Avoiding perforations in endodontics

Precis: While it will be impossible to eliminate all iatrogenic errors in endodontics, by focusing on key areas during the endodontic process, we can reduce the potential for problems for ourselves and our patients.

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Introduction

A perforation is a communication between the root canal system and the supporting tissues of the tooth or oral cavity.[1,2] Perforations may be iatrogenic, resorptive or carious in origin. Iatrogenic root perforations are the second most common reason for endodontic failure.[3,4] The frequency of iatrogenic root perforations has been reported to range from 3% to 10%.[3,4,5] This article will focus on iatrogenic perforations and their avoidance.

Perforations in endodontics can occur during:

- Access preparation.
- Canal location and identification.
- Root canal instrumentation.
- Post space preparation.

The aim of this article is to:

- Review the causes of perforations.
- Discuss their prevention.

Location and aetiology of root perforations

Kvinnsland *et al.*[6] found that perforations occurred in all tooth groups but were most common in the maxilla accounting for 73% of the cases reported in their study. This correlates well with the frequency of endodontic therapy and the frequency with which endodontically treated teeth received prosthodontics treatment in other studies.[7,8] Such studies show that maxillary teeth receive endodontic and prosthetic treatment more than twice as often as mandibular teeth.

In this study,[6] the maxillary canine was the most frequently perforated tooth, followed by the lateral incisor, and then with about equal frequency the central incisors, premolars and first molar teeth. It is difficult to speculate as to why specifically the maxillary canine was the most frequently perforated tooth.

Kvinnsland *et al.*[6] concluded that in the maxillary anterior teeth, all perforations occurred on the labial aspect of the roots and were due to deficiencies in access extension. In the mandibular arch Kvinnsland *et al.*[6] found that the first molar was the tooth most frequently perforated. It is probable that this tooth is also the most heavily restored tooth in the mandible.

Root perforation occurred during routine endodontic treatment in 47% of the cases while it occurred during post space preparation in 53% of the cases reported.[6] It seems reasonable to conclude that post space preparation adds a significant risk to tooth mortality.

During root canal treatment the most common reason for perforation was attempting to negotiate calcified canals (42%). Calcification occurs typically in elderly teeth, traumatised teeth, teeth with a history of extensive restorations or periodontally diseased teeth.[9,10] It is most commonly referred to as reparative dentine and so is frequently formed in response to injury and appears to be a component of the reparative process.[10] However, it can also be seen in the pulps of normal unerupted teeth.[10] The presence of reparative dentine in the pulp chamber can complicate the location and identification of canal orifices and the floor of the pulp chamber leading to perforations.

Access Cavities

A well designed access cavity is essential for a quality endodontic result.[11] A poorly executed access cavity will compromise the tooth's long term survival.[11] The objective of an access cavity is to create a smooth, straight line path to the canal system while retaining as much tooth structure as possible.[11]

FIGURE 1: *A radiographic image of a maxillary central incisor taken in the mesio-distal plane with a tungsten carbide bur superimposed in the classical access cavity position. It is clear to see how the labial perforation can occur with this approach.*

FIGURE 2: *Shows the same radiographic image and bur but using a more incisal approach to the access cavity. This approach significantly reduces the chance of a root perforation on the labial aspect. Secondly, it retains more tooth structure on the palatal aspect of the tooth.*

FIGURE 3: *The clinical presentation of a maxillary left central incisor.*

FIGURE 4: *The radiographic appearance of the maxillary left central incisor.*

FIGURE 5: *This shows actual perforation following flap elevation using a papillary base incision. Epithelial migration and pocket formation occurs quickly with the loss of crestal bone height.*

Maxillary Anterior Teeth

Kvinnsland *et al.*[6] found that in maxillary anterior teeth, all perforations were located on the labial aspect of the root and concluded that deficiencies in access extension were contributory to the perforation. The traditional approach for access cavity preparation in the anterior tooth is made from the lingual aspect (Figure 1). This has not changed over the last thirty years. It is not surprising that perforations resulting from this approach, exit on the labial aspect of the root. Secondly, the perforation site is likely to be located at the buccal crestal bone level.

