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TREATMENT

Strategies to reduce the risk of reinfection and cross-contamination in endodontics

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Abstract
Operative procedures should be carried out to the best practice level to reduce the risk of failure of endodontic treatment. Several operative strategies for eradicating endodontic infection and decreasing the risk of endodontic reinfection are indicated.

Keywords Nosocomial infection · Iatrogenic contamination · Best practice · Reinfection

Quick reference/description

Secondary endodontic infections are caused by facultative anaerobes and Gram-positive bacteria particularly, *Enterococcus faecalis*, *Streptococcus* spp., *Peptostreptococcus micros* and *Fusobacterium necrophorum* [1]. The prognosis of endodontic treatment is poorer in the presence of pre-existing factors like long-standing infection, fistulae, insufficient residual tooth structure, lack of coronal seal, hairline cracks and endo/perio lesion [2]. Maximizing infection eradication is important to increase the chances of success. Furthermore, specific operative procedures should be carried out to prevent cross-contamination and nosocomial infections.

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Overview

Operative procedures should be carried out to the best practice level to reduce the risk of failure of endodontic treatment. Following are the various operative strategies for eradicating endodontic infection and decreasing the risk of endodontic reinfection:

Operative strategies	Clinical steps	Advantages
I. Access cavity and infection prevention	Rubber dam isolation	Elimination of salivary cross-contamination
	Disinfection of operative field	Tooth surface decontamination to prevent oral bacterial introduction into the root canal system
	Removal of existing restorations	Confirmation of restorability and future coronal seal
	Removal of infected dentin	Decrease chances of endodontic reinfection
	Convenient access cavity to avoid keyhole approaches	Enable complete disinfection of root canal system
	Confirmation of absence of hairline cracks	Prevention of bacterial leakage
	Location of all existing canals	Prevention of failure of endodontic treatment
	Removal of calcifications within the pulp chamber	Complete removal of pulpal remnants underlying the pulp stones
II. Shaping with stainless steel and Ni–Ti instruments	Coronal flare	Creation of an irrigation reservoir and maximum exchange of irrigants
	Adequate shaping	Apical gauging with removal of sufficient infected dentin
	Removal of infected dentinal debris from the flutes of the instrument	Prevent cross-contamination between canals
III. Irrigation	Copious irrigation with sodium hypochlorite solution	Sufficient contact time for reaching the infected non-instrumented areas
	EDTA irrigation	Penultimate rinse for removal of smear layer
	Final sodium hypochlorite irrigation	Disinfection of exposed dentinal tubules
	Chemo-debridement of the canal	Better outcome of root canal therapy and minimize the risk of endodontic reinfection
IV. Avoiding iatrogenic infection	Drying the canal with sterile paper points	Prevention of iatrogenic infection
	Change of gloves at the time of obturation	Decrease environmental cross-contamination
	Disinfection of gutta-percha points for 1 min in sodium hypochlorite	Decrease risk of nosocomial infection

Operative strategies	Clinical steps	Advantages
V. Dressing	Dressing with calcium hydroxide (if used)	Maximize disinfection in the presence of drainage from within the canal and wide periapical lesions
VI. Advanced disinfection techniques	Patency filing	Removal of vapor lock
	Manual agitation with gutta-percha cone	Disruption of air bubbles
	Activation of irrigants with sonic or ultrasonic tips	Enhanced antibacterial activity
VII. Photodynamic therapy (optional)	Incubation of the root canal space with a dye	Activity inside the dentinal tubules via optical scattering
VIII. Final restoration	Rapid provision of a final restoration and/or full cuspal coverage	Maximize coronal seal

Materials/instruments

- Rubber dam, with single tooth isolation when possible
- Winged clamps, to minimize leakage
- OraSeal, caulking agent to improve seal
- Surface disinfectants, to disinfect the operative field
- CBCT, to determine anatomy and assess pre-existing periapical lesions presence
- Irrigants—sodium hypochlorite, 1–5% solution
- Calcium hydroxide, non-setting used as dressing agents applied for a minimum of 2 weeks
- Gutta-percha, pre-soaked in NaOCl prior to obturation
- EDTA, 17% to remove smear layer and render dentinal tubules accessible
- EDTA/urea peroxide, as lubricant gel to maximize shaping efficiency and removal of infected dentinal shavings
- Sterile paper points, used from individual sterile packages to dry the canals
- Gloves, changed prior to obturation phase to reduce risk of cross-contamination
- Sterile stainless steel and Ni–Ti files, to minimize environmental cross-contamination
- Ultrasonic tip, to carry out passive ultrasonic irrigation
- GIC, to provide immediate temporisation to create immediate coronal seal prior to rubber dam removal
- Periodontal probe, to rule out presence of single spot probing, associated with radicular cracks
- Endo-chuck/endosonore files to carry out ultrasonic irrigation
- Photosensitizer and photodynamic light source to carry out photodynamic (optional)

Procedure

Recurrent endodontic infection occurs due to the following factors:

- Incomplete eradication of the microbial biofilms
- Incomplete disinfection of inaccessible areas
- Insufficient operative skills and incomplete chemo-debridement and shaping protocols
- Iatrogenic contaminations
- Lack of coronal seal

A better outcome of root canal therapy and decreased risk of endodontic reinfection can be achieved by following various operative strategies.

