

IN BRIEF

- Emphasises the anatomy of molar teeth in relation to endodontic treatment.
- Discusses the assessment of teeth prior to commencing endodontic treatment.
- Describes common problems encountered when preparing access cavities and how to overcome them.

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CPD PAPER

A practical guide to endodontic access cavity preparation in molar teeth

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The main objective of access cavity preparation is to identify the root canal entrances for subsequent preparation and obturation of the root canal system. Access cavity preparation can be one of the most challenging and frustrating aspects of endodontic treatment, but it is the key to successful treatment. Inadequate access cavity preparation may result in difficulty locating or negotiating the root canals. This may result in inadequate cleaning, shaping and filling of the root canal system. It may also contribute to instrument separation and aberrations of canal shape. These factors may ultimately lead to failure of treatment. Good access cavity design and preparation is therefore imperative for quality endodontic treatment, prevention of iatrogenic problems, and prevention of endodontic failure (Fig. 1).

The aim of this paper is to present a simple guide to preparing access cavities in molar teeth, and how to identify and avoid potential complications.

The 'ideal' access cavity frequently described in endodontic textbooks usually show easily identifiable canal entrances at the base of a large pulp floor (Fig. 2). In the past, access cavities tended to be standardised depending on tooth type, however with modern endodontic techniques, a dental operating microscope and loupes providing magnification and better illumination, an access cavity is now mostly dictated by the individual pulp chamber morphology of the tooth being treated.

Access cavity preparation may be divided into four stages:

- Pre-treatment assessment
- Preparation of the tooth for endodontic treatment
- Removal of the roof of the pulp chamber and coronal pulp tissue
- Creating straight line access.

Pre-treatment assessment

The likelihood of gaining adequate access for endodontic treatment should be determined during treatment planning. If access to the tooth is difficult treatment may be compromised. This is likely to be even more relevant with complex re-treatment procedures. Once accessibility has been confirmed, it is necessary to mentally visualise the location of the pulp chamber. The angulation and any rotation of the tooth or coronal restoration in relation to the roots should be assessed as this will have a bearing on the design of the access cavity. The position of the cemento-enamel junction and furcation should also be noted as these landmarks help indicate the location of the level of the pulp floor and the probable position of the canal entrances.

A pre-operative periapical radiograph of the tooth taken with a beam-aiming device to ensure no image distortion should be studied, along with any relevant bitewing radiographs. In some instances it may be helpful to take additional angled periapical radiographs to

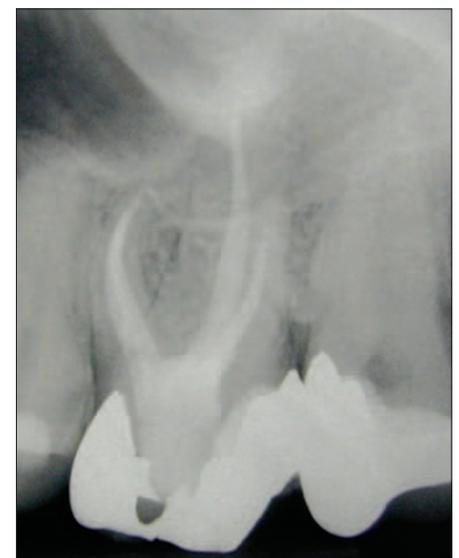


Fig. 1 Good access cavity design results in identification and subsequent disinfection and obturation of the entire root canal system

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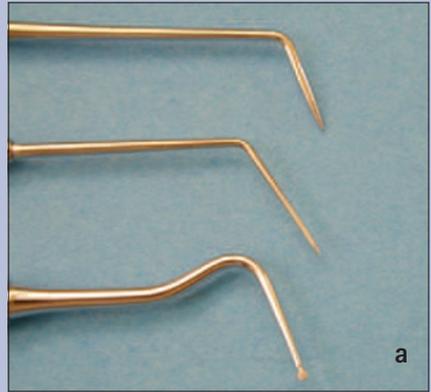
Fig. 2 Access cavity of a lower first molar; note the three canal orifices are connected by developmental (dark) lines. These lines are sometimes referred to as the 'dentine map'



Figs 3a-b (a) Lower first molar with significantly reduced pulp chamber height, pulp calcifications and signs of canal sclerosis; this tooth will be more challenging to access. (b) The canals in this upper first molar tooth appear to be completely sclerosed



Fig. 4 Pulp calcifications obscuring the canal orifices



Figs 5a-c (a) Top to bottom, standard probe, a DG16 endodontic explorer and a long shank small spooned excavator. (b) Operating dental microscope with an observer-scope for the dental assistant (Global Surgical Corporation, St. Louis, USA). (c) Loupes with a fibre optic light source (Global Surgical Corporation, St. Louis, USA)

separate the different roots which may otherwise be superimposed over each other. From these radiographs the position, size, depth and shape of the pulp chamber, position of the pulp horns, number of roots and the degree of curvature can be assessed.