Straight line access is essential in endodontics as it provides unimpeded access to the critical apical third of the root.[11] However this is not possible on anterior teeth if a lingual approach is taken.[12,13,14] La Turno *et al.*[12] have shown that the traditional lingual approach allows straight line access on only 10% of maxillary central incisors.[12] It seems reasonable that our access approach in anterior teeth should be modified to reduce the potential perforation and that a more incisal approach should be taken (Figure 2).

Another added risk with the maxillary anterior teeth, may be the operator's underestimation of the palatal inclination of the roots in the upper jaw.[6] In order to prevent disorientation during access preparation, due consideration should be given to the anatomy of the tooth in question and its orientation intraorally. This should be supplemented with clear pre-operative radiographs. If the tooth poses special difficulties, i.e., imbrication, rotation, dilacerations, which make access preparation more difficult and beyond the limits of the dentist, referral should be considered.

The results of a labial perforation on a maxillary central incisor may be significant as the perforation will occur at or just below the crestal bone level. Figures 3,4,5 show an upper left maxillary central incisor with an unusually angled root. The perforation which occurred during access preparation resulted from probable disorientation during access preparation.

Another reason to encourage a more incisal access approach relates to the retention of remaining tooth structure. Access cavities positioned in the cingulum area of an anterior tooth, remove a lot of tooth structure to access the pulp space (Figure 1). Ingle and Taintor[4] noted also that a failure to reduce the palatal shoulder in maxillary anterior teeth could lead to the excessive removal of labial root dentine and a possible root perforation when the classical cingulum access cavity is adopted. So by electing to access an anterior tooth from the cingulum area, more tooth structure is sacrificed. The incisal approach retains the cingulum area of the tooth (Figure 2).

FIGURE 6: Mandibular lateral incisor which has a lateral root perforation following disorientation during access preparation. The mandibular incisors pose real problems because of their size.

FIGURE 7: Shows an actual access cavity position taken in a mandibular lateral incisor tooth which would largely be perceived as ideal.

FIGURE 8: Shows the radiographic appearance of the mandibular lateral incisor tooth at presentation shown in Figure 7.

FIGURE 9: Shows the labial view of the same tooth at presentation with the temporary perforation repair just visible at the free gingival margin.

Mandibular Anterior Teeth

These are broader in the labiolingual dimension than they are mesiodistally and are the smallest teeth in the dental arch. Small errors in the orientation of the access cavity can have disastrous consequences (Figure 6).

Similarly, the traditional approach for accessing mandibular incisor teeth, has been to take a lingual approach rather than adopt a straight line approach[11] (Figure 7). Likewise perforations resulting from this lingual approach will end up on the labial aspect of the tooth (Figures 8 and 9).

The logic behind this lingual access cavity on anterior teeth was to cover up the short comings of the restorative materials of the time such as the silicate cements which were poor aesthetically.[11] However, there have been huge improvements in the aesthetic capabilities of modern restorative materials since the introduction of resin bonded composite materials. Composites build ups involving the incisal edge are routine dental practice and results have become predictable.

Another reason to encourage a more incisal access approach relates to the anatomy of the mandibular incisors with up to 41.4% of these teeth having two separate canals.[15] A lingual access approach may complicate the identification and preparation of the lingual canal.

Posterior Teeth

The advice given in text books is of little value in the placement of access cavities in posterior teeth as it relates the pulp chamber to the idealised occlusal anatomy. Given that the clinician works from the outside in and relating the location of the pulp chamber, this idealised occlusal anatomy is of little value. Most of the posterior teeth requiring endodontic treatment have had extensive restorative treatment and the existing occlusal anatomy may have no relevance to the position of the underlying chamber.

Clinically, it makes more sense to observe the external outline of the tooth at the level of the CEJ which is a fixed landmark rarely involved in the overlying dentistry. The pulp chamber is in the centre of the tooth at this level.[16] Secondly, the walls of the pulp chamber are always concentric to the external surface of the crown at the level of the CEJ.[16] Thirdly, the distance from the external surface of the clinical crown to the wall of the pulp chamber was the same throughout the circumference of the tooth at the level of the CEJ.[16]

Due consideration should be given to the orientation of the tooth intraorally prior to the placement of the dental dam. Mandibular molar teeth are often tilted lingually. Likewise, maxillary molar teeth may be tilted buccally.

