the location of the root canals in conservative and traditional cavities in a similar way.[9,18] On the other hand, it is important to emphasize that, when no additional resources were used, the conservative access cavities showed less detection of root canals.[9,19]

When we talk about more restrict access cavities, such as UltraAC, it is possible that there will be difficulty in locating the root canals, even when the technological resources cited previously are used. However, more studies need to be performed in this regard.

Root canal instrumentation

Minimally invasive access cavities can create coronal interferences, since the roof of the pulp chamber is not removed. This can lead to an excessive inclination of the endodontic instruments during the root canal instrumentation when compared to traditional access[20,21] (Fig 3), increasing the risk of instrument fractures, even the most flexible, such as Martensitic NiTi instruments (with heat treatments).[22]

In addition, these coronal interferences, especially in ultraconservative cavities, can cause a deviation from the original anatomy of the root canal,[6,9,23] although many studies have shown that an adequate root canal instrumentation in conservative cavities is possible.[7,10]

Cleaning and disinfection of root canals

The minimally invasive access cavities seem to prevent the adequate cleaning and removal of pulp tissue,[10] which can serve as a reservoir for colonization of biofilms, resulting in persistent infection and unsuccessful endodontic treatment.[24]

Regarding the potential impacts of minimally invasive access cavities on the disinfection of the root canal system, it has already been demonstrated that microbial reduction is compromised after the chemomechanical preparation of root canals in teeth with minimally invasive cavities, reinforcing the idea that the access cavity, by itself, can influence the disinfection of the root canal.[13] Contrarily, some studies have found no differences between types of access, regarding microbial reduction.[11,25] The fact that there are differences in the results obtained previously, suggests that further research should be conducted on this subject, since no clear answer has yet been provided.

