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Topic : Clinical Protocol For Endodontic Irrigants
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CLINICAL PROTOCOL FOR ENDODONTIC IRRIGANTS

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INTRODUCTION

- Root canal cleaning and disinfection during chemo mechanical preparation relies heavily on Irrigants .
- Irrigants should ideally have antimicrobial and tissue-dissolution actions.
- No single solution is able to fulfill these actions completely so combinations are preferred.

Functions of irrigating solutions

- Washing action (helps remove debris)
- Reduce instrument friction during preparation (lubricant)
- Facilitate dentin removal (lubricant)
- Dissolve inorganic tissue (dentin)
- Penetrate to canal periphery
- Dissolve organic matter (dentin collagen, pulp tissue, biofilm)
- Kill bacteria and yeasts (also in biofilm)
- Do not irritate or damage vital periapical tissue, no caustic or cytotoxic effects
- Do not weaken tooth structure

Haapasalo et al ,Dental clin N Am 2004

ENDODONTIC IRRIGANTS

K.GULABIVALA, ENDO TOPICS,2005

Table 1. A classification of types of chemicals used for root canal irrigation

Type of chemical	Generic and brand examples
Chelating agents (EDTA containing)	EDTA, EDTAC, REDTA, Salvizol, Tublicid, RCPrep; Glyde; EGTA
Halide complexes	Sodium hypochlorite, tincture of iodine, povidone–iodine, iodine potassium iodide, oxidative potential water (electrochemically activated water)
Acids (organic and inorganic)	Phosphoric acid, citric acid, lactic acid, polyacrylic acid, tannic acid, DMSA (dimercaptosuccinic acid)
Antibiotics	Tetracycline hydrochloride, doxycycline hydrochloride
Oxidizing agents	Hydrogen peroxide
Others	Cetrimide, bardac-22 (quaternary ammonium compound), tergensol (0.2% lauryl sodium sulfate), chlorhexidine, MTAD (tetracycline isomer, an acid, detergent), ethylenediamine, methylene blue dye, titanium tetrafluoride, trientine hydrochloride (Syprine), Succimer (Chemet)
Organic solvents	Chloroform, halothane, xylene, eucalyptus oil, orange oil

Characteristics of Some Root Canal Irrigants

Compound	Chemical structure	Type	Concentration of solution (%)	Typical pH of solutions
Sodium hypochlorite	NaOCl	Chlorine-releasing agent	0.5 to 15	9 to 12
EDTA	$C_{10}H_{16}N_2O_8$	Polyprotic acid	10 to 17	7 to 8
CHX	$C_{22}H_{30}Cl_2N_{10}$	Bisguanide	0.2 to 2	5.5 to 7
CA	$C_6H_8O_7$	Organic acid	10 to 50	1 to 2

SODIUM HYPOCHLORITE (NAOCL)

- It is recommended as the main endodontic Irrigant.
- It has ability to dissolve organic matter together with its broad antimicrobial action.
- No irrigation solution has been found capable of demineralizing the smear layer and dissolving organic tissue simultaneously.
- The adjunctive use of chelating agents such as EDTA or citric acid (CA) is suggested

MODE OF ACTION

- NaOCl dissolves organic material- pulp tissue and collagen
- Bacteria inside the main root canal, lateral canals & dentinal tubules-direct contact with irrigant- **Endotoxin elimination**
- **Minimally** removes dentin debris or smear layer.
- Use of **demineralizing solutions** to rid the canal of post instrumentation smear layer
- **Role of duration-** undesired side effect on the flexural strength of dentin
- **Loss of Ca++ ions-** depends on NaOCl concentration and time of exposure

Martinho FC, J Endod, 34:268,2008

Nygaard Ostby, Tidskr, 65:3,1957

VARIATIONS OF NaOCL ph

- Variations of NaOCl pH will modify the antimicrobial and tissue-dissolution activities (Rossi-fedele G,Int Endod J,2011).
- A reduction of the pH to values around 6.0 to 7.5 has been found to improve the antimicrobial efficacy but hinders tissue dissolution action.
- If the pH is lowered to values below 4, then the amount of Unstable chlorine gas in the solution will increase.
- If NaOCl is mixed with other irrigants possessing low pH values, there is a possibility of altering its properties

SODIUM HYPOCLORITE
CLINICAL CONCLUSIONS

- **Concentration**- 1% - 5.25%,
- **Lower concentrations** (0.5% ,1%) - dissolve necrotic tissue.
- **Higher concentration-** necrotic & vital tissue.