Careful assessment of pre-treatment radiographs may indicate potential challenges to canal identification. Large pulp spaces and obviously patent canal entrances may be common in younger patients, but as teeth age, secondary dentine is laid down resulting in a reduction in the pulp chamber volume, and size of the root canal lumen. This often results in the loss of helpful anatomical landmarks and changes in the shape of the pulp chamber which will be unique to each tooth.

The dimensions of the pulp chamber and location of the root canal entrances will also be influenced by the amount and position of tertiary dentine deposited as a specific response to caries, microleakage and tooth surface loss over the course of a tooth's life (Figs 3a-b). These insults on the pulp may have a dramatic effect on the size and shape of the pulp chamber. Canal entrances may also become obstructed by pulp stones and other dystrophic calcifications, resulting in the identification of the

root canal entrances being more challenging (Fig. 4).

Preparation of the tooth for endodontic treatment

A front surface mirror, DG16 endodontic probe, long shank small excavator, magnification and good illumination are essential for endodontic treatment (Figs 5a-c).

Caries and failing restorations must be completely removed prior to preparing the access cavity. If at the pre-treatment assessment stage there is any doubt regarding the restorability of the tooth, the existing restoration should be completely removed to confirm that there is sufficient tooth substance remaining (Figs 6a-e). Removal of existing restorations may also reveal hairline cracks on one or more axial walls which could influence the endodontic prognosis and the design of the future post-endodontic restoration (Fig. 7).

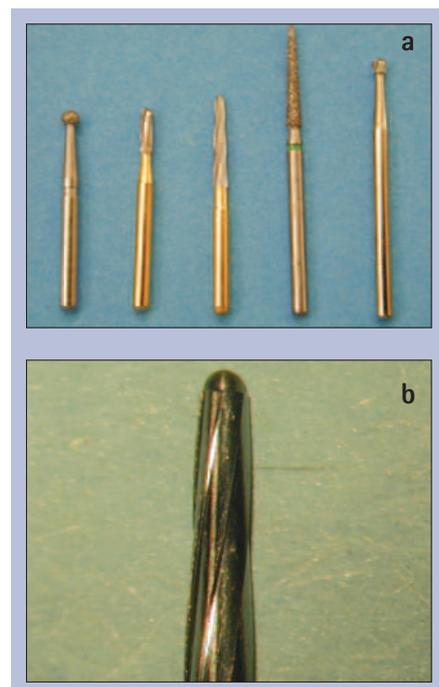
Unsupported cusps should be removed or protected by placing an orthodontic band around the tooth to prevent cusp fracture during and immediately after treatment. In some cases, following dismantling of the coronal restoration, it may be necessary to place a provisional restoration to firstly aid rubber dam placement, and secondly create



Figs 6a-e (a) WamKey (Dentsply Maillefer Instruments, Ballaigues, Switzerland) can be used to atraumatically and quickly remove crowns, (b) a slot is prepared on the buccal aspect just below the fit surface of the occlusal aspect of this metal-ceramic crown. (c) The WamKey is inserted into the access hole and rotated, (d) the crown comes off in one piece. (e) The existing restoration is removed to reveal an unrestorable tooth. If the tooth had been restorable the existing crown may have been used as a temporary crown



Fig. 7 Removing the entire restoration reveals a crack (red arrow) and caries in the mesial box



Figs 8 a-b (a) left to right, #2 round diamond bur, tungsten carbide fissure bur, Endo Z bur, Axxcess bur and #2 tungsten carbide round bur, the last two burs (SybronEndo, Orange, CA, USA) have a longer shank and allow better vision when used with magnification. (b) Close up of the non-end cutting Endo-Z bur (Dentsply Maillefer Instruments, Ballaigues, Switzerland)

a reservoir for irrigant solution in the access cavity.

Removal of the roof of the pulp chamber and coronal pulp tissue

The roof of the pulp chamber should be penetrated through the central portion of the crown, at a point where the roof and floor of the pulp chamber are at the widest; this commonly occurs at the point where the pulp horn relating to the largest canal is situated (for example, palatal root in maxillary molars and distal canal of mandibular molars). Tungsten carbide burs are ideal for cutting through metal; however, a diamond bur should be used to map out the access in porcelain fused to metal crowns before using a tungsten

carbide bur to reduce the likelihood of porcelain fracture (Fig. 8). It is always wise to warn the patient that the crown may be irreversibly damaged and may need replacement following endodontic treatment. Once the roof of the pulp chamber has been breached, the bur will suddenly drop into the pulp chamber space (Figs 9a-d).