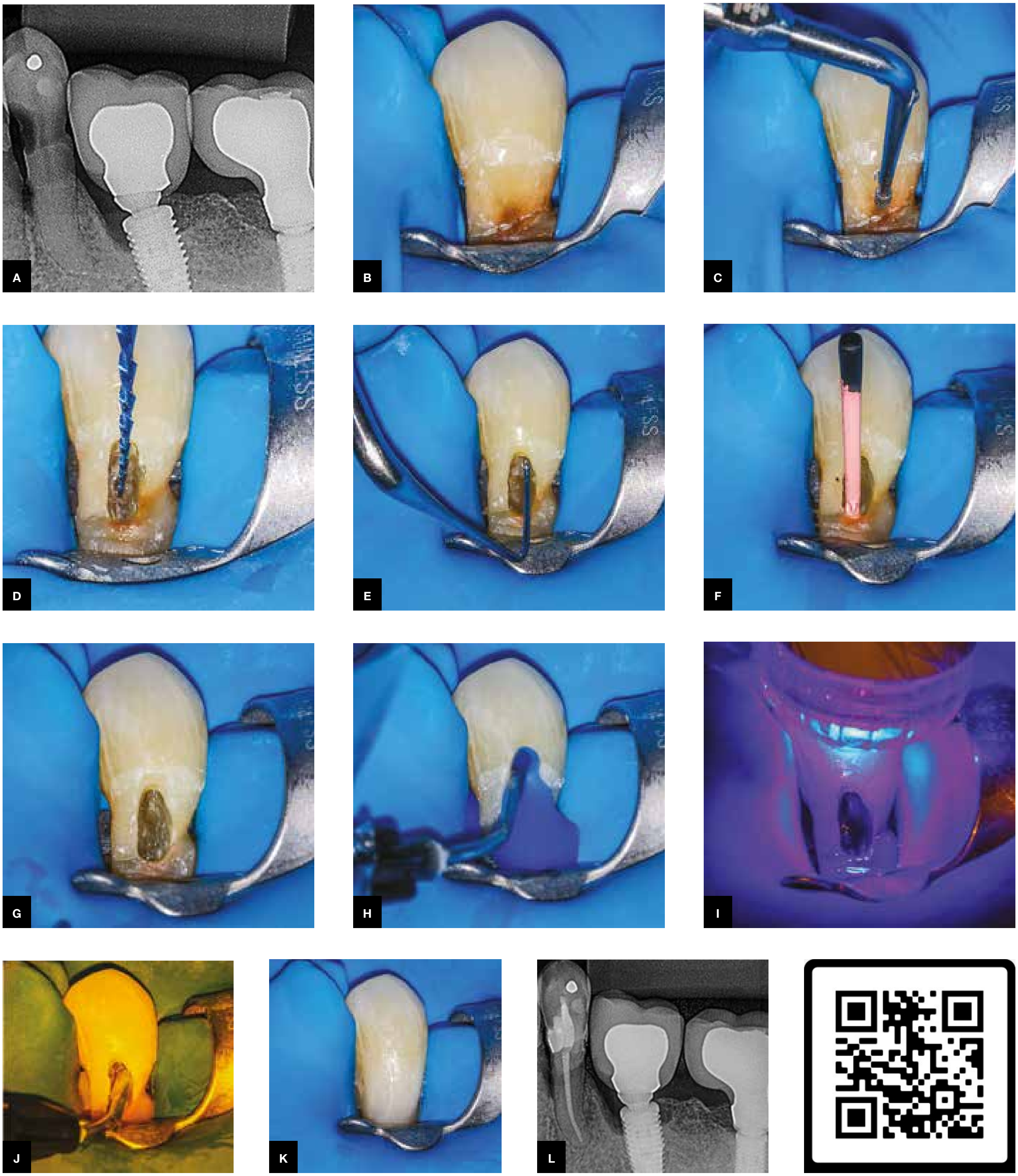

Figure 2. A) Periapical radiograph indicating the presence of caries in tooth #35. **B**) Visualization of caries in the buccal surface of the tooth. **C**) Caries removal and endodontic access through the buccal surface, using an E6D ultrasonic insert (Helse Ultrasonic). **D**) Root canal preparation with Reciproc Blue R25 and R40 instruments. **E**) Cleaning the roof of pulp chamber with pre-curved ClearSonic ultrasonic insert (Helse Ultrasonic) **F**) Selection of gutta-percha cones. **G**) Post-obturation image, showing the absence of filling materials remnants on the dentine walls. **H**) Acid conditioning with 37% phosphoric acid gel. **I**) Light curing of the adhesive system (Scotchbond Multipurpose - 3M). **J**) Restoration with flow resin (Tetric N-Ceram Ivoclair Vivadent). **K**) Final image of the post-restoration tooth. **L**) Periapical radiograph of the endodontic treatment. QR Code that refers to a video of the clinical case.

Table 1. Traditional and minimally invasive endodontic accesses at different stages of endodontic treatment.

Evaluated criteria	Traditional access	Minimally invasive endodontic access
Root canal detection	Root canal detection is easer	The root canal detection is totally dependent on the use of CBCT, operating microscope and selective wear with ultrasonic tips.
Apical transportation/ centering ability/ unprepared area/ removed dentin	None of studies showed worse results on TradAC when compared to EMI	Some studies have shown worse results, more frequently, in EMI.
Cleaning	Debridement of the pulp chamber is facilitated by the complete removal of the roof	Greater accumulation of pulp tissue remnants in the pulp chamber.
Disinfection	None of the study showed worse results on TradAC when compared to EMI	Some studies have demonstrated worse disinfection
Root canal filling	The removal of filling material is facilitated by the complete removal of the pulp chamber roof	A greater percentage of filling material was found within the pulp chamber.
Fracture resistance	Most studies did not observe any differences between TradAC and EMI	Studies that demonstrated that EMI was better than TradAC, had methodological problems.

Figure 3. Radiographic image of a mandibular molar with conservative access cavity showing excessive inclination of the endodontic instrument within the mesial (**A**) and distal (**B**) root canals during instrumentation.

Root canal filling

Although the vast majority of studies do not show differences in the ability to fill the root canals in teeth with minimally invasive access cavities, the adequate removal of the pulp chamber filling materials is a worrying fact, described in several studies (Fig 4).[11,12] Even with the use of operative microscopy, ultrasonic inserts and other specific instruments, minimally invasive access cavities are related to a greater amount of filling material remnants in pulp chamber, when compared to traditional accesses.[11,12] These remnants can compromise aesthetics by causing tooth crown discoloration over time.[26] From a clinical point of view, it is also clear that filling procedures on teeth with UltraAC cannot be performed simultaneously, for example, during the selection of the gutta-percha cone, requiring, in some cases, a greater number of radiographs.

