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Iatrogenic complications arising from cleaning and shaping: A Review

Sachin Dev Mehta

Professor, Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh

Sunil Malhan

HOD, Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh

Chahat Bansal

PG student (Final year), Department of Conservative Dentistry & Endodontics, Desh Bhagat Dental College & Hospital, Mandi Gobindgarh
Email: chahatbansal777@gmail.com

Abstract---Endodontic treatments tend to have very high successful rates in spite of the fact that they are quite an invasive, difficult procedure, especially in complex anatomies. As a consequence, retreatment has become a well-defined field of knowledge and expertise in endodontics, since most complications can be solved with proper surgical or nonsurgical retreatments. Failure to grasp the rationale behind cleaning and shaping concepts can increase the occurrence of needless complications, such as ledges. Extension of the access cavity to provide unobstructed access to the root canals, precurving and not forcing instruments, using NiTi files, using passive step-back and balanced force techniques, and instrumenting the canal to its full length will all help to prevent ledge formation. Initial negotiation and bypassing the ledge can be achieved using a small file with a distinct curve at the tip, whereas a slight rotation motion of the file combined with a picking motion can often help advance the instrument. Blockage, laceration, and foraminal damage are the most common results. Each alters the reliability of the procedure and must be prevented if one is to obtain the best possible prognosis for the patient.

Keywords---iatrogenic, endodontic treatment, Niti files, ledge formation.

Introduction

Iatrogenic changes in the canal wall occur rapidly, and frequently unknown to the clinician. The majority of cleaning and shaping complications are a result of improper control over the preparation instruments. Resulting damage is therefore a mechanical injury to the canal system. Blockage, laceration, and foraminal damage are the most common results. Each alters the reliability of the procedure and must be prevented if one is to obtain the best possible prognosis for the patient. Endodontic treatments tend to have very high successful rates in spite of the fact that they are quite an invasive, difficult procedure, especially in complex anatomies. Some complications can arise during or after a root canal procedure due to poor understanding of the anatomy and iatrogenic errors mainly during instrumentation. While some of these problems can be anticipated, many can never really be predicted.¹⁻³

As a consequence, retreatment has become a well-defined field of knowledge and expertise in endodontics, since most complications can be solved with proper surgical or nonsurgical retreatments.³ Reinfection or persistent infections: Root canal treatment can fail due to a persistent bacterial infections or reinfections. These include inadequate shaping, cleaning, and obturation procedures, poor restorations, and exposure through a fracture. The remedies are dependent on the primary cause of the reinfection and the affected parts. Persistent infection is the major cause of short-term endodontic failures.³

Content

Endodontic mishaps or procedural accidents are unfortunate occurrences that can occur during treatment. Some might be due to inattention to detail, whereas others are unpredictable.⁴ Failure to grasp the rationale behind cleaning and shaping concepts can increase the occurrence of needless complications such as blockages, ledge formation, apical transportation, and perforations. These have been attributed to inappropriate cleaning and shaping concepts.⁴

Missed Root Canals

Canal anatomy can be complex and variable. Clinicians can sometimes miss a canal in a complex tooth structure. The increasing use of more advanced 3D radiographic images (CBCT) is very helpful to reduce these errors.⁵ Fractured root or crown: The carious lesions and the endodontic procedure (access cavity and canal enlargement) leaves make it brittle and fragile. Fractures on the crown or root can be detected before, during, or after the root canal. Crown fracture is the major cause of long-term endodontic failures.⁵ Depending on the extent and severity of the fracture, the dentist will advise on whether extraction (and placement of an implant) or a filling is the correct option. Fractured instruments: This happens especially if the canal is complex and curved, and instrumentation stresses become greater than the mechanical resistance of the instruments. Being a quite frequent complication in common practice, many studies have been published to understand the mechanisms of these iatrogenic errors and instruments' resistance (cyclic fatigue and torsional tests). A fractured instrument is a potential factor for failure when it negatively affects the correct shaping and

cleaning procedure. Clinicians should be very careful in avoiding overstressing, mainly the rotating nickel-titanium instruments of greater tapers.⁶

Blockage

The canal may suddenly lose patency during a cleaning and shaping process. This can be a result of tissue compression, debris accumulation, wall damage, or instrument separation. Any of these conditions blocks access into the deeper regions of the canal.⁷ Early detection and incorporation of the proper corrective action can prevent secondary damage, which can cause the situation to become so adverse that cleaning cannot be completed internally. Correcting a blockage requires preparation comprehension gained through experience. Without extensive experience one may not recognize signs and make timely and appropriate decisions. Therefore, an inexperienced clinician should request assistance when a blockage persists⁷.