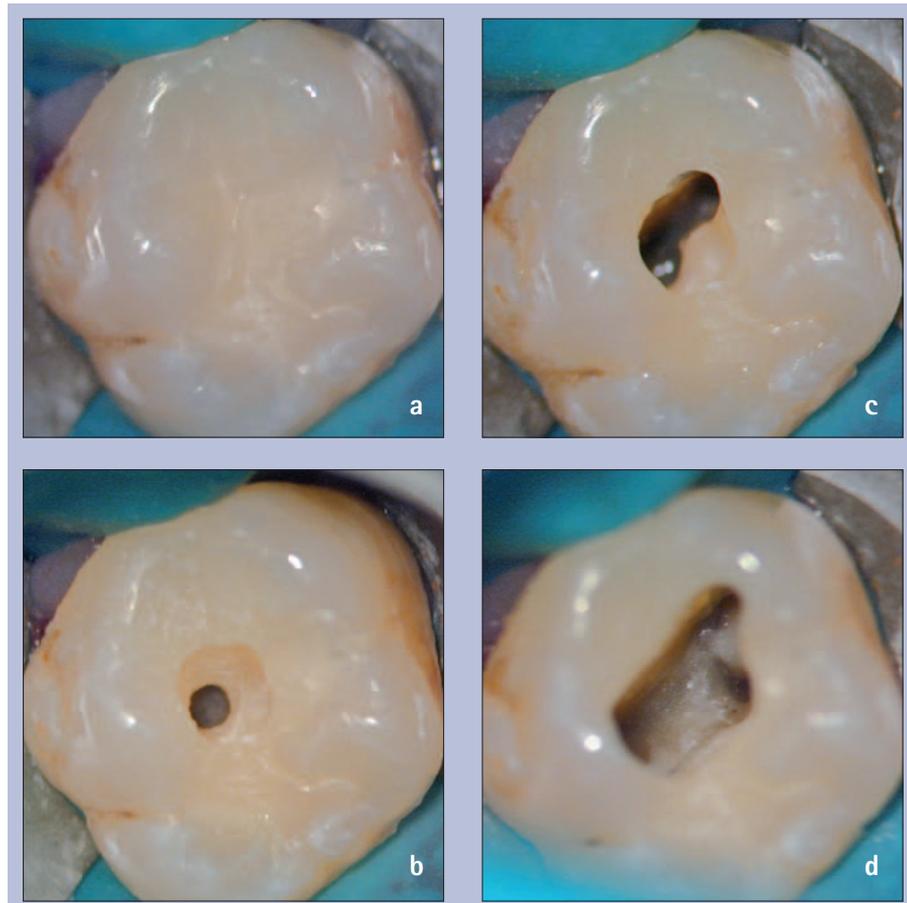
To prevent damage to the floor of the pulp chamber a non end-cutting bur (for example, Endo-Z bur [Dentsply Maillefer Instruments, Ballaigues, Switzerland]) is then used to remove the entire roof of the pulp chamber. The walls of the access cavity should be probed to ensure that the roof of the pulp chamber has been completely removed, ie no dentine

ledges/lips are present.

Careful inspection of the pulp chamber floor of molar teeth will reveal subtle changes in the colour of the dentine which aid identification of the canal entrances (Fig. 2). Dark developmental lines may be identified linking canal entrances and the location of an undetected canal entrance may be indicated by tracking along the developmental line. The canal entrance will appear as a small area of white opaque dentine against a background of yellow/grey secondary dentine. The tiny canal entrance will feel sticky when probed with a DG16 endodontic probe.

Creating straight line access

Once the canal entrance(s) have been



Figs 9 a-d (a, b) The roof of the pulp chamber has been penetrated using a tungsten carbide bur; (c) an 'Endo-Z' bur has been used to completely remove the roof of the pulp chamber. (d) All canals readily identifiable

identified it may be necessary to refine/modify the shape of the access cavity to allow endodontic files to have unimpeded (straight line) access into the coronal-third of the root canal.

Straight line access will reduce the likelihood of iatrogenic problems such as zips, elbows and ledges being created by large (and therefore inflexible) stainless steel files as they attempt to straighten in curved canals, and will also allow easier insertion of rotary instruments during preparation (Figs 10a-c). Straight line access is essential when using nickel-titanium instruments. Although these instruments are very flexible, poor straight line access may result in the files' distortion and eventual separation due to cyclic fatigue (Fig. 11).

