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RESEARCH ARTICLE

IATROGENIC PERFORATIONS

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ABSTRACT

Root perforations are the communications between the periodontal apparatus of the tooth and the root canal system. Although some of them are pathologic, the majority are caused by iatrogenic events. Regardless of the etiology, a perforation is an invasion into the supporting structures that causes inflammation and loss of attachment. These in turn compromise the health of the periradicular tissues and ultimately the prognosis of the tooth. Left untreated, perforations result in the loss of integrity of the root and further destruction of the adjacent periodontal tissues. Root canal perforations can occur before, during or after an intervention. Clauder and Shin reported that a high percentage (53%) occurs as a result of prosthodontic treatment, with 47% taking place during routine endodontic treatment.

INTRODUCTION

Root canal treatment is one of the most commonly performed dental interventions. After successful treatment, most teeth can remain as functional units within the dental arch. However, as the number of root canal interventions has increased exponentially in recent years, so have the nature and number of complications. Root canal deviations, fractures of endodontic instruments, and root canal perforations are now among the most common complications observed in modern dentistry. Although up-to-date reliable data are not available, conservative estimates suggest that perforations occur in around 20% of endodontically treated teeth. Furthermore, perforations were detected in up to 12% of patients during nonsurgical retreatment of prior endodontic interventions. In endodontic practice procedural accidents are encountered that will affect the prognosis of root canal treatment. One of these procedural accidents is endodontic perforation.[1]

Root perforations are defined as the communication between the periodontal apparatus of the tooth and the root canal system.

Effective management of root canal perforations depends on many factors, including early diagnosis, size, shape, location, and nature of the perforation, chosen treatment, materials used for the obturation, host response, and importantly, the experience of the practitioner. Fuss and Trope concluded that location is probably the overriding factor affecting prognosis, with crestal root perforations being the most susceptible to epithelial migration and rapid pocket formation and thus having the lowest success rate of repair. Successful treatment depends on accurate diagnosis and visualization of perforations as well as the use of biocompatible materials effective in sealing the perforation and preventing bacterial penetration.[4]

The clinician must be particularly concerned about avoiding perforations of the tooth during endodontic therapy, since a perforation will necessitate additional treatment. If a perforation occurs, the tooth does not necessarily require surgery, intentional replantation, or extraction; in fact, it can be treated successfully in a conservative manner and continue to function as it did before the perforation. Following perforation, an inflammatory reaction is set up in the surrounding periodontium of the affected site. This is due to mechanical trauma and microbial infiltration. Once identified the perforation should be sealed as soon as possible, otherwise irreversible periodontal damage may result. Today, there is no reason to believe that the tooth will be lost prematurely because of this complication.[2]

Sealing perforations of iatrogenic, resorptive, or carious origin poses a challenge even for dentists with endodontic experience. The rationale of treatment of such cases should be immediate sealing with a biocompatible material that is insoluble in the presence of tissue fluid sand allows regeneration of surrounding tissues.

When evaluating a perforated tooth, variables should be considered: level, location, size and shape, and time. Root canal perforations of whatever origin may have serious implications, and timely and appropriate treatment is imperative to ensure long-term survival of the affected tooth.

Effective management of perforations represents a challenge even for experienced endodontists.[3]

DISCUSSION

Perforations may be iatrogenic, resorptive or carious in origin. Iatrogenic root perforations are the second most common reason for endodontic failure. Perforations may be categorized by their location. Such as

1. Perforations at the cervical 1/3rd of the root canal, i.e. cervical perforations
2. Perforations at the middle 1/3rd of the root canal, i.e. mid root perforations
3. Perforations at the apical 1/3rd of the root canal, i.e. apical perforations
4. Perforations into the furcation area, i.e. furcation perforations.

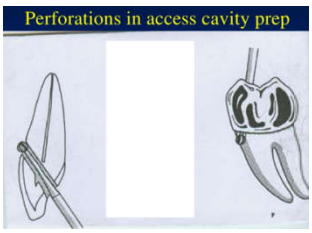
Cervical perforations

It is defined as an artificial passage created at cervical 1/3rd of the root canal above alveolar crest, whether iatrogenic or due to pathological resorption, which produces a communication between the pulp cavity and the periodontal tissues.

Causes

During access cavity preparation

It usually occurs due to misleading of access cavity burs in calcified and narrow canals with blocked root canal orifices.[5]



Cervical perforations

Misleading of access burs leading to cervical and furcation perforations.

During Bio mechanical preparation of root canal space

The cervical portion of the canal is most often perforated during the process of locating and widening of the canal orifice or in appropriate use of Gates-Glidden burs.