FIGURE 10: *Shows the significant mesial inclination of a tipper mandibular right second molar.*

FIGURE 11: *Shows the significant mesial inclination of a tipped mandibular left second molar following attempted access cavity preparation and the ensuing furcation perforation.*

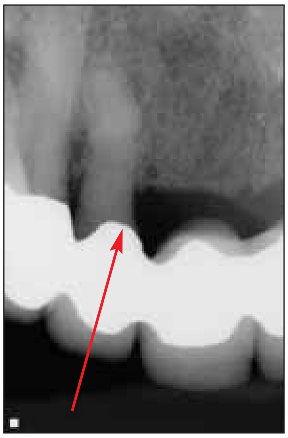

FIGURE 12: *Shows the periapical radiographic view of a maxillary lateral incisor used as an abutment in a long span anterior bridge. The black arrow indicates the long axis of the coronal restoration which is at variance to that of the root.*

FIGURE 13: *Clinical view of the anterior bridge in Figure 12.*

FIGURE 14: *Shows the bitewing view of a maxillary first molar with a mesial perforation following the excessive removal of tooth structure as a result of disorientation and failure to keep to a definite access outline.*

However a pre-operative bitewing view of any posterior tooth undergoing root canal treatment is worthwhile (Figures 10 and 11). The presence of restorations can complicate access to the root canal system greatly. Extracoronal restorations may alter the crown root angulation or coronal rotations or occlusal anatomy of the tooth, so that the position of the pulp chamber or canals may not be as expected (Figures 12 and 13). In addition, light penetration into the access opening made through a metal restoration is poor, even with the aid of a microscope making identification of key landmarks even more hazardous. The complete removal of the restoration is merited particularly in the presence of secondary decay or poor marginal fit where there will be isolation difficulties compounding the poor access. However, removal of the restoration may make rubber dam placement more difficult and compromise isolation. Under such circumstances, the placement of a semi -permanent restoration may be indicated. Referral should be considered where isolation poses a difficulty beyond the capabilities of the operator.

Access preparation in posterior teeth may be compounded further by mouth opening restrictions which were not anticipated and dictate an alteration in handpiece orientation.

It has been recommended in certain circumstances to carry out the access preparation without having the rubber dam in place so that the different angulations can be more readily appreciated relative to the adjacent teeth.[11] However, the author feels that if there are some concerns regarding the inclination of a particular tooth which may impact on the operator's ability to locate the pulp chamber, multiple tooth isolation with rubber dam will offer the operator the same information but will have all the advantages of the rubber dam. The orientation of the adjacent teeth relative to the tooth in question can be readily visualised.

The Furcation Perforation

The classic furcation perforation is that of the pulp chamber floor of a molar tooth. It usually occurs during access cavity preparation in cases where the normal anatomy is often severely distorted. This is usually from previous restorative dentistry which has resulted in calcifications or operator disorientation in tipped or rotated teeth (Figure 11).

Radiographically, the bitewing radiograph is probably the best radiographic view which can be used to assess the position of the pulp chamber, if present, or more importantly the floor of the pulp chamber. From this view, it should be possible to take a measurement of the distance from the occlusal aspect of the restoration or tooth to the level of the pulp floor. Once this distance is fixed and if the operator does not exceed it, it reduces the chances of a chamber floor perforation occurring greatly. However, it will still be possible to perforate the axial walls (Figure 14).

FIGURE 15: *Maxillary second premolar following decay removal showing the white axial walls and the greyish calcified pulp chamber which is darker in colour and located centrally. The pulp chamber follows the outline of the root at the cemento-enamel junction level.*

FIGURE 16: *Maxillary right first molar showing calcification of the pulp chamber. However the outline of the chamber is still visible.*

FIGURE 17: *Maxillary right first molar as seen in Figure 16 after the removal of the pulp chamber calcifications. Note the pale grey colour of the pulp floor and the white colour of the axial walls. The pulp chamber can be seen to be in the centre of the tooth.*

FIGURE 18: *Shows the floor of the pulp chamber of a mandibular left second molar. The area highlighted by arrows is 'blushing' indicating that this is, in all probability, a micro-perforation of the chamber floor. This was subsequently repaired by lining the pulp floor with MTA after completion of the required root canal treatment.*

FIGURE 19: *Shows the radiographic view of the completed root filling on the mandibular left second molar seen in Figure 18. A layer of MTA has been placed across the floor of the pulp chamber and into the canal orifices illustrated by the arrow.*

Illumination and magnification are very beneficial in determining the position of the chamber as it is always darker in colour (Figure 15). The reparative dentine or calcifications are lighter in colour than the pulp floor (Figure 16 and 17). This colour difference creates a distinct junction where the walls and the floor of the pulp chamber meet. The canal orifices are always located at this junction (Figure 16 and 17). Similarly in molar teeth, pre-existing restoration and attempts at pulp chamber location may make canal identification significantly more difficult (Figure 18). Sudden changes in colour when searching for a canal are indicative that a perforation is near (Figures 18 and 19).