COMMON PROBLEMS

Limited access

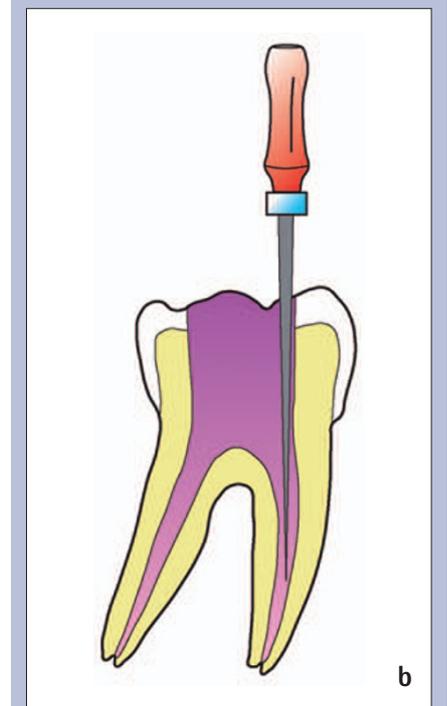
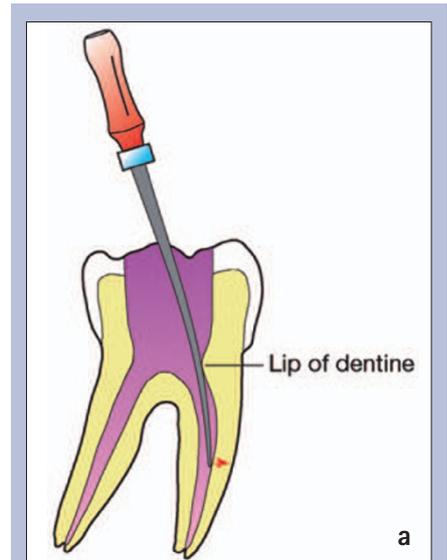
Limited mouth opening and/or an unfavourably positioned tooth may result in difficulty to correctly align the handpiece along the long axis of

the tooth. Even when the canals have been located another challenge may be their negotiation.

A well-positioned mouth prop and a children's fast handpiece which has a smaller head will significantly improve access and treatment. Standard length friction grip burs may also be shortened with a tungsten carbide bur by 3-4 mm and used in combination with a children's head handpiece to give even greater access (Fig. 12). Reducing the height of the buccal cusp tips by 2-3 mm prior to accessing the pulp chamber will increase the inter-cuspal distance and improve the visibility and accessibility.

Full coverage restorations

It is not uncommon for molar teeth requiring endodontic treatment to be already restored with crowns. Without adequate magnification and illumination the access cavity will be nothing more than a black hole. Subtle colour changes of the dentine on the floor of the pulp chamber and other anatomical signs indicating the position of the



Figs 10 a-c (a) Inadequate straight line access resulting in the tip of the file attempting to straighten itself (red arrow). (b) Refining the shape of the access cavity results in unimpeded, straight line access into the root canal. (c) The mesio-buccal corner of the access cavity has been modified (red arrow) to ensure straight line access into the mesiobuccal canal of this lower molar



Fig. 11 Separation of a nickel-titanium rotary instrument due to inadequate straight line access of the mesio-buccal in the upper left first molar



Fig. 12 The handpiece (KaVo 637 Bellatorque, KaVo Dental GmbH, Biberach, Germany) on the left has a smaller head, when used with a shortened bur it makes accessing molar teeth easier on patients with restricted opening

canal entrances will be difficult to identify. This may further be complicated by the crown masking the orientation of the tooth (Figs 13 a-c). If the canals cannot be identified it may be necessary to remove the crown. Removing the crown will also reduce the likelihood of removing sound dentine unnecessarily and also reduce the chances of perforation.

Calcifications within the pulp chamber

The cumulative effects of ageing and the consequences of restorative dentistry reduce the pulp chamber volume due to the deposition of secondary dentine. Localised deposition of tertiary dentine as a specific response to caries, microleakage and tooth surface loss will also reduce the volume of the pulp chamber. The natural dome shape of the pulp chamber floor will become



Figs 13 a-c (a) The crown on this upper right molar masks the true position of the tooth, upon removing the crown the actual position of the tooth becomes evident. (b) Failure to remove the crown would have most probably led to failure to locate all the root canals and perforation. (c) Post-obturation radiograph

progressively flatter which results in the canals entrances becoming narrower and thus harder to locate (Fig. 14).

Tertiary dentine overlying the canal entrances may be differentiated from physiological secondary dentine by its whiter/opaque appearance compared to the yellow/grey colour of secondary dentine. Long shank burs or ultrasonic tips should be used with a gentle brush stroke action to remove tertiary dentine. Pulp stones and calcifications are best removed with small long shank excavators or ultrasonic endodontic tips (Figs 15a-b). Once the canal entrance has been exposed it will feel sticky when probed with a DG16 probe.

Often it is prudent to take a radiograph

to confirm that the access cavity is being prepared in the correct direction and secondly to assess how much dentine has been removed. If necessary rubber dam should not be applied until the canal(s) have been identified to ensure that access cavity preparation is following the long axis of the root(s), and also reduce the likelihood of perforating the pulpal floor. Once the canal entrance(s) have been located, rubber dam should be applied.