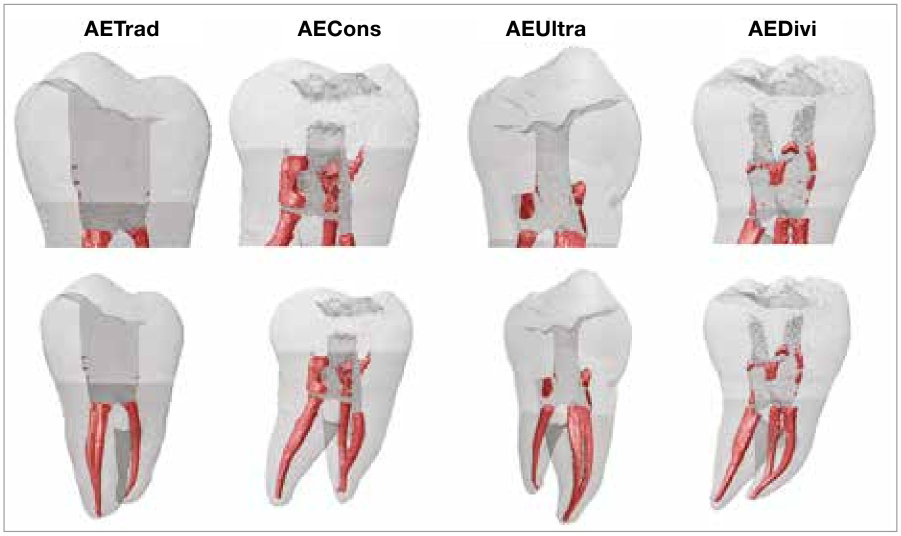

Figure 4. Images obtained by micro-CT after root canal filling in the access cavities modalities: TradAC, ConsAC, UltraAC, TrussAC demonstrating the remnants filling material in the pulp chamber.

It is important to note that some of the approaches described, such as CariesAC and RestoAC may be very similar to TradAC and, therefore, not be associated with possible impairments to the endodontic treatment. On the other hand, extremely conservative cavities, or even the one that suggests the maintenance of the pulp chamber, showed potential negative implications in several studies. Thus, due to the absence of clinical studies proving the success of these access modalities and, based on the evidence from previous laboratory studies, it is necessary, at the present time, that the use of these access cavities be avoided.

The question that everybody has been asking: do minimally invasive access cavities really preserve the fracture resistance of endodontically treated teeth?

As previously described, minimally invasive access cavities were proposed with the aim of preserving the as much dentine as possible to, supposedly, maintain the fracture resistance of endodontically treated teeth.[6,8,27,28] However, a large majority of the findings indicate that the EMI access cavities are not able to provide better results in fracture resistance, when compared to TradAC.[7,9,11,12,15]

The similar results between the types of access can be explained by the fact that the endodontic access is responsible for a minimal reduction of the relative dental hardness (5%), when compared to the occlusal (20%) or mesio-occlusive-distal (63%) cavities preparation,[29] and due to the fact that coronal restoration is able to reestablish resistance by up to 72% in relation to healthy teeth.[7,30]

Previous studies showed that 15% to 59% of endodontically treated teeth are extracted due to the presence of unsatisfactory coronal restoration.[31,32,33] Since the restorative procedure is able to directly influence the survival of endodontically treated teeth, it is important to highlight that the clinician should be able to indicate and/or perform an adequate coronal restoration according to each case.[34,35] Therefore, the knowledge of the best way to restore these teeth, associated with the excellent materials on the market, promotes an adequate reestablishment of fracture resistance, regardless of the access cavity.

Are dental fractures the great villain of Endodontics? Is the endodontist responsible for dental fractures?

Vertical root fracture is a clinical complication extremely important, as it leads to the tooth loss, and its occurrence is the main responsible for all the discussion about the performance of minimally invasive access cavities. Although these fractures can occur in teeth without endodontic treatment, it is more commonly reported in endodontically treated teeth.[36,37,38] Nevertheless, are these dental fractures the main responsible for the extraction of endodontically treated teeth?

Several studies indicate the presence of caries, inadequate restorations, unsatisfactory endodontic treatment and prosthetic reasons as the main causes of failure of an endodontic treatment,[31,33,37] while the vertical root fracture is responsible for the extraction of endodontically treated teeth in 6.4 %[33] to 13.4% of cases (Fig 5).[31,32] Even with regard to these percentages, little is known if the dental fracture occurred due to a loss of dental tissue or for any cause unrelated to endodontic treatment - such as occlusal interferences, severe periodontal disease and/or rehabilitation carried out incorrectly (Fig 6). Dental fractures certainly have a multifactorial component, and the different stages of endodontic treatment, per se, should not be considered, at the present time, as the main responsible for these fractures. It is also important to emphasize that endodontic treatment performed in a traditional way is extremely predictable, with success rates (with variations, depending on the study) of up to 97%, when adequate endodontic treatments are associated with an adequate coronal restoration.[35,39,40] These high success rates, associated with the non-role of dental fractures in the failure of endodontic treatment, lead to an important consideration: Are endodontist to blame for fractures in endodontically treated teeth? Or are these fractures, mostly, not related to the endodontic treatment itself? The performance of minimally invasive access cavities, compromising the other stages of endodontic treatment, could be able to change this scenario?

