TOP TIPS

Top tips for endodontic access

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Background

Orthograde root canal treatment (RCT) or root canal treatment (RCReTx) is a multi-step process for the treatment or prevention of apical periodontitis. Securing adequate access to the root canal system is one of several factors which influence the overall success of these procedures. In this paper, we offer top tips for effectively and efficiently securing endodontic access.

Clinical objectives for endodontic access

a. Removal of all diseased tooth tissue and identification of poor prognostic factors (cracks/fractures)
b. Direct (ideally straight-line) access to the root canal orifice(s) (Fig. 1)
c. Conservation of dentine (as far as is practicable)
d. A four-walled cavity that facilitates controlled provision of the RCT
e. Temporisation that reduces the risk of (further) bacterial ingress and tooth fracture.

Armamentarium

a. Dental loupes with a direct light source are recommended for use in RCT/RCReTx, as well as an operating microscope (if available). However, magnification may affect spatial awareness, and the operator must take care to orientate their handpiece correctly to avoid adverse angulation of the cavity and the subsequent risks of excessive removal of tooth structure and perforation
b. Front surface reflecting dental mirrors are preferred as they eliminate the 'double image' produced with rear surfaced mirrors
c. Further recommended equipment is listed in Table 1.

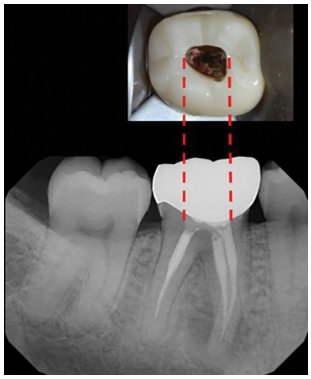

Fig. 1 Conservative endodontic access cavity prepared through a recently placed zirconia crown, prior to RCReTx

Table 1 Further recommended equipment for endodontic access

Instrument	Photo	Comments
DG-16 probe.	Fig. a 	Double-ended probe with long sharp tips. Useful for identifying root canal orifices and determining the angulation of the coronal aspect of the canal with respect to the pulp chamber floor. Can be used to 'pick' away material from the walls and floor of the access cavity.
Long-tapered, round-ended, course diamond bur (eg 770.8C bur from Two-Striper, Abrasive Technology, Lewis Center, Ohio, USA).	Fig. b 	Length of bur enhances ability to orientate and improves visibility. Round-end avoids creation of step defects. Course diamond coating provides for efficient tooth preparation. Useful for removal of restorative material* within the restorability assessment, and for gaining initial access to the pulp chamber.
Long-tapered, safe-ended, tungsten carbide bur (eg Endo-Z, Dentsply Maillefer, Ballaigues, Switzerland).	Fig. c 	The non-cutting tip will follow the outline of the floor of the access cavity (or walls of the root canal in teeth with single wide canals). The tip can then be moved laterally like a 'milling machine' to de-roof the pulp chamber, and create smooth flowing axial walls into the root canal(s).
Pulp chamber bur (Hager & Meisinger GmbH, Neuss, Germany).	Fig. d 	Long shank enhances visibility. Round end cuts dentine without leaving steps (and does not 'smear' dentine like ultrasonic instruments can). Available in different sizes 120 (1.2 mm) – 180 (1.8 mm). Useful for removing calcifications to uncover the pulp chamber floor.
Ultrasonic instruments (eg Start-X, Dentsply Maillefer, Ballaigues, Switzerland).	Fig. e 	Ultrasonic instruments of various designs can be used to refine and finish the preparation of the access cavity walls, and remove calcification from the floor of the pulp chamber of the access cavity. Using ultrasonics dry (eg without water coolant) enhances visibility, but will heat the dentine, necessitating intermittent alternate irrigation to cool the dentine. Caution should be exercised that 'false canals' are not inadvertently prepared when using pointed tipped ultrasonic instruments.

*Where a metallic restoration needs to be cut through, a tungsten-carbide bur may be more efficient than a diamond coated bur.