Once a canal has been identified with a DG16 probe, a small file (size 06 or 08) with lubricant (for example Glyde® [Dentsply Maillefer Instruments, Ballaigues, Switzerland]) should gently be used in a watch winding action to negotiate the canal entrance. It may be

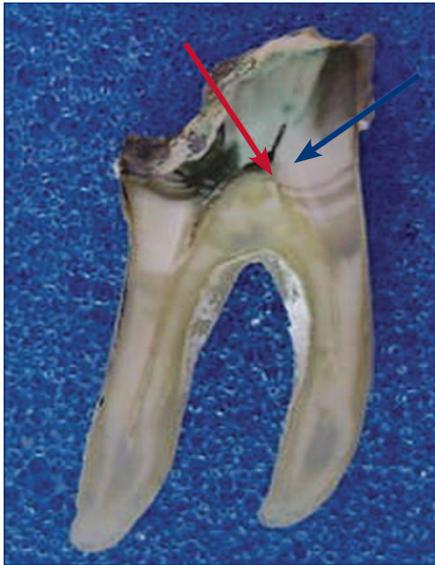


Fig. 14 The deposition of tertiary dentine has resulted in the pulp floor and roof becoming closer. The mesial canals project distally in the coronal aspect of the tooth (red arrow). Dentine will need to be removed in order achieve straight line access (blue arrow)

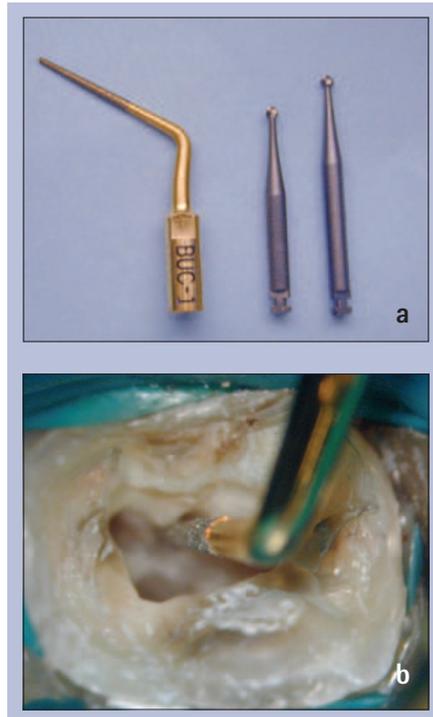
necessary to precurve small files to negotiate the canal. Various manufacturers have specifically designed hand files to aid negotiation of sclerosed canals. Rigid 'C-Pilot' files (VDW Endodontic Synergy, Munich, Germany) have a cutting tip and are ideal to gently negotiate sclerosed canals as they are less likely to distort or buckle compared to regular stainless steel files (Fig. 16). If the canal is completely sclerosed for several millimetres apical to the pulp floor, instruments should be advanced gradually and a confirmatory radiograph taken to ascertain the orientation of the instrument within the canal.

MANDIBULAR MOLAR TEETH

First molars

Mandibular molar teeth usually have two roots in which there are commonly three or four root canals. The mesial root almost always has two mesial canals (mesio-buccal and mesio-lingual) linked by a developmental groove. Approximately 60% of distal roots have only one canal, and the remaining 40% have two canals (disto-buccal and disto-lingual).

The canals are more readily accessible when the access cavity outline is rectangular or trapezoid, depending on the number of canals present (Figs 17 a-b). The mesio-buccal canal entrance is usually located under the mesio-buccal cusp tip, and the mesio-lingual canal will be

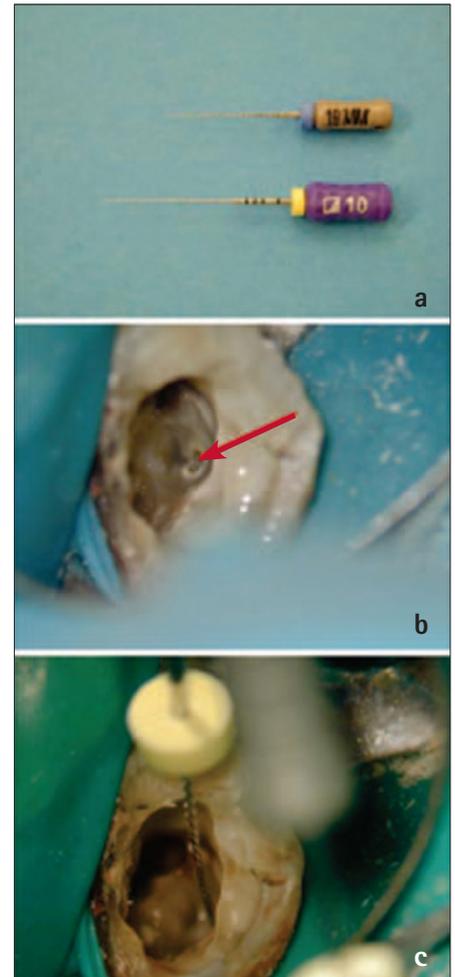


Figs 15 a-b (a) Left to right, a BUC 1 ultrasonic endodontic tip (SyronEndo, Orange, CA, USA), Standard #4 rose head bur and long shank #4 rose head bur. The ultrasonic tip and the long shank bur are ideal for removing small amounts of dentine from the floor of the pulp chamber. (b) Ultrasonic endodontic tip in use

slightly to the buccal of the mesio-lingual cusp tip. The mesial canals commonly curve distally, this may result in the mesio-buccal canal being challenging to identify and negotiate as the canal follows a mesial course coronally and then changes to a distal direction half to two-thirds of the way down the canal.