Blaming the endodontist or endodontic treatment for dental fractures seems frivolous in light of the current scientific evidence. It also seems inappropriate for the specialty and for us, endodontists, to associate endodontic treatment with dental fracture as an absolute truth. Endodontics has recently suffered, unfairly, a series of offenses and attempts to discredit the specialty (see the fraudulent documentary "Root Cause", from the Netflix platform). The movement of associating endodontic treatment with tooth loss can contribute to a new wave of depreciation.

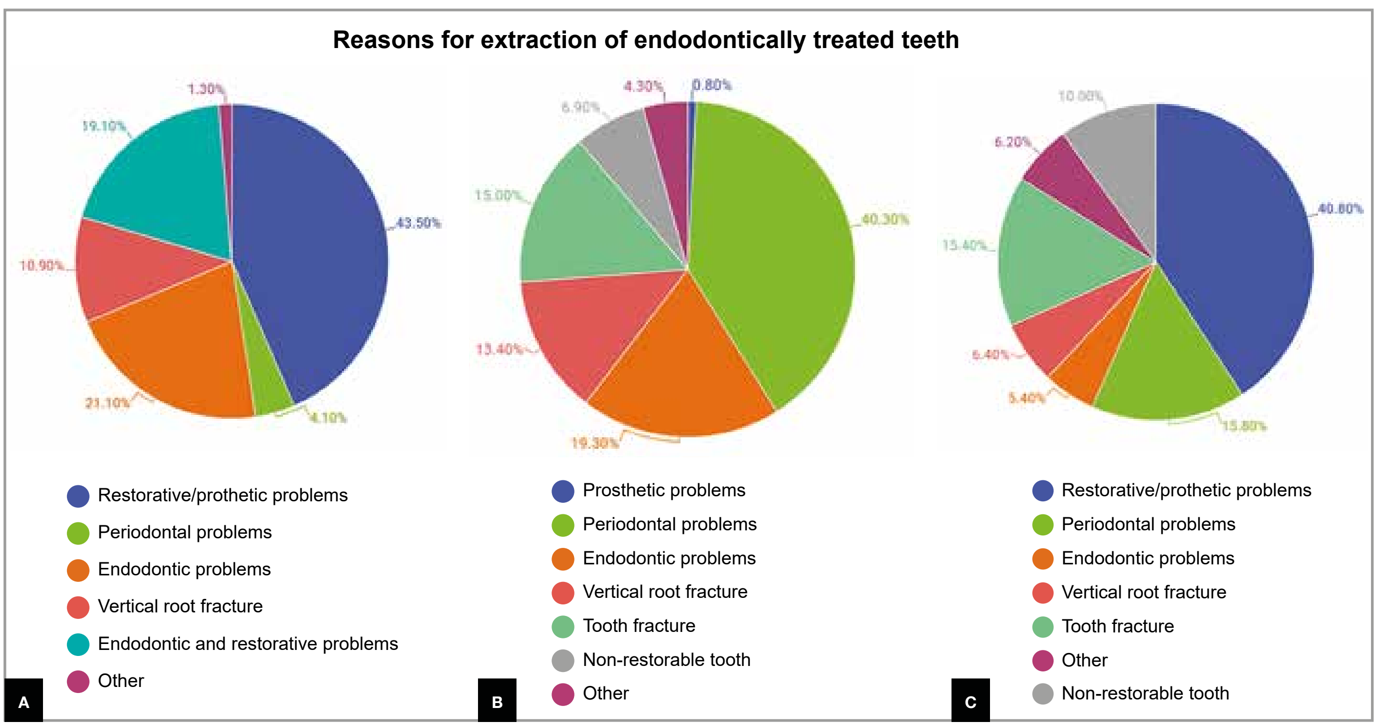

Figure 5. Graphics adapted from **A**) Fuss et al.[31] (1999), **B**) Touré et al.[32] (2011) and **C**) Olcay et al.[33] (2018), showing the main reasons for the extraction of endodontically treated tooth.