Overzealous use of rotary and hand cutting instruments might lead to cervical perforations. Use of initial instruments during BMP with larger diameters predisposes the risk of cervical perforations. Prior knowledge of root canal morphology should be obtained with the help of pre-operative radiographs in order avoid the mishap. Tilted and malposed teeth also pose a potent risk for the occurrence of this type of endodontic mishap. Use of Ni-Ti instruments (which tend to resist any change in their shape) in these type of teeth increases the chances of cervical perforations manifolds.[6]

During post space preparation

Post space preparation is one of the important steps for proper placement of the post. Peeso reamers are used for this purpose. Peeso reamers should be used with caution as its misleading within the canal can lead to wide perforation within the canal. A wider perforation leads to poor prognosis of the perforation repair.

Cervical perforations

Perforations during pin placement

Either penetration into the pulp or perforation of the external surface of the tooth is obvious if there is hemorrhage in the pinhole following removal of the drill. However, with profound anaesthesia some patients may not feel pulpal penetration. Radiographs can verify pulpal and external perforation.

Diagnosis: The first sign of perforation is presence of sudden heamorrhage at the perforated site. When a file is inserted at the perforation site, the patient usually responds with sharp pain which subsides after removal of the instrument. If the perforation is present for prolonged period of time, tissue overgrowth might be evident.

To confirm the suspicion of such an unwanted opening, place as mall file through the opening and take a radiograph; the film should clearly demonstrate that the file is not in a canal. Magnification with either loupes, an endoscope, or a microscopeis very useful in these situations. It has been suggested that an electronic apex locator (EAL) can accurately determine the location of iatrogenic perforations. According to a study conducted by Fuss *et al*. the electronic devices were accurate tools for locating root perforations within a clinically acceptable range.

The Treatment of the perforation may include both internal and external repair. A small area of perforation may be sealed from inside the tooth. If the perforation is large, it may be necessary to seal the perforation by surgically exposing the perforated area and repair the damaged tooth structure with MTA.

Prognosis: The prognosis depends on various factors such as location of perforation, accessibility to perforated site, size of the defect, time lapse between perforation and repair and the sealing ability of the material used.

Prevention may be achieved by reviewing each tooth' smorphology prior to entering its pulp space. Additionally, radiographically verifying one's position in the tooth.[7]

Mid-root perforations

It is the lateral perforation at mid root level of the root canal which tend to occur mostly in curved canals, either as a result of perforating when a ledge has formed during initial instrumentation or along the inside curvature of the root as the canal is straightened out. The later is often referred to as canal "stripping" and results in a fairly long perforation that seriously compromises the outcome of treatment. The mesiobuccal canal is in most danger of being stripped.

Diagnosisis easily done by the sudden appearance of hemorrhage in a previously dry canal or by a sudden pain complaint by the patient. A paper point is placed in the canal can confirm the presence and location of the perforation. Pain

is usually evident upon instrumentation. A radiograph with the instrument in the canal helps to establish a proper diagnosis.

Treatment of a lateral perforation is contingent on the adequacy of the seal established by the repair material. Since the primary concern is to prevent overextension, unless a resorbable material is first introduced against which to condense, the material is often forced out into the ligament space despite gentle placement, and a likely poor seal will result. Access to mid root perforation is most often difficult, and repair is not predictable. Repair of strip perforations has been attempted both non surgically and surgically. A majority of the techniques, however, propose a two-step method wherein the root canals are first obturated, and then the defect is repaired surgically. Removal of the excess gutta-percha using a hot spatula and cold burnishing the perforation site was reported by Allam.

Prognosis: Both "stripping" perforation and direct lateral perforation of the root result in a reduction of the prognosis. The reduced prognosis must be considered when evaluating the tooth's role in an overall treatment plan.

Stripping can be prevented by exercising caution in two areas: careful use of rotary instruments inside the canal and following recommendations for canal preparation in curved roots, as proposed by the USC group.

Mid-root perforations

Apical perforations

Perforations in the apical segment of the root canal may be the result of the file not negotiating a curved canal or not establishing accurate working length and instrumenting beyond the apical confines.

Perforation of a curved root is the result of "ledging,""apical transportation, "or "apical zipping." The glossary of accepted endodontic terminology defines "transportation" as "removal of canal wall structure on the outside curve in the apical half of the canal due to the tendency of files to restore themselves to their original linear shape during canal preparation." The term "apical zip" is also defined as "an elliptical shape that may be formed in the apical foramen during preparation of a curved canal when a file extends through the apical foramen and subsequently transports that outer wall." Owing to their curvatures, the maxillary lateral incisor, mesiobuccal, and palatal roots of maxillary molars and the mesial root of mandibular molars are most often the sites of these types of perforations.