Approximately 5% of mandibular molar teeth have three mesial canals, the third mesial (middle mesial) canal is usually located between the mesio-buccal and mesio-lingual canals (Figs 18a-d). This middle mesial canal is usually located along the developmental groove between the mesio-buccal and mesio-lingual canals.

The distal canal(s) are located just distal of the buccal developmental groove; the canal entrance is usually oval in shape if there is only one canal present. If two canals are present then the canal entrances tend to be rounder and are usually connected by an isthmus. As with the mesial canals they tend to be located an equal distance away from the mesio-distal mid-line of the tooth. The distal canal entrances tend to be much closer together than the mesial canal entrances, and once prepared may be confluent. It is



Figs 16 a-c (a) Size 08 'C-Pilot' file (top), and a size 10 Senseus Profinder stainless steel files for negotiating sclerosed canals (bottom). (b) White opaque tertiary dentine indicates canal orifice (red arrow) (c) #08 C-Pilot file is used to gently negotiate the canal. Irrigating with sodium hypochlorite and ethylene diamine-tetra-acetic acid (EDTA) will aid canal penetration and negotiation

rarely necessary to extend the access distally beyond the midline as the angulation of the distal root allows straight line access.

Approximately 5% of molar teeth have a third (disto-lingual) root. As well as being evident on a pre-operative radiograph, careful widening (bucco-lingually) of the distal canal may reveal a second distal canal entrance.

Second molars

The anatomy of second molar teeth varies more than that of first molars, and the incidence of two distal canals in second mandibular molar teeth is less than in first molars. The pulp chamber volume and canal entrances are smaller than in first molars.

In a small proportion of mandibular second molar teeth the roots may be

fused resulting in one main C-shaped canal (in cross section) once preparation has been completed.

MAXILLARY TEETH

First molars

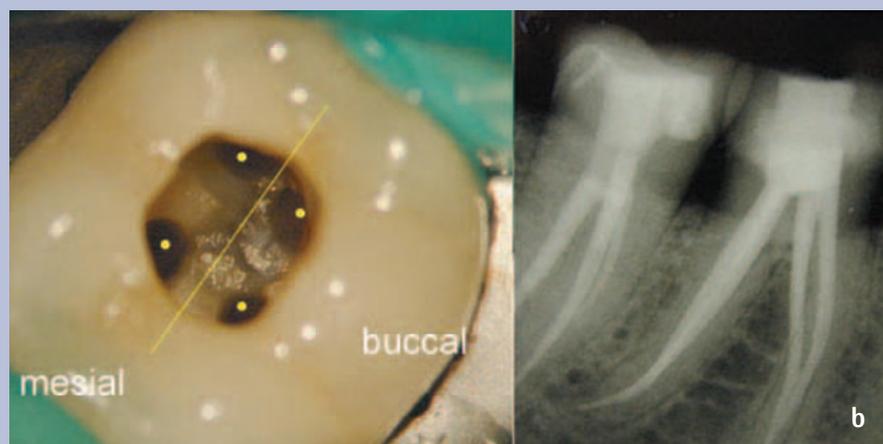
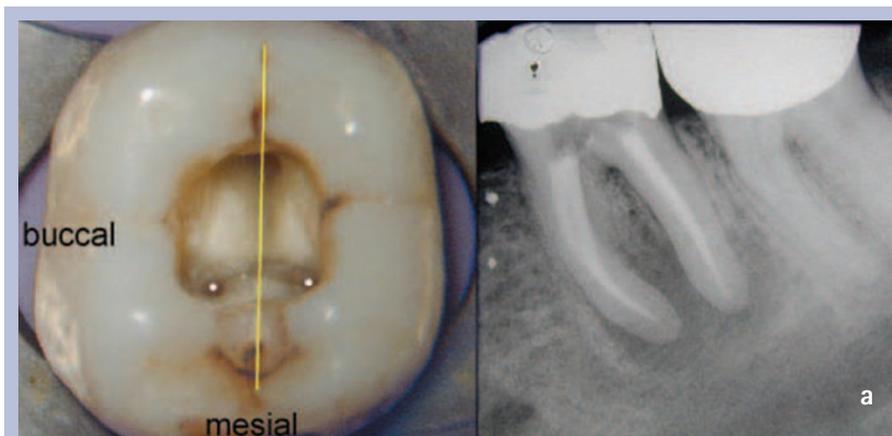
Maxillary molar teeth usually have three roots, with three or four canals. The palatal and disto-buccal roots each have one canal. Approximately 90% and 45% of maxillary first and second molar teeth respectively have two mesio-buccal canals (MB1 and MB2) in the mesio-buccal root.