Canal Identification

Kvinnsland *et al.*[6] found that attempts to negotiate calcified canals resulted in 42% of the reported perforations in their study. As discussed above, reparative dentine is frequently found in older teeth or where there is a history of extensive restorations and or previous periodontal disease.

Unfortunately, there is no easy technique for dealing with such cases. It involves knowing the anatomy of the tooth in question, reading and understanding the pre-operative radiographic views of the tooth (which preferably include a bitewing view if it is a posterior tooth) and accessing the pulp chamber using illumination and magnification to detect the colour differences between the pulp floor and the axial walls of the tooth. Once the actual access cavity outline has been prepared following the anatomic guidelines for the tooth in question, the author then switches over to the operating microscope and ultrasonic tips to remove smaller amounts of dentine, looking to differentiate the colours between axial wall dentine and secondary dentine and pulp calcifications (Figures 15,16 and 17).

FIGURE 20: *Periapical radiographic view of a maxillary left central incisor with a large periapical radiolucency and showed very obvious pulpal obliteration. Clinically this tooth was symptomatic*

FIGURE 21: *The radiographic view of the completed root treatment on the maxillary left central incisor seen in Figure 20.*

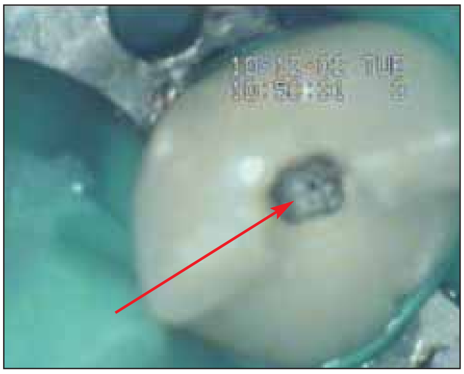

FIGURE 22: *Shows the actual access approach taken on the maxillary left central incisor seen in Figures 20 and 21. The arrow denotes the actual canal system as identified under the operating microscope.*

FIGURE 23: *Shows a maxillary right lateral incisor with a skewed attempt to locate the pulp chamber/ canal system with pulpal obliteration. There is widening of the periodontal ligament at the crestal bone level indicating a perforation (arrow).*

FIGURE 24: *Shows the perforation repair of the tooth shown in Figure 23.*

FIGURE 25: *Shows an upper right maxillary central incisor which has been perforated as a result of over vigorous use of a rotary instrument - probably a Gates Glidden drill - in an attempt to get to working length quickly. Note the pronounced canal straightening and again the positioning of the access cavity which is directing the instrument into the labial wall of the root.*

FIGURE 26: *Shows the recaptured canal in Figure 25 and the repair which was obturated with MTA.*

The use of the microscope and ultrasonic tips to chase hidden anatomy is invaluable. It preserves tooth structure and helps avoid perforation (Figures 20, 21 and 22). Coelho de Carvalho and Zuolo[17] have shown the use of the operating microscope increases the number of canal orifices located.

Without the use of the microscope and the failure to adhere rigidly to the expected outline of the pulp chamber, the temptation to chase aggressively these calcified pulp chambers or sclerosed canals with the air rotor, can result in the removal of an excessive amount of tooth structure and perforation (Figures 23 and 24).