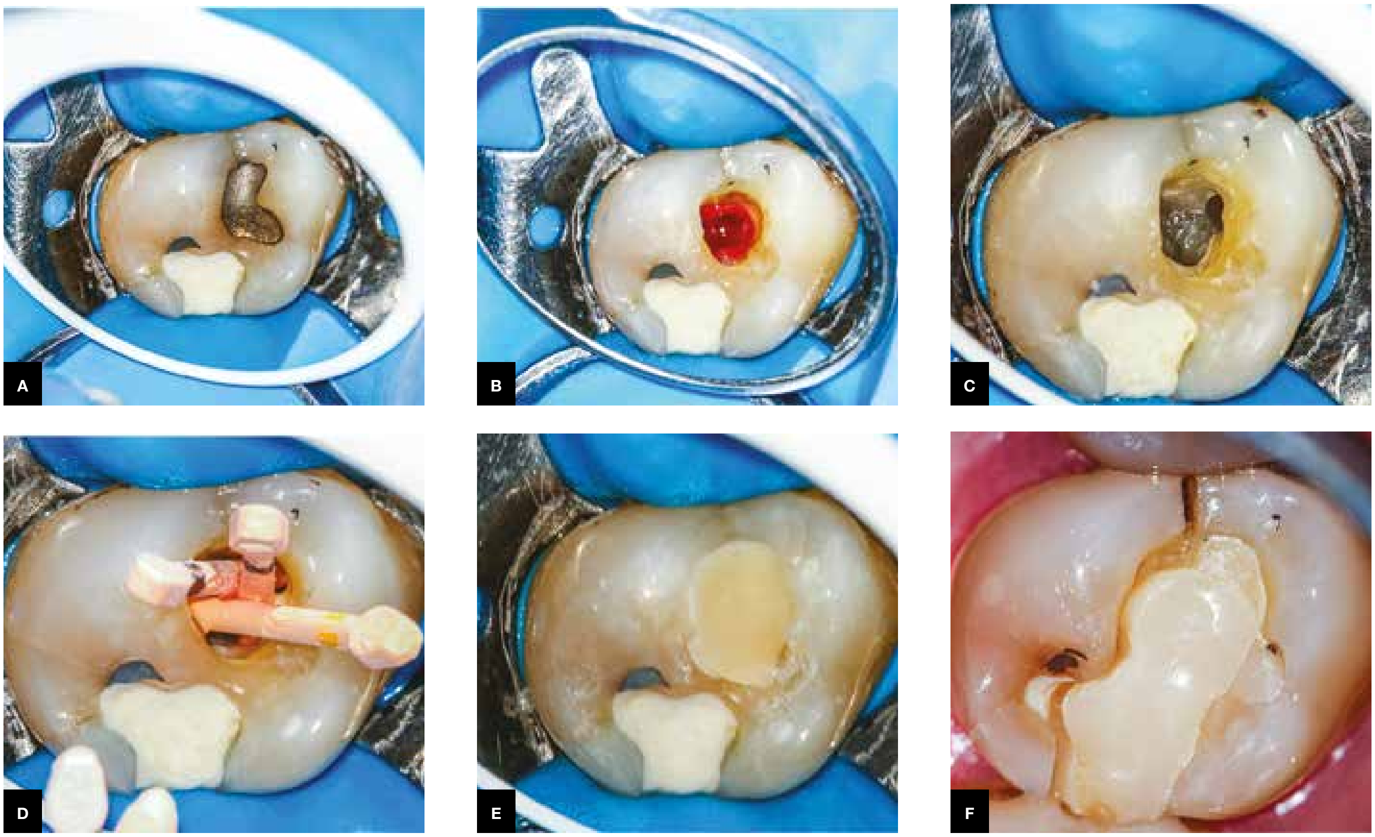

Figure 6. A) Clinical aspect of tooth #17 referred for endodontic treatment due to the presence of irreversible pulpitis. **B**) Conservative access cavity (ConsAC). **C**) Occlusal aspect after access and root canal instrumentation. **D**) Root canal filling with gutta-percha cone and AH plus sealer. **E**) Tooth with temporary restoration after endodontic treatment **F**) inadequate rehabilitation and tooth fracture.

Guided endodontic accesses - an excellent option for well-indicated cases

Guided endodontic access consists in using a personalized guide for accessing root canals, produced by 3D printers from accurate digital planning. This is based on three-dimensional images obtained by cone beam computed tomography associated with digital impression (3D) scan of dental surface.[41,42] This guide, performed mainly on teeth with calcified canal,[43] allows the access to root canals with drills, preserving dentin and reducing the risk of deviation or perforations during the procedure.[42] This access has a greater predictability and less clinical time with the patient. However, the guided access cannot be classified as a minimally invasive type of access, when compared to attempts at traditional access in calcified root canals[44] despite the dentin preservation. It is a modality with specific indications and should not be interpreted as a facilitating technique for professionals with less clinical experience and/or who do not use the appropriate technology for complex endodontic treatments, but rather as an additional tool in the arsenal of endodontists (Fig 7).