Diagnosis of apical perforation should be suspected if the patient suddenly complains of pain during treatment, if the canal becomes flooded with hemorrhage, or if the tactile resistance of the confines of the canal space is lost. If any of these occur, it is important to confirm one's suspicions radiographically and attempt to correct them before further damage is done. A paper point inserted to the apex will confirm a suspected apical perforation

Treatment: Efforts to repair may be to attempt to renegotiate the apical canal segment or to consider the perforation site as the new apical opening and then decide what treatment the untreated apical root segment will require. One is now dealing with two foramina: one natural, the other iatrogenic. Obturation of both of these foramina and of the main body of the canal requires the vertical compacting techniques with heat-softened gutta-percha. Often surgery is necessary, particularly if a lesion is present apically.

Apical perforation can also occur in a perfectly straight canal if instrument use exceeds the correct working length. This destroys the Resistance Form of the root canal preparation at the cementodentinal junction, making it difficult to control the apical extensions of the root canal filling. If the perforation is caused by over-instrumentation, corrective treatment includes re-establishing tooth length short of the original length and then enlarging the canal, with larger instruments. A careful adaptation of the primary filling point, often blunted, is imperative. The canal is then cautiously filled to that length cautiously so that the Resistance Form thus created will prevent filling extrusion out the apex. Creating an apical barrier is another technique that can be used to prevent overextensions during root canal filling. Materials used for developing such barriers include dentin chips, calcium hydroxide powder, Proplast, hydroxyapatite, and, more recently, MTA.

Prognosis: There are probably more apical perforations than perforations in other areas of the pulp space. Fortunately, with successful repair, apical perforations have less adverse effect on prognosis than more coronal perforations.

Apical perforation

Furcation perforations

Defined as an artificial passage created within a tooth at the furcation area, whether iatrogenic or due to pathological resorption, which produces a communication between the pulp cavity and the periodontal tissues. Furcation perforations have a negative impact on the prognosis of endodontic treatment, as they trigger an inflammatory reaction in the periodontal region that may lead to attachment loss and occasionally, tooth loss as well. Depending on the size of perforation the prognosis can be assessed.

Causes of Furcation perforations: They may occur during preparation of the access cavity. Presence of pulp stone in the pulp chamber reduces the volume of the chamber and can cause perforation. Many a times, missed judgement about the location of floor of the chamber or failure to study the pre-operative radiograph also can cause perforation in the furcation area. Perforationinto furcation using a surgical-lengthbur and failing to realize that the narrow pulpchamber had been passed. Operator error in failure to compare the length of the bur to the depth of the pulp canal floor. Length should be marked on the bur shank. In the process of searching for canal orifices, perforations of the furcation area can occur, either peripherally through the sides of the crown or through the floor of the

chamber into the furcation.

Diagnosis: When the furcation is perforated, bleeding into the access cavity is often the first indication of an accidental perforation. Patient gets pain when the file touches the periodontium through the perforation area. Clear visualisation with the naked eyes is possible due to its location. To confirm the suspicion of such an unwanted opening, place a small file through the opening and take a radiograph; the radiograph should clearly demonstrate that the file is not in a canal.

Furcation perforation

Treatment: Since the area is accessible, immediate repair with MTA is advised. If proper isolation is possible then composite and glass ionomer can seal the perforation. If not repaired non-surgically, or in accessible areas then surgical intervention is required, like radisection, bicuspidization, hemisection or intentional replantation.

Prevention: It can be prevented by using safe-end carbide fissure bur for initial entrance through the enamel surface or through a restoration, the ideal cutting instrument is the such as the Maillefer Transmetal bur or Endo Access diamond stone (Dentsply/Maillefer, Tulsa, Okla.), mounted in a contra-angle handpiece operating at accelerated speed. With this instrument, enamel, resin, ceramic, or metal perforation is easily accomplished, and surface extensions may be rapidly completed. High-speed burs should not be used to penetrate into, or initially enlarge, the pulp chamber unless the operator is skilled in endodontic preparations.

Prognosis is good if repaired immediately.[11]

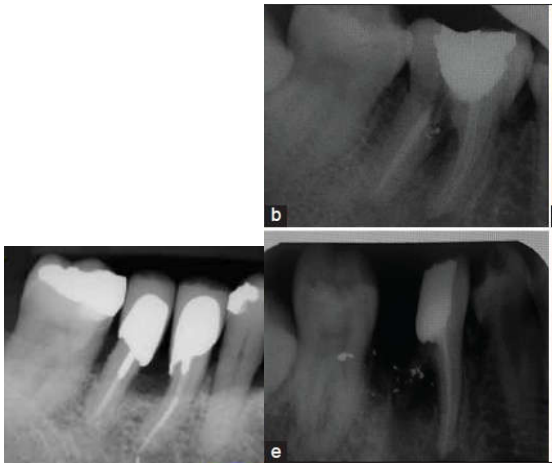


Fig Bicuspidization and hemisection

CONCLUSION

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.

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