The access cavity should be rhomboidal in outline, and positioned in the mesial two-thirds of the tooth. The palatal canal entrance is the largest canal and is located in the middle of the palatal half of the tooth and is usually the easiest canal to locate due to its size and position. The palatal canal usually curves buccally in its apical-third, often resulting in the estimated working length determined from the pre-operative radiograph being shorter than the true length as determined with an apex locator. The disto-buccal canal has a round canal entrance and is usually the shortest and straightest of the canals. It is located just distal to the buccal groove and slightly more palatal than the mesio-buccal(s).

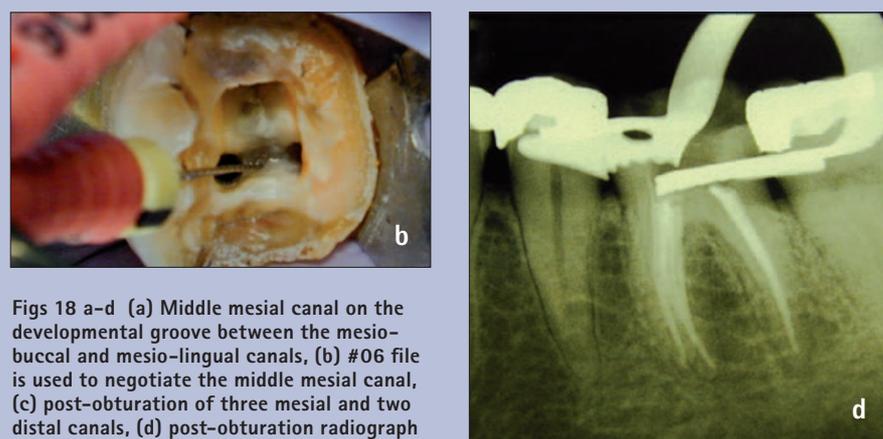
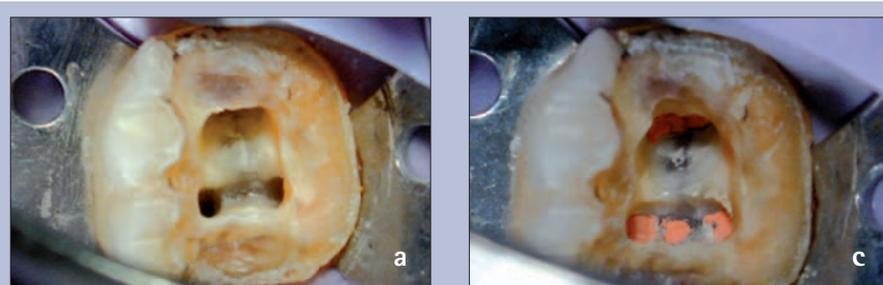
The mesio-buccal root is flatter (mesio-distally) resulting in the mesio-buccal canal entrances being ribbon-shaped. Care must be taken to prevent the mesio-buccal canals being over prepared mesio-distally. The MB1 is located just palatal to the mesio-buccal cusp tip.

The MB2 can be challenging to locate and ideally should be identified once the first three canals have been prepared. It is usually located within 2 mm of the MB1, between the MB1 entrance and the palatal canal entrance. The canal entrance is usually covered with a ridge of dentine which has to be removed before the MB2 can be identified. Ultrasonic tips and/or small rose head burs (LN Burs) are ideal to gently remove this ridge of dentine covering the MB2 canal entrance. The MB2 opening will feel sticky when probed with a DG16 (Figs 19 a-e).