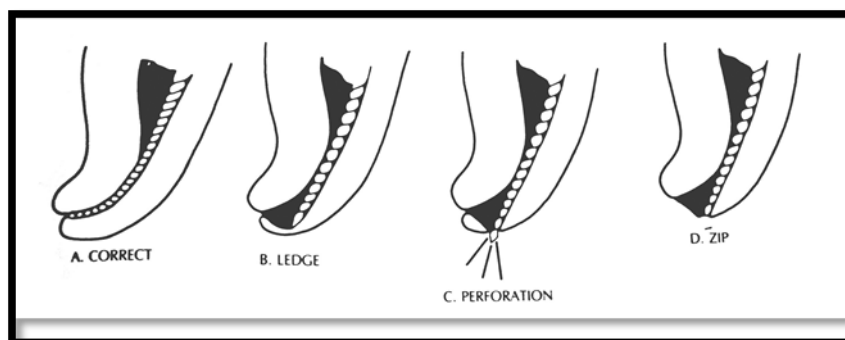
Soft Tissues

When pulp tissue is intact, the clinician must be cognizant that it can be packed into the apex by insertion of instruments. Extirpation of tissue is an important factor in reducing this potential problem. Generally, placing an instrument into the foramen and carefully rotating it there cuts the tissues loose and facilitates their removal. Clinical experience has shown that lubricants such as RC Prep or Glyoxide tend to emulsify the pulp stump and so prevent cohesion of collagenous debris. They are best used only during the initial 'negotiation' phase of cleaning and shaping (i.e., until enough coronal enlargement is created to allow the effective use of irrigants).⁸

Ledge Formation

Among the complications most commonly observed during root canal instrumentation is a deviation from the original canal curvature without communication with the periodontal ligament, resulting in a procedural error termed ledge formation or ledging. This often results when the operator works the files short of the full canal length, and the canal becomes blocked at that "short point". This might create a ledge, or it might begin to form a new pathway at a tangent to the true pathway of the root canal.⁹

The presence of a ledge might exclude the possibility of achieving an adequately shaped canal preparation that reaches the ideal working length, and this can result in incomplete instrumentation and disinfection of the root canal system as well as incomplete filling of the canal. The root canal space apical to the ledge is difficult to thoroughly clean and shape; therefore, ledges frequently result in ongoing periapical pathosis after the endodontic treatment. Consequently, there might be a causal relationship between ledge formation and unfavourable endodontic treatment outcomes.⁹⁻¹⁰



Hard Tissue

Dentin generated by the cutting action of files and drills settle into the apical regions and if not removed by recapitulation and irrigation can obstruct that region. Filing near the canal terminus exaggerates apical blockage by packing debris into the smaller apical regions. Once chips block the canal, continued generation extends the depth of blockage and causes obturation to fall short of the canal terminus. Accumulation of debris contributes to the formation of ledges. Some blockages are present in the canal before instrumentation. These are natural calcifications that have accumulated along the vascular channels and on canal walls. Pulp stones and secondary calcifications that project from the canal wall may be moved down the canal and become lodged by insertion of an instrument.¹¹

These can on occasion be bypassed by precurving the tip of preparation instruments. Loose pulp stones, which are wedged into the small diameter of deep apical canal spaces, are very difficult to remove or to instrument past. Once bypassed the particle is often reoriented to again obstruct the canal.¹² Frequent, generous irrigation and early radicular access help reduce the risk of accidental blockage with particles. Teeth with a diminished pulp chamber, narrowed canals, long-standing periodontal involvement, and / or multiple previous restorations are more likely to contain calcifications and manifest hard tissue blockage.¹²

Broken Instruments

During the cleaning and shaping of a canal system over-stressing of an instrument can cause it to break in the canal. The fragment blocks the canal system and prevents routine cleaning and shaping. Clinical recall evaluation has shown that broken instruments whose tip rests in the apical constriction are not as likely to fail as those that lie more coronally. In all situations blockage compromises cleaning, shaping and sealing.¹³ This type of blockage is preventable and requires constant attention to the force used to manipulate instruments. Frequent and close instrument examination and instrument disposal are the best preventives. Absolute awareness of the minute stress that each instrument can withstand without suffering irreversible structural damage is essential before prevention of separated instruments is possible. Minimal torque resistance and angle to fracture for standardized instruments provide a valuable relative measure of the strength of instruments in relation to their cutting diameter.¹⁴