Access cavity and infection prevention

- Prior to initiation of endodontic treatment, the tooth should be isolated using a rubber dam, winged clamps and OraSeal for improving the peripheral seal thus preventing the risk of endodontic reinfection.
- Following placement of the rubber dam, surface disinfectants can be used before accessing the endodontium to reduce the risk of introducing plaque bacteria into the root canal system.
- The existing restorations of the tooth should be removed with sterile burs for confirming the prognosis of the tooth by evaluating the restorability and predict the chances of achieving a future coronal seal.
- To decrease the risk of relapse of endodontic infection, decay and infected dentin should be thoroughly removed.
- Access cavity should be prepared to avoid keyhole approaches that may leave undercut that cannot be cleaned efficiently and may contain pulp remnants that may represent a bacterial substrate.
- Examine pulp chamber under magnification to confirm the absence of hairline cracks or other defects as these can lead to reinfection.
- All existing canal orifices should be located because overlooking the anatomy of the root canal system can lead to treatment failure. A CBCT can be obtained during treatment planning to minimize iatrogenic errors and missed anatomy.
- Ultrasonic tips or long shank rose-head burs can be used to remove calcifications within the pulp chamber.

Shaping with sterile stainless steel and Ni–Ti instruments

- Establish an adequate coronal flare to reduce extrusion of debris and bacteria through the apex and avoid formation of blockages.

- For preparation of taper with stainless steel files, the step back technique should be considered.
- For predictable and standardized removal of dentin, files made from flexible alloys (Ni–Ti) should be used with a more standardized shaping compared with the manual technique.
- Balanced force technique together with circumferential and anticurvature filling is used for maximizing the contact with the dentinal walls and to remove the adhering biofilm.
- The dentinal debris from the flutes of the instrument should be removed using different sponges that reduce the chances of cross-contamination between thirds of each individual canal and among different canals.
- Infected dentin should be removed with chemo-debridement of the canal using files and concomitant irrigation with adequate disinfection.

Irrigation

- Eradication of the endodontic biofilm and the removal of organic and inorganic debris produced during the shaping are achieved by irrigation.
- Use biocompatible irrigants such as sodium hypochlorite, EDTA, EDTA/urea peroxide as lubricant gel (Table 1).
- Irrigation should be used concomitantly along with filing to remove infected dentin.

Avoiding iatrogenic infection

- Endodontic treatment has the possibility of causing nosocomial infections due to cross-contamination from the clinical environment.
- During root canal treatment, the canals should be dried with sterile paper points.
- Prior to obturation, the gutta-percha cones should be soaked in sodium hypochlorite solution or Milton solution for at least 1 min.
- Gloves should be changed at the time of obturation to prevent environmental cross-contamination, as gloves tend to accumulate viable bacteria from the environment during clinical procedures [3].

Table 1 Irrigation regimen for infected teeth

	Volume	Concentration	Minimal contact time/volume
Antimicrobial irrigant	NaOCl	1–2%	45′/10 mL
Chelating agent	EDTA	17%	1′ (penultimate rinse)/0.5 mL
Adjuvant	Urea peroxide/EDTA gel	Variable	During shaping/ad-lib
Sequence	[NaOCl + EDTA + NaOCl] repeated *n* times + final rinse protocol (1′ EDTA + final rinse with NaOCl)		
Activation	Passive ultrasonic irrigation (size 10 file to working length activated by touch with an ultrasonic tip)		

Dressing

- Dressing is the safest method of achieving root canal sterility of the root canal space prior to obturation.
- Maximum efficiency of dressing can be obtained by inserting non-setting calcium hydroxide in each canal till the working length. It is debated that the minimal amount of time required to efficiently eradicate the bacteria contaminating the root canal space, as the available evidence indicates is between 1 and 2 weeks. The temporary restoration needs to provide an intact coronal seal.

Advanced disinfection techniques

- To minimize the phenomenon of the vapor lock that happens when bubbles of air are entrapped, due to capillarity at the apical third during cleaning and shaping, patency filing and manual pumping of gutta-percha cone can be utilized.
- Passive ultrasonic irrigation (PUI) is used to disrupt the endodontic biofilm.
- PUI is carried out by flooding the canal with sodium hypochlorite, selecting a passive file reaching the full working length and touching with a periodontal probe to activate the irrigant for at least 20 s.
- Alternatives such as endo-chuck, endosonore files or sonic activation can also be used.

Photodynamic therapy (optional)

- Photodynamic therapy is based on the incubation of the root canal space with a dye (photosensitizer) which when excited with a light of the appropriate wave length releases free radical ions damaging the biofilm.
- Optical scattering activity within the dentinal tubules is the advantage of photodynamic therapy.

Final restoration

The final restoration should consist of permanent core followed promptly by a cuspal coverage in posterior teeth. Glass ionomer composite can be utilized as a base over the obturated canal orifice, followed by a composite restoration. Timing of the cuspal coverage effect has a positive effect on the long-term outcome and survival of the root canal treated tooth. Cuspal coverage should be provided between 2 weeks and 4 months from completion of the root canal treatment. Anterior teeth do not require cuspal coverage, whereas premolar may benefit in case of unfavorable occlusal patterns. Teeth which are not restorable to start with or have limited remaining tissue structure (< 30%) have a higher chance of failure.

Pitfalls and complications

- Limitation of irrigation includes:
    - Difficulty in reaching non-instrumented area, such as isthmuses, accessory canals and dentinal tubules
    - Resilience of mature biofilms that are well adhering to the root canal walls [4]
    - Limited contact time
    - Volume of delivery
- Temporary restorations tend to lose coronal seal and allow bacterial microleakage after 4 weeks.
- The effect of irrigation is affected by the presence of bubble of air or dentinal debris plugs or other blockages closing the apex, creating a closed system.
- Bubbles of air produced during PUI can limit the contact time of irrigants.
- Sodium hypochlorite can cause bleaching of photosensitizer if photodynamic therapy is considered.

Further reading

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