Canal Instrumentation

The ideal canal shape is a continuously tapering preparation, largest coronally and narrowing apically, maintaining the original canal anatomy, and keeping the apical foramen as small as practical in its original position.[11] This canal shape is achieved with hand files,

FIGURE 27: *The radiographic view of a maxillary right lateral incisor with a root filling which is short of the radiographic apex. There is pronounced straightening of the canal system which fails to negotiate the significant apical curvature. There is a lesion centred at the termination point for this root filling. This is suggestive of a perforation created by taking excessively stiff instruments deep into the root canal system.*

FIGURE 28: *Shows the dis-assembled maxillary right lateral incisor seen in Figure 27. The original canal system has been recaptured, prepared and obturated using a warm vertical compaction technique. The repair of the perforation was carried out with sealer and gutta percha in an attempt to avoid surgical repair.*

FIGURE 29: *A periapical radiographic view of a mandibular left lateral incisor with a perforation in the apical third of the root denoted by the excess root filling material on the lateral aspect of the root. There is an associated periapical lesion. It is probable that this perforation resulted from the mis-use of a rotary instrument. It is necessary to prepare the canal system using a handfile up to an ISO #15 before introducing the rotary instrument to create what is known as the 'guide path'.*

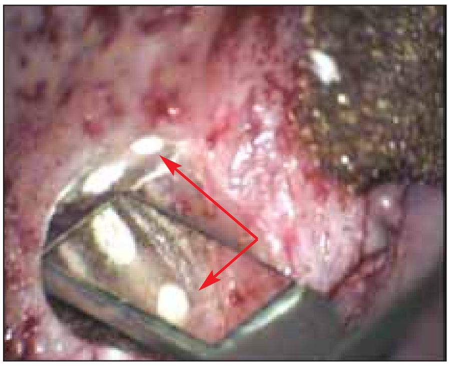

FIGURE 30: *Shows the actual surgical field during the repair of the same mandibular left lateral incisor as seen in Figure 29. The root apex has been resected above the level of the perforation. Both the anatomical and the created canal have been ultrasonically prepared and filled with MTA. The arrow indicates the created canal which is perfectly rounded.*

reamers and hedstroems in conjunction with rotary-driven devices.

A major contributor to iatrogenic problems in the canal preparation process lies in the method of use of the above instruments. Techniques of getting to working length early encourage the use of an aggressive cutting action.[11] If an aggressive approach is taken in canal preparation, particularly with a rotary driven instrument, a perforation is likely even in a single rooted tooth (Figures 25 and 26). Large inflexible rotary instruments should never be taken into the apical third of the root canal system even in apparently straight-rooted teeth. A poorly positioned access cavity under such circumstances will exaggerate the problem by directing the instrument into the tooth wall. For example, if in the case of a maxillary central incisor, the access cavity is positioned in the cingulum area and a Gates Glidden bur is advanced deep into the canal system. This bur will be directed into the labial wall of root dentine as it advances down the canal. The further down the canal it advances, the greater the restoring force will be, the more labial root dentine will be removed, the higher the chance of a perforation (Figures 25 and 26).

Until recently, all hand instruments were end cutting, with a two-degree taper over 16mm of cutting flutes, and twisted or machined from stainless steel stock. As a consequence, increasing stiffness was noted when progressing through any type of instrument series while preparing a canal. The introduction of the so called 'Step Back' technique of canal preparation was advocated to reduce the need to take excessively large stiff instruments in to the apical third of the root. With this approach, smaller more flexible files were used in the apical third, keeping the larger stiffer files for the straighter parts of the canal system in an attempt to reduce the inevitable canal straightening and/or perforation that occurred as a result of a large file being forced into the apical third of the canal (Figures 27 and 28). Large inflexible stainless steel hand instruments should never be taken into the apical third of any canal system. The restoring force on larger instruments as they negotiate the curvature is greater and as a consequence they are more likely to deflect the preparation of the canal system into the wall of the root, rather than follow the canal system around the curvature. If this deflected preparation is advanced it will result in a perforation (Figures 27 and 28). The need to use smaller more flexible instruments in curved canals is obvious. Numerous studies[19,20] have shown that rotary nickel titanium instruments can efficiently create acceptable preparation shapes, while minimising iatrogenic errors such as perforations. Even with the use of modern rotary nickel titanium instruments, the preparation of a guide or pilot hole using hand instrumentation is essential prior to the introduction of the rotary instruments. Failure to establish this guide path can result in the rotary instrument cutting its own path through the root and resulting in a perforation (Figures 29, 30 and

FIGURE 31: *Shows the radiographic appearance of the surgically corrected mandibular left lateral incisor as seen in Figures 29 and 30. The limitations of the surgical approach are clear to see. While the perforation has been removed and the root repaired, a large portion of the anatomical canal system remains un-obturated.*