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Fig. 2 Maxillary left first molar with previous, aborted attempt, to gain endodontic access through existing metallic (amalgam) restoration

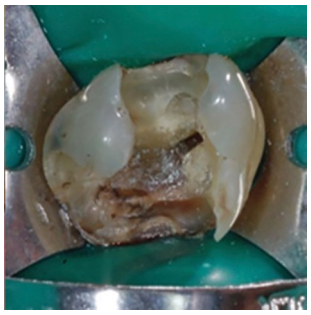

Fig. 3 Removal of restorations revealed secondary caries, and that the pulp chamber floor was obscured by calcification

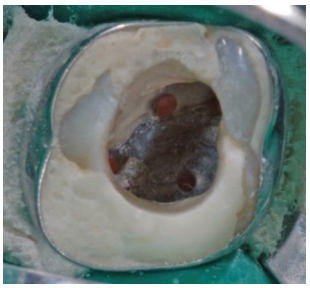

Fig. 4 Following removal of the caries and calcifications, missing axial walls were replaced with temporary restorative material, access cavity refined, and RCT completed

Fig. 5 Expected position of pulp chambers in mandibular and maxillary teeth (with the exception of third molars, in which the anatomy is particularly variable)

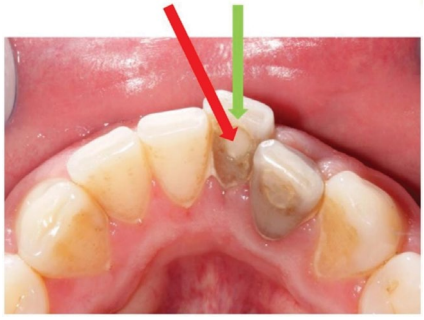

Fig. 6 Misaligned access cavity in the 41. Red arrow indicates direction of tunnelling (which resulted in root perforation on the labial aspect). Green arrow indicates the correct orientation of the bur for initial access cavity preparation in this tooth

Restorative assessment

a. Teeth requiring RCT/RCReTx should be assessed for restorability, with all caries and existing restorations removed prior to endodontic access[1] (unless the restoration has been recently placed and is deemed to be satisfactory)

b. Direct visualisation and assessment of the remaining sound dentine enables the clinician to formulate a restorative prognosis for the patient's tooth[2,3,4] and allows planning of the definitive restoration (Figures 2, 3 and 4).

Orientation and initial access

a. Prior to access cavity preparation, the expected boundaries of the pulp chamber (roof, walls, and floor) and root canal orifice(s) should be mentally visualised, aided by:

i. Knowledge of anatomical trends in the position of pulp chambers and root canals, based on tooth type (Fig. 5)

ii. Clinical assessment to determine the orientation of the tooth in the arch (eg proclination/retroclination, or rotation) (Fig. 6), which may be disguised by restorative materials

iii. Two-dimensional (2D) radiographic assessment with long cone periapical (LCPA) radiograph (supplemented by a second LCPA at a different angle as required), to assess for:

1. Presence and extent of existing restorative materials and caries
2. Position of pulp chamber/pulp horns. Measurement of the distance between the occlusal table (or incisal edge), and the roof of the pulp chamber can help guide the point of initial entry to the pulp chamber. Equally, especially where there has been extensive calcific metamorphosis within the pulp chamber, the expected position of the floor of the pulp chamber can also be estimated from the LCPA
3. Position and number of root canals

iv. three-dimensional cone radiographic assessment with cone beam computed tomography (CBCT) scan can be a useful adjunct to 2D imaging. However, the use of CBCT should be balanced against the risks of additional radiation exposure, as well as awareness of the limitations in image quality associated with artefacts due to metallic restorations and root-fillings.[5] Situations where CBCT may be helpful within the assessment include:

1. Complex anatomy, including *dens invaginatus*
2. RCReTx where there is suspected untreated root canal anatomy.
3. Assessment and planning for management of iatrogenic issues (Figures 7 and 8).

b. The drilling sequence for access cavity preparation should commence in the centre of the outline of the planned access cavity, using a long-tapered diamond bur, heading initially for the point of the maximum height of the pulp chamber (as identified on a pre-operative radiograph). Once the roof of pulp chamber is breached and floor identified, the access cavity can be extended laterally, using a safe-ended side-cutting bur, and refined (as far as possible) to meet the requirements of the objectives of access cavity preparation listed in section 2

Fig. 7 LCPA radiograph of 41, 42 and 43 (as shown clinically in Fig. 6). Although not demonstrated in this 2D image, from the history and examination, a labial root perforation was suspected

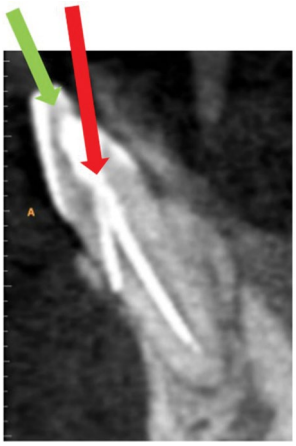

Fig. 8 Sagittal slice from CBCT showing 41 with mis-aligned access cavity (red arrow) and iatrogenic perforation within the mid-third of root at the labial aspect. Straight-line access to the root canal(s) was subsequently achieved by extending the access cavity just into the incisal edge, with bur angulated to the long-axis of the tooth (direction indicated by green arrow)