Neither minimally nor maximally: understanding contemporary endodontic access

The current technologies of three-dimensional imaging exams, operative microscopy, ultrasound inserts and more flexible endodontic instruments associated with extensive clinical experience and adequate case selection, allows, in a predictable way, what we will nominate as Contemporary Endodontic Access. As a definition, contemporary means "what is of the present time" and, as well as any operative stage, the concept behind access cavities should not be viewed in

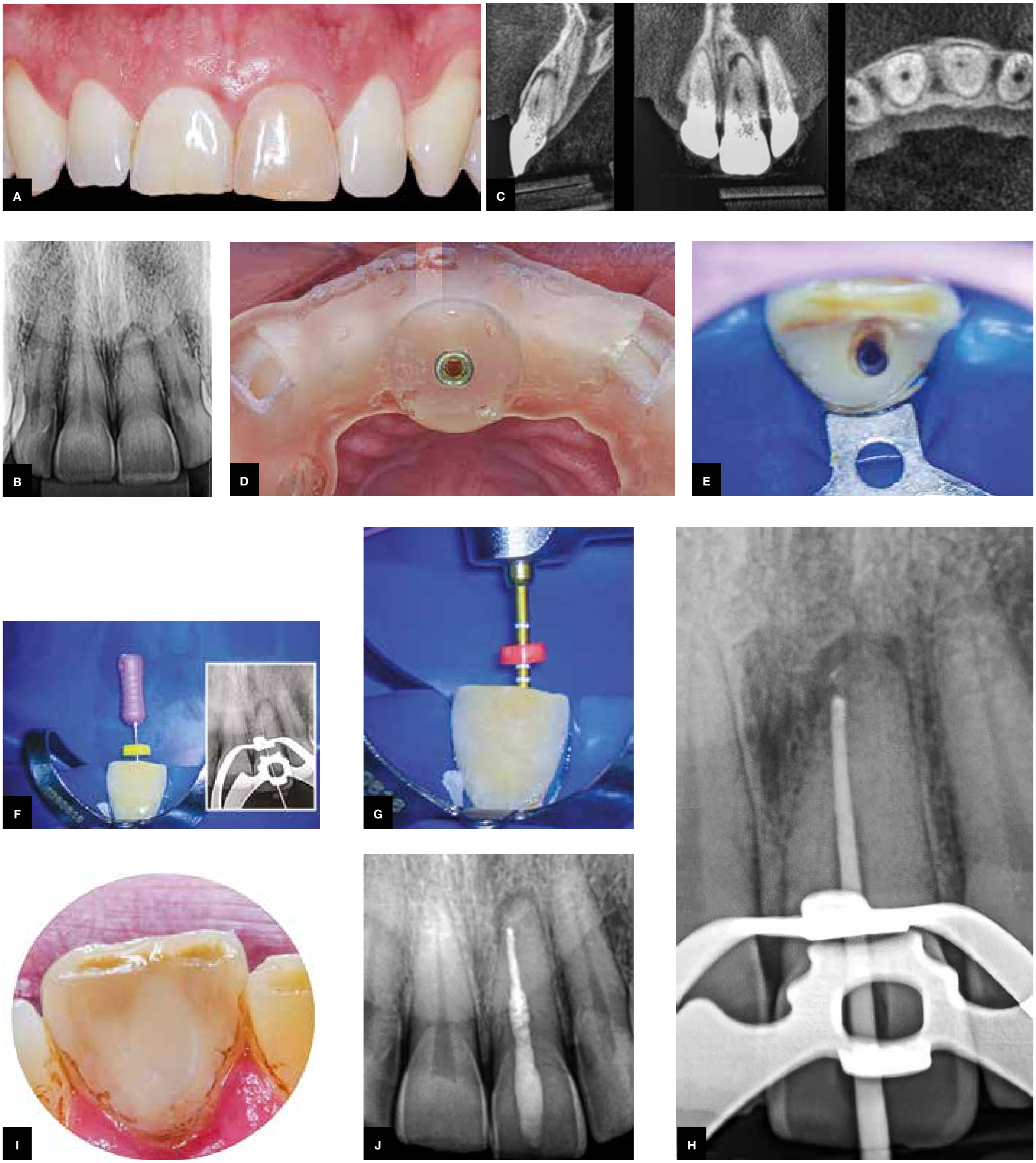

Figure 7. Sequence of a clinical case in which guided access was performed, due to the presence of calcification until the middle third of the root, and its lateralization as a result of dental trauma and unusual root formation. **A**) initial clinical aspect, with color change on tooth # 21; **B**) diagnostic radiograph, showing the presence of root calcification and periapical disease; **C**) cone beam computed tomography images showing calcification up to the middle third of the root, lateralization of the root canal and presence of apical lesion; **D**) adaptation of the guide in the mouth; **E**) coronary access using the guide, without excessive wear and direct access to the root canals; **F**) radiograph to verify the patency length; **G**) root canal instrumentation, respecting the biological and mechanical principles of preparation; **H**) selection of gutta-percha cones; **I**) clinical occlusal appearance after restoration of the access cavity with composite resin; and **J**) periapical radiograph immediately after root canal filling, showing greater cervical wear, referring to the drill's path until the limit of calcification.

a static way as these accesses can change over time. In fact, these changes have already happened in the so-called traditional endodontic accesses; just check out a textbook from the beginning of the last century and compare it with a current book. Although the two books, at different times, can describe the access as being traditional, they will certainly point out marked differences in their form. However, like all interventions in the area of health sciences, a procedure, to be modified or introduced, must be based on scientific evidence, without leaving aside the basic principles of Endodontics.

Contemporary access is guided by the anatomy of root canals, allowing the preservation of dental tissue without leaving aside scientific and biological basis of endodontics, such as the removal of the pulp chamber roof, guaranteeing an adequate disinfection and the use of endodontic instruments with no coronal interference (Figs 8, 9 and 10).[45,46] It is important to remember that, although much is discussed about the minimally invasive accesses, the clinical scenario that allows its accomplishment does not seem to occur very often, representing only 8% of the cases according to a recent study.[8] This is also the reality observed by the authors of this paper (Fig 11).