FIGURE 32: *Shows a radiographic view of a mandibular first molar. Excessive root preparation has occurred in the mesial root on the furcation side, resulting in a near perforation or microperforation. This could have been avoided by using smaller instruments less aggressively in the first place, and directing them away from the furcation side of the root.*

FIGURE 33: *Shows the radiographic view of a maxillary central incisor with a post retained crown. The post is obviously skewed and there is an associated perforation on the distal aspect of the root. There is an associated radiolucency.*

FIGURE 34: *Shows a maxillary central incisor with a post retained crown. Radiographically there appears to be a gap between the end of the post and the root filling. There is an associated lateral radiolucency at the termination point of the post suggestive of a perforation.*

31). Even using more modern instrumentation techniques and instruments, due consideration must be given to the dimensions of the canal system. Gates Glidden drills are widely used for pre-enlarging the coronal two thirds of most root canal systems.[18] However, their use should be confined to the straighter portions of the canal and their cutting action should be directed away from root concavities in furcated teeth.[21] This so-called 'anticurvature' method of canal preparation whereby the instrument is directed away from the furcation area in a multi-rooted tooth has been shown to reduce the potential for root perforation.[22] Due consideration should be given to the size of the bur relative the size of the root, as these instruments can be very aggressive (Figure 32). A similar philosophy should be applied when using rotary nickel titanium instruments.[18] All instruments will have a straightening effect on a curved canal.

Post Space Preparation

According to Kvinnsland *et al.*[6] post preparation accounts for 53% of all perforations. It is postulated that with the increased use and predictability of bonding in dentistry, the need to place posts into roots should be diminishing.

Goodacre and Spolnik[23] recommend a post length equal to three quarters of the root length, if possible, or at least equal to the length of the crown. They caution that at least 4 - 5mm of gutta percha should remain apically to maintain an adequate apical seal. Limiting the post size so that the post diameter is no larger than one third the mesial distal width of the root is also helpful.[24]

There are two principal ways in which a root may be perforated during post space preparation: a skewed preparation which is where the post space deviates away from the long axis of the root and perforates the lateral aspect of the root (Figure 34) and secondly where a parallel-sided preparation is advanced too far apically and does not take into consideration the tapering nature of the root, or the diameter of the preparation is excessive relative to the root diameter and root length (Figures 35 and 36).

The primary purpose of a post is to retain a core in a tooth where there has been extensive loss of tooth structure.[25] The preparation and placement of a post adds a certain degree of risk to the restorative procedure. These risks not only include that of perforation during preparation but also include an increased risk of root fracture post restoration, especially where the diameter of the post is large.[26] It is therefore important to consider the alternative options to post placement as a means of core retention.

The need for post placement varies greatly between anterior and posterior teeth.[25] Generally speaking, if an anterior root filled tooth is to receive a crown, a post is often indicated because of the amount of remaining coronal tooth structure. The pulp chambers in anterior teeth are generally too small to provide adequate retention and resistance for a tooth core without a post.[25] However by adopting a more incisal approach to access the tooth during the endodontic procedure, less tooth structure is removed reducing the need to place a post. Secondly, the placement of the post is greatly facilitated because of the straight line approach adopted for the initial root filling.

Endodontically treated molar teeth on the other hand rarely require a post, unless there is extensive loss of coronal tooth structure (Figure 36 and 37).[25] Rarely if ever, is more than one post required.[25]

FIGURE 35: *Shows the actual surgical correction of the tooth seen in Figure 34. It would appear that during post space preparation the rotary drill was advanced into the apical third of the root causing the perforation. The root tapers very quickly in this area. The root has been resected and prepared ultrasonically before being repaired with MTA. The arrow denotes the perforation repair.*

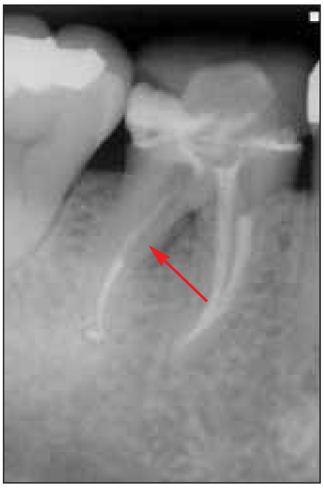

FIGURE 36: *Radiographic view of a lower first molar with a perforation in the distal canal on the furcation side following post space preparation. The arrow indicates the actual perforation.*