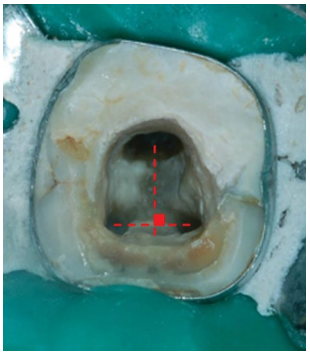

Fig. 9 Lines superimposed over the pulp chamber floor of a mandibular first molar to demonstrate adherence to the 'laws' of the symmetry

c. The cavity should allow direct (ideally) or indirect access to the pulp horns for debridement and disinfection, as remaining pulpal tissue may compromise the disinfection and result in unsightly staining of the tooth.[6] There should be an absence of overhangs or ledges above the root canal orifices that may inhibit easy placement of files or obturating materials
d. Upon preparation of the access cavity, the walls and floor of the pulp chamber should be screened for cracks and fractures, which if present, may influence the restorability of the tooth.

Rubber dam

a. Rubber dam isolation is considered the standard of care within the delivery of RCT/RCReTx.[7] However, if rubber dam is placed prior to access cavity preparation, this will obscure key anatomical landmarks, increasing the risk of misalignment, compromising identification and instrumentation of the root canals, and weakening the tooth +/- perforation. Therefore, less experienced operators may find it pragmatic to initiate access cavity preparation without rubber dam in-place, but to isolate with rubber dam immediately after the initial access has been secured
b. Once rubber dam is *in situ* +/- placement of caulking agent (eg OraSeal Caulking, Ultradent Products, South Jordan, Utah, USA) to enhance the seal, the following surfaces should be disinfected by wiping them over with a cotton wool pledget soaked in 1–5% sodium hypochlorite irrigant (concentration as per operator preference): external surface of the tooth/teeth to be treated, rubber dam adjacent to the tooth/teeth, as well as the clamp (as applicable). The access cavity should then be flushed with the same irrigant and refined, as necessary, prior to initiating chemomechanical preparation of the root canals.

Identification of the pulp chamber floor and root canal orifice(s)

a. In teeth with multiple root canals, the root canal orifices naturally lie in the floor of the pulp chamber. The exception to this is if there has been significant instrumentation (dentine removal) from the pulp chamber floor, which can result in the transportation of the orifice(s) to the wall(s) of the pulp chamber
b. In teeth subject to ageing/cracks/caries/restoration, the pulp chamber may be significantly reduced in size, or even completely obliterated, due to the presence of calcification or restorative materials related to previous treatment. Such situations can present significant challenges to root canal identification. However, fortunately, there are a number of anatomical landmarks which can aid in the identification of the pulp chamber floor and root canal orifice(s), which were described by Krasner and Rankow[8] in 2004, and are listed below. Described as 'laws', the guidance is applicable in most situations, but anatomical variation exists, and so judicious application is required in the clinical setting
c. 'Laws' for the identification of the pulp chamber floor:
   i. **Law of centrality**: the floor of the pulp chamber is always located in the centre of the tooth at the level of the cementoenamel junction (CEJ)
   ii. **Law of concentricity**: the walls of the pulp chamber are always concentric to the external surface of the tooth at the level of the CEJ
   iii. **Law of the CEJ**: the CEJ is the most consistent and repeatable landmark for locating the position of the pulp chamber. In cases of pulp canal obliteration use of this landmark to aid location of the pulp chamber floor may be particularly helpful. The expected required depth of access cavity can be determined by measuring/comparing the distance between CEJ and an occlusal reference point using either a UNC-15 probe, or the access bur itself
d. Laws for the identification of root canal orifices:
   i. **Law of symmetry 1**: except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesio-distal direction through the pulp chamber floor (Fig. 9)
   ii. **Law of symmetry 2**: except for maxillary molars, the orifices of the canals lie on a perpendicular line

drawn in a mesio-distal direction across the centre of the floor of the pulp chamber (Fig. 9)

iii. **Law of colour change**: colour of the pulp-chamber floor is always darker than the walls (Fig. 10)