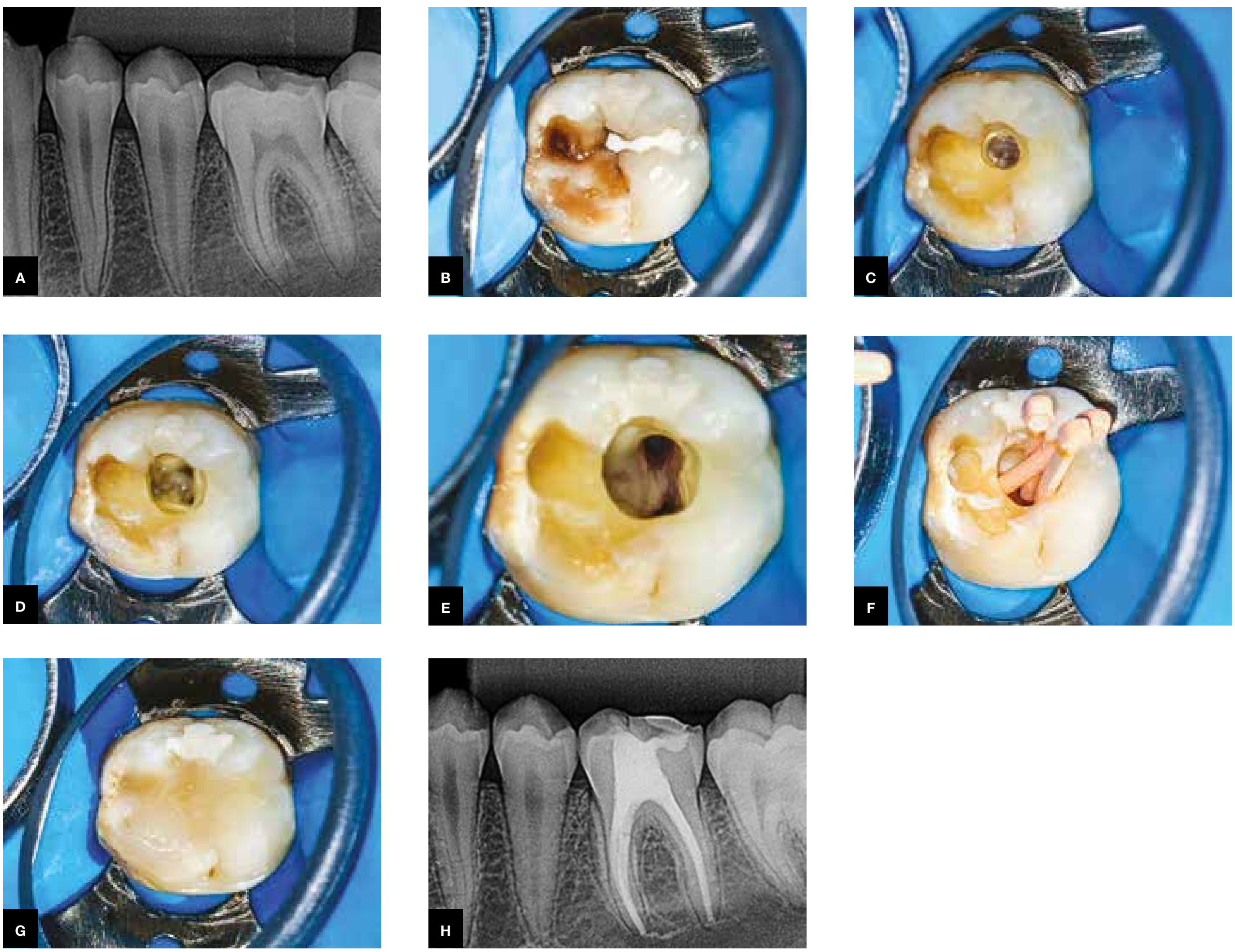

Figure 8. A) Initial radiograph indicating the presence of a perirradicular lesion at the mesial root of tooth # 46. **B**) Occlusal surface showing the presence of caries. **C**) Endodontic access cavity initiated. **D**) Image after access cavity was completed. **E**) Post-instrumentation image of the root canals. **F**) Selection of gutta-percha cones. **G**) Restoration with flow resin (Tetric N-Ceram Ivoclair Vivadent). **H**) Final radiograph after endodontic treatment.

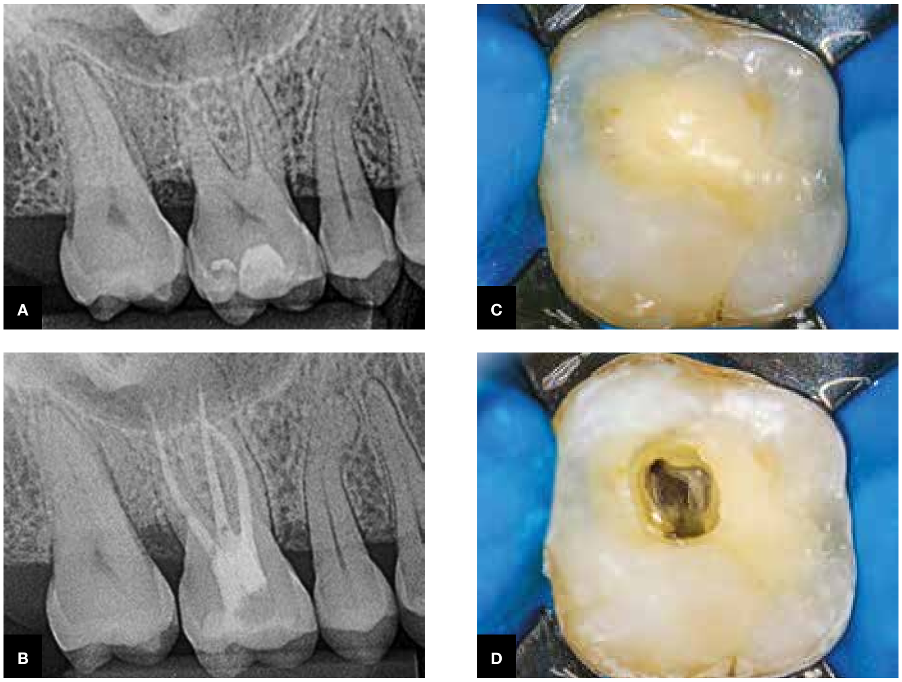

Figure 9. A) Initial radiograph. **B**) Final radiograph of endodontic treatment. **C**) Image of the occlusal surface of the tooth before access. **D**) Post-access occlusal surface.

Figure 10. A) Initial radiograph. **B**) Final radiograph of endodontic treatment with contemporary endodontic access.

Figure 11. Routine clinical cases that require endodontic treatment, in which the performance of any minimally access cavity is not viable.

Conclusion

Considering the data available in literature, there is a lack of robust evidence to support the claim that minimally invasive access cavities preserve the fracture resistance of endodontically treated teeth better than in teeth accessed in a traditional way. Moreover, these cavities can interfere in other stages of endodontic treatment, and can make it unpredictable. Thus, it can be concluded that there is a lack of evidence to support the introduction of minimally invasive access cavities in practice routine clinic and/or in the training process of undergraduate and graduate students.

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