Furcal Perforations

A furcal perforation is a mid-curvature opening into the periodontal ligaments space and is the worst possible outcome of any cleaning and shaping procedure. Its location is close to the clinical crown and consequently is very likely to develop or continue micro leakage from the coronal restorations into the space. Iatrogenic damage in this region must be prevented in order to give a tooth a reasonable chance for long-term functional stability and freedom from endodontic infections. Furcal perforations result from improper file manipulation or oversized radicular access preparations.¹⁵ Incorporating anticurvature pressure when cutting instruments are pushed or pulled in a curved canal system can minimize the risk of occurrence. Anticurvature pressure is extremely effective when used with Gates-Glidden drills in early radicular access preparations. Clinicians who employ conventional Hedstrom files for the preparation of curved canals, since conventional Hedstroms are very capable of creating a midcanal perforation and must be carefully used in curved roots commonly advocate anticurvature technique.¹⁶⁻¹⁷

Anticurvature principles provide little protection against perforation in the apical regions of a canal, but that is not a region in which a Hedstrom file is prone to perforate. Another most important consideration in preventing furcal perforations is developing the discipline to never take large Gates-Glidden or Peezo drills deeply into root canals.¹⁷ Deep insertion generally is not the operator's intention but rather a result of self-propelled inward motion of the drill. New drills of the larger sizes often grab the canal walls and pull themselves deeply into the canal before the clinician can stop the handpiece.¹⁸

A helpful technique to prevent this sometimes-disastrous occurrence is to run the handpiece in reverse direction with new drills. Run thus, the drills tend to back out of the canal. By applying more apical pressure the drill can be moved into the canal and made to cut dentin. It will go only to the intended depth, since it does not self-propel when rotated counter clockwise, and the applied pressure can be terminated as the desired depth is obtained.¹⁹ A reverse order of drill sizes is also very reliable in reducing furcal lacerations from excessive penetration depths. This technique seems more demanding and is difficult for many clinicians to master.¹⁹

Apical Perforations

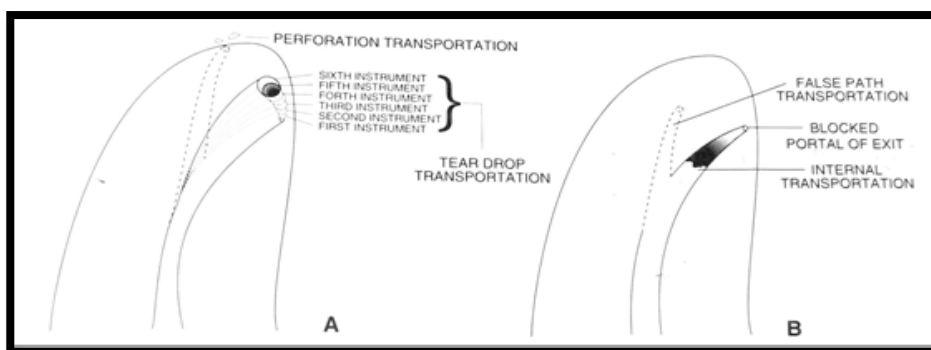
When the apical region of a canal is curved, condition exists that can result in an apical communication other than the foramen. Here the communication is most often a result of uncontrolled transportation and subsequent ledge formation. Attempts to re-establish canal length past the ledge finally result in the file tip cutting straight through the root structure and into the periodontal ligament space.²⁰

Altered Formina

When instruments are passed through a foramen, they can change the shape of that region very rapidly and irreversibly. Placed through the foramen, an

instrument receives its support primarily from that region of the canal. This relationship means a file will concentrate its internal forces against the structure of the foramen²⁰. In return, that delicate region must provide resistance to those forces and to the abrasive effects of instrument movements. In a nutshell, a few in and out movements can open a single side of the foramen several millimetres.

When the foramen is zipped it cannot be cleansed of tissue over most of its surfaces. Transportation of this type has a most serious effect on the prognosis for a treatment and is therefore recognized with special terminology (i.e., rip and zip). Opening of the foramen should be kept relatively small and a minimal number of passes made through it. If an enlargement of the foraminal diameter is desired, that enlargement should be the last and final step of the instrumentation procedure.²⁰



Foramina are delicate. At the interface between a canal system and the attachment apparatus, foramina must be maintained in their original position if complete removal of pulpal tissues and elimination of periapical stimuli is to occur. Instruments that pass through the foramina are routinely kept rather small (i.e., no. 10 or 15).²¹ They are procurved to minimize elastic forces that would be generated should the foramen have to alter their path. If the foramen is to be prepared to a specified diameter, that alteration is accomplished as the final step of cleaning and shaping and with a piloted (safe tip) file. The final shape must be round in order to not change the relationship between the canal and the supportive structures. For obturation the foramen must be smaller than the apical shaping diameter, free of tissue, and contoured so that a gutta-percha cone will tightly into the patent space (round is optimal).²¹

Conclusion

The most prevalent type of error observed in teeth treated by fifth year dentistry student was the apical transportation.²³ Molars were more prone to errors than other type of teeth. The quality of training provided for dentistry student should be improved and endodontic curriculum should be modified.²³

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