iv. **Law of orifice location 1**: orifices of the root canals are always located at the junction of the walls and the floor (Fig. 10)

v. **Law of orifice location 2**: orifices of the root canals are located at the angles in the floor-wall junction (Fig. 11)

vi. **Law of orifice location 3**: orifices of the root canals are located at the terminus of the root developmental fusion lines

e. In vital teeth, a root canal orifice may be identified from a bleeding point in the floor of the pulp chamber

f. Where it is uncertain whether a bleeding point represents a root canal orifice or perforation, an apex locator connected to the end of a DG-16 probe or endodontic file (when rubber dam is in place) can be placed on the bleeding point. A perforation will register as a 'zero-reading'

g. The degradation of organic tissue by sodium hypochlorite produces gaseous products, which within a pulp chamber filled with this irrigant, can sometimes be seen to bubble up from their point of origin – helping to identify the position of root canal orifices

h. Where a root has a single canal, the canal will be centred within the root. However, where a root has more than one root canal, the root canals will be 'off-centre'. Where one root canal been identified, and a second suspected, but not yet found, an angled LCPA radiograph may be taken (with a file inserted inside the located canal) to determine whether this is centred or not

i. The closer the root canal orifices are to each other, the more likely they are to merge into a single canal within the root

j. Maxillary first molar teeth generally have four root canals, mesio-buccal (MB) 1, MB2, disto-buccal and palatal. Untreated MB2 canals are a common cause of endodontic failure in these teeth,[9] as the MB2 orifice can be challenging to locate, especially without the use of magnification. Görduysus *et al.* (2001)[10] reported that the MB2 orifice was often found on a line between the MB1 and palatal root canal, usually within 2 mm of the MB1 orifice (Fig. 11).

Fig. 10 Maxillary first molar with failed primary RCT in which MB2 had not been previously located

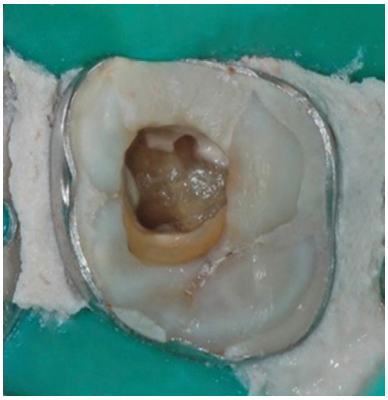

Fig. 11 Intra-operative view of the same tooth, after identification and shaping of MB2

Optimisation of RCT/RCReTx

a. Following restorability assessment, any missing axial walls should ideally be (temporarily) restored (Fig. 4) with a glass-ionomer cement +/- an orthodontic band (in posterior teeth), or composite resin (directly or via a temporary crown). This facilitates creation of a four-walled access cavity, which provides the following advantages:

i. Alongside the use of rubber dam, contributes to effective intra-appointment isolation

ii. Creates a reservoir for irrigants to pool and exchange

iii. Ease of temporisation (if multi-visit treatment), allowing efficient and effective attainment of an inter-appointment coronal seal

iv. Reduces the risk of coronal fracture

b. The replacement of metallic restorations with non-metallic direct restorations reduces aberrant electronic apex locator readings via short-circuiting.

Protection of the tooth and temporisation

a. The stiffness, and resistance to fracture, of teeth which are undergoing, or which have undergone RCT/RCReTx, is significantly reduced, especially in posterior teeth, where one or more marginal ridges have been lost.[11] Ultimately the predictability of survival posterior root filled teeth is enhanced by provision of a definitive cast cuspal-coverage restoration (ideally cast).[12] However, prior to definitive restoration of posterior teeth, undergoing, or which have undergone RCT/RCReTx, the following precautions can be taken to reduce the risk of fracture:

i. Placement of an orthodontic band (Fig. 11)

ii. Reduction of cusps by 2 mm and provision of occlusal coverage with a 2 mm layer of either glass ionomer cement (GIC) or composite resin to contribute to a more uniform loading of the tooth tissue. Where there is already inter-occlusal space (eg posterior open bite, deficient opposing restoration, etc) then occlusal reduction may not be necessary prior to provision of the build-up

iii. Provision of a temporary crown, and (re)accessing through it

b. Where the RCT/RCReTx is being carried out over more than one session, inter-appointment temporisation can be achieved by dressing the root canal(s) with non-setting calcium hydroxide, placement of a piece of sponge into the access cavity (allowing room for a depth temporary restorative material coronally), and placement of a temporary restoration, such as GIC or Intermediate Restorative Material (IRM) (Dentsply Sirona, Charlotte, North Carolina, USA).