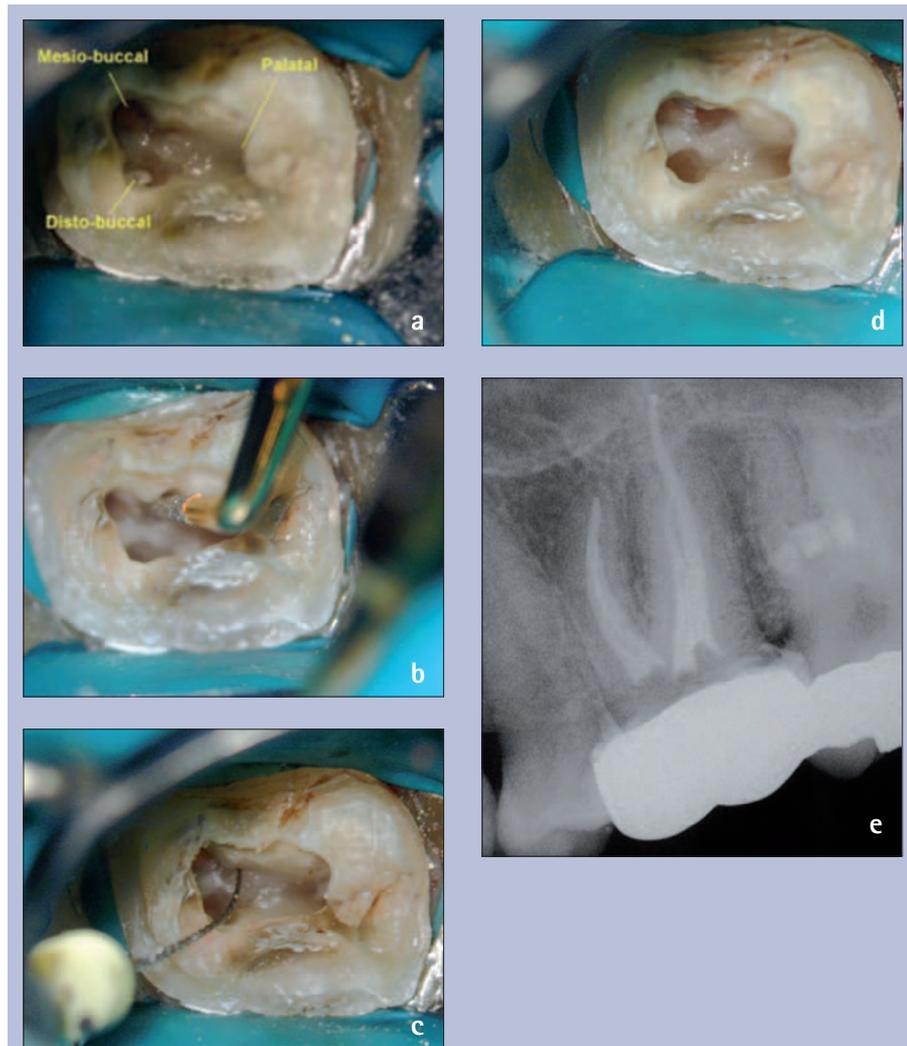
The MB2 and to a lesser extent the MB1 may be challenging to instruments as they are commonly curved. Small sized files are required to initially negotiate these narrow and tortuous canals. Below



Figs 17 a-b (a) Access cavity and radiograph of a lower first molar tooth three canal orifices, note that the mesio-buccal and mesio-lingual canals are found approximately the same distance from the midline (mesial to distal) of the tooth (yellow line). (b) Access cavity and radiograph of a lower first molar with four root canals, note that the buccal and lingual canals can be found on either side of the mesial to distal mid-line (yellow line) of the tooth. If an imaginary line is joined between the buccal and lingual canal entrances (yellow dots) it will intersect the mesial-to-distal mid-line at right angles. The distal canal orifices are closer to the midline than their mesial counterparts



Figs 18 a-d (a) Middle mesial canal on the developmental groove between the mesio-buccal and mesio-lingual canals, (b) #06 file is used to negotiate the middle mesial canal, (c) post-obturation of three mesial and two distal canals, (d) post-obturation radiograph



Figs 19 a-e (a) Three root canals have been identified and prepared in this maxillary first molar, the second mesio-buccal (MB2) canal is usually located within 2 mm of the first mesio-buccal, between this canal and the palatal canal. (b) A BUC 1 ultrasonic endodontic tip is ideal to remove the lip of dentine that may be covering this fourth root canal orifice, it may also be used to make a 1-2 mm deep trough between the first mesio-canal and palatal canal exposing the entrance of the second mesio-buccal canal. (c) An O6 sized file is ideal to explore the canal, note that the canal is entered from the distal aspect. (d) All four canals ready to be obturated, (e) post treatment radiograph

the canal entrance it is not uncommon for the MB2 to follow a mesial direction which changes to a distal direction half way down the canal.

Second molars

The roots of second molars tend to be closer or even fused together, hence the canal entrances in second molar teeth tend to be located more closely to each other (Fig. 20). It is not usual to find

all three or four root canal entrances lying along the same line between the mesio-buccal and palatal canals. The floor of the access cavity is also more domed-shaped.

CONCLUSION

The use of magnification, illumination and specialised items of equipment (for example, ultrasonic endodontic tips) greatly improves the ability of



Fig. 20 The canal orifices in upper second molar teeth tend to be closer together

an operator to identify the root canal entrances in molar teeth, however nothing can substitute the experience and knowledge gleaned from practice both in a clinical environment and on extracted teeth. Successful access cavity preparation relies on a sound knowledge of the internal and external anatomy of teeth.

The importance of gaining straight line endodontic access cannot be over-emphasised. Ultimately poor access cavity design could lead to inadequate cleaning, shaping and obturation compromising successful outcome.

Thank you to Oxford University Press for Figs 10 a-b, which are taken from Principles of endodontics by Michael Manogue, Shanon Patel and Richard Walker, 2005. Thanks also to Dr B. S. Chong for his help and advice in the preparation of this article.

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