FIGURE 37: *Shows the radiographic view of the tooth in Figure 36 following the perforation repair with MTA and the placement of the definitive cast restoration. It is worth noting that and amalgam core supplemented with pin placement was sufficient to retain the crown. This suggests that the need to place the post in the first place was questionable putting the tooth at great risk.*

When it comes to post placement, there is a huge variety of post systems that can be considered. It is not the intention of the author to review the merits of the different systems in this article but direct the interested readers to a review type article by Schwartz and Robbins.[25]
In order to reduce the potential for a skewed perforation during post space preparation, the preparation should follow the long axis of the root. Removal of the coronal and mid- root gutta percha with heat and hand instruments will help provide a pilot hole for the post drills to follow.[27] By inserting a heated instrument into the gutta percha, the material will be softened considerably, some of the material will adhere to the instrument on its removal creating a hole into which the pilot drill can be inserted and advanced. The surrounding gutta percha will also have been softened and will therefore provide less resistance to the pilot drill. If resistance is encountered, the softening process can be repeated until the ideal post length is achieved. Preparation of the post space with an engine driven rotary instrument can be done in a counter-clockwise direction to reduce the aggressive cutting potential of these drills.

Posterior teeth pose real problems from a post-placement perspective. Access may be restricted, directing the preparation off-centre. Great care should be taken when access is restricted and post placement is required. It may be more sensible to look at alternative roots in the case of a multirooted tooth when access is a limiting factor, or it may be preferable to look at alternative means of achieving core retention such as pins, slots and grooves which have been shown to work equally well in posterior teeth (Figures 36 and 37).

The root anatomy of posterior teeth is more complex. The roots will exhibit curvature and there are associated root concavities which cannot be detected either clinically or radiographically both of which complicate post-placement significantly. Nayaar *et al.*[27] have described a coronal-radicular post and core technique for endodontically treated posterior teeth whereby amalgam is condensed 2 – 4mm into each canal and into the pulp chamber and the coronal portion of the tooth. The natural divergence of the canals and the undercuts in the pulp chamber provide retention to the amalgam dowel and core. The authors reported that in 400 cases treated in this way, no failures were reported over a four-year period. Amalgam cores are highly retentive when used as described above and require more force to dislodge than cast post cores.[28] A significant disadvantage of amalgam cores is the potential for corrosion and subsequent discoloration of the remaining tooth structure and gingival. Amalgam use is declining worldwide, because of legislative, safety and environmental issues.[29] Its use is superseded by composite, but it too has significant short comings such as polymerisation shrinkage, water absorption and technique sensitivity.

Conclusions

While it will be impossible to eliminate all iatrogenic errors in endodontics, it is clear to see from the above that by focusing on key areas during the endodontic process, we can reduce the potential for problems for ourselves and our patients.

It is suggested that by taking a more incisal starting point in your access preparation on all anterior teeth, we will reduce the potential for a buccal perforation. We will retain more tooth structure, facilitate true straight line access improving the quality of our root treatment and facilitate the post space preparation if and when required.

Use a bitewing radiograph to determine the location of the pulp chamber for all posterior teeth. This should be supplemented with a clinical examination of the tooth at the cemento-enamel junction level as the pulp chamber will follow the outline of the tooth at this level.

We should remember that teeth with with pulpal calcifications or total pulpal obliteration are significantly more difficult to treat and account for 42% of the perforations that occur during root canal treatment.

By using some form of illumination and magnification (preferably an operating microscope) we should be able to differentiate between the root dentine, the floor of the pulp chamber and calcified deposits within the pulp chamber. Secondly we should be able to identify and locate more anatomy, improving the quality of our root treatment.

With regards to canal instrumentation, we should consider the root anatomy before the preparation process from our anatomical knowledge of the tooth or root in question, supplemented with multiple angled radiographic views of the tooth, where possible. We should not use excessively large instruments to prepare the coronal two thirds of the root system. We should move towards the rotary nickel titanium instruments for canal preparation.

We should assess the need to place a post on all teeth but particularly posterior teeth where alternatives such as the Nayaar core have been shown to be equally successful.[26,27]

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