We hope that these top tips will provide a useful guide for achieving efficient and effective endodontic access. The advice given may require some adaptation to individual clinical circumstances. ■

Top tips are intended as a series of experiential tips, rather than a compendium of the evidence.

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New data confirm distressing trend in child oral health

New data[1] published by the NHS in February for the financial year 2022 to 2023 expose a concerning reality: a staggering 47,581 episodes of tooth extractions for 0 to 19-year-olds in NHS hospitals, marking a distressing trend in childhood oral health.

Of these extractions, a significant 66% – 31,165 episodes – were attributed to tooth decay, underlining the pervasive impact of dental issues among the younger demographic.

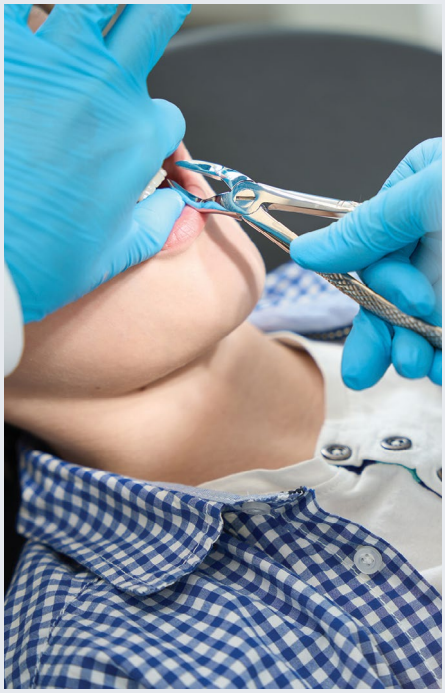
Worryingly, there has been a notable 17% increase in decay-related tooth extractions for 0 to 19-year-olds compared to the previous financial year (2021 to 2022). The increase has been attributed to the ongoing recovery of hospital services from post-COVID-19 backlogs.

Notably, children and young people residing in the most deprived communities faced a staggering 3.5 times higher decay-related tooth extraction rate than those in affluent areas, highlighting deep-rooted oral health inequalities.

Even more concerning is the revelation that tooth decay remains the leading cause of hospital admission for children aged 5 to 9 years.

Dr Nigel Carter, chief executive of the Oral Health Foundation, said: 'In the face of staggering oral health inequalities, it is disheartening to witness over 30,000 teeth being extracted due to tooth decay. It is a stark reminder of the persistent connection between dental health and deprivation.

'The current data reveal a concerning truth – although the number of extractions is lower than pre-COVID levels, the lingering backlogs in the system obscure the real extent of the issue. This



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situation is unequivocally unacceptable, demanding immediate action.

'To combat childhood tooth decay, the implementation of preventive policies such as water fluoridation and comprehensive toothbrushing programmes is imperative.

'The government must step up efforts to enhance dental access nationwide, ensuring that every child has the opportunity to receive routine dental care. It is time for a concerted effort to address this pressing public health concern and pave the way for a brighter, healthier future for our children.'

Geographical variations in decay-related tooth extraction rates are evident, with Yorkshire and the Humber reporting the highest rates (405 per 100,000 population of 0 to 19-year-olds) and the East Midlands the lowest (80 per 100,000 population of 0 to 19-year-olds).

On the financial front, the costs to the NHS for hospital admissions related to tooth extractions in children aged 0 to 19 years were estimated at £64.3 million, with £40.7 million specifically for decay-related procedures.

Dr Charlotte Eckhardt, Dean of the Faculty of Dental Surgery (FDS) at the Royal College of Surgeons of England, said that the figures 'Are a sobering reminder of the prevalence of tooth decay, something which is largely preventable. The 17% jump in the number of episodes of decay-related tooth extractions in hospitals for 0 to 19-year-olds highlights the urgent need for improved access to NHS dentists.

'Children and young people should be encouraged to brush their teeth regularly with fluoride toothpaste, visit the dentist, and cut down on sugary foods that can lead to decay. The data lay bare the huge inequalities in dental care and enormous cost to the NHS, with decay-related tooth extraction episode rates for children and young people living in the most deprived communities nearly three and a half times that of those living in the most affluent communities.

'The FDS supports the expansion of targeted fluoridation to low socioeconomic areas and the introduction of supervised tooth brushing.'

The full data are available at: https://www.gov.uk/government/statistics/hospital-tooth-extractions-in-0-to-19-year-olds-2023.

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