- **pH**- 9(0.5%)- 11(0.5-5.25%)
- **Duration**-18 min of irrigation is required per canal.*
- **Volume of irrigant-** 2ml of NaOCl , applied between each instrument (Walters et al, 2002), followed by a final flush of 5-10 ml (Santos et al, 1999)

Calt S, J Endod 28:17,2002, Mayer BE, Int Endod J,35:582,2002

ETHYLENE DIAMINE TETRAACETIC Acid (EDTA)

- It Is a polyprotic acid whose sodium salts are noncolloidal organic agents that can form nonionic chelates with metallic ions.
- EDTA exists in aqueous solutions as an equilibrium mixture of both protonated and unprotonated forms.
- 2.5% to 5% NaOCl followed by 17% EDTA had a profoundly beneficial effect on secondary nonsurgical root canal treatment.(Int Endod J-2011)

MODE OF ACTION

- Formula-
- **Disodium salt of EDTA - 17 .0 g**
- **Distilled water - 100.0 ml**
- **5N sodium Hydroxide - 9.25 ml**

- Concentration- **17%**
- Forms a **calcium –chelate solution** with the calcium ion of dentin.
- Chelating agent- **sequesters di and tricationic metal ions** such as Ca 2+ and Fe3 +.
- After being bound by EDTA- metal ions remain in solution but exhibit diminished reactivity
- EDTA **extracts bacterial surface proteins** by combining with metal ions from the cell envelope-bacterial death.

EDTA- CLINICAL CONCLUSIONS

- EDTA is effective in softening dentin.
- EDTA has distinct antimicrobial properties
- EDTA is capable of causing moderate degree of irritation.
- No deleterious effect when used clinically as an irrigating solution
- **Irrigation with 17% EDTA- removes the smear layer- period of 1 min** (*Calt S,Serper J Endod 2000*)
- Extent of demin is proportional to the exposure time
- Partial demin of dentin 30-50 u in 5 min

Grossman's endodontic practice, 11 th e/d

Chlorhexidine (CHX)

- A polybiguanide, is stable as a salt although it dissociates in water at a physiologic Ph.
- CHX can be used as either an alternative or an adjunct root canal irrigant because of its antimicrobial qualities.
- CHX lacks tissue dissolution capacity

(0kino LA et al, Int Endod J,2004)

- CHX before the application of adhesives prevents resin-dentin bond degradation because of inhibiting collagenolytic enzymes.(J Dent Research,2011)

MODE OF ACTION

- **Bacteriostatic** & **Bacteriocida**l effects.
- **High concentrations-** acts as a detergent –cell membrane damage, precipitation of cytoplasm-Bactericidal.
- **Low sublethal concentration-** CHX is bacteriostatic- causes low molecular wt substances to leak out , reversible cell damage.
- Abolishes **sugar phosphotransferase system** (PTS) transport activity and inhibits acid production

Basrani B, Aust Endod J,31:48,2005

SUBSTANTIVITY

- Mohammadi et al- Direct correlation of CHX **concentration with its Substantivity**.
- Lin et al - Antimicrobial capability of CHX **increases with time.**

- Komorowski et al

1. **Dentin** should be treated with CHX for **7 days**.
2. **Antimicrobial activity** of CHX in the root canal system remains upto **12 weeks**.

- **Available** -Liquid ,gel form.
- Antibacterial efficacy of CHX depends on its concentration level
- CHX- lacks tissue dissolving property unlike NaOCl .
- **Invitro studies-**

1. 2% CHX gel vs 2% CHX liquid or 5.25% NaOCl.
2. 2% CHX liquid inferior to 2.5% NaOCl in cleaning canals.

- **Invivo studies –**
- **Better disinfection** of Root canals using **CHX compared to saline as a final rinse.**
- **Teeth with apical periodontitis-** greater bacterial reduction with 2.5% NaOCl, compared to 2% CHX.

Basrani B, J Endod:33:966,2007

Yamashita JC, Int Endod J 36:391,2003

CHLORHEXIDINE
CLINICAL CONCLUSIONS

- Concentration- 2%
- pH- 11-11.5
- final rinse following in re-treatment procedures & non vital teeth.

MTAD- mixture of antibiotics. Citric acid and detergent

- Capable of removing both smear layer and disinfecting the root canal system.
- Mixture of **3% doxycycline hyclate, 4.25% citric acid, 0.5% polysorbate -80 (Tween 80) detergent**.*
- Commercially available as Biopure MTAD.
- Final rinse after completion of chemomechanical prep.
- Bacterial load reduction was not significant compared to NaOCl.(Giardino l,J Endod 2007)

*Torabinejad M, J Endod 2003,29:170-5

- Suggested protocol- 20 min disinfection with 1.3 % NaOCl, followed by 5 min rinse with MTAD.

Shabahang S, J Endod 29:450,2003

The redox reaction between NaOCl and MTAD resulted in a red purple color precipitate.

- This precipitate ***a tetracyline degradation***

  precipitate which has reduced anti-microbial property***.(no longer preferred)***

N Sridevi et el.Endodontology

TETRACLEAN

- Similar to MTAD
- Differs in the concentration of antibiotic- 50 mg/ml of doxycycline and polypropylene glycol as detergent.
- **Mode of Action-**
- **Removal of smear layer-** Citric acid .
- **Antibacterial Effect-** doxycycline, an isomer of Tetracycline, Bacteriostatic/Bacteriocidal, broad spectrum, inhibition of protein synthesis.
- **Tween 80** -facilitates penetration of MTAD into dentin, decreases the surface tension.

HYDROGEN PEROXIDE

- **Concentration**- 3-5%
- Active against bacteria, viruses and yeasts.
- Hydroxy free radicals (OH) destroy proteins and DNA.
- Tissue dissolving property of H2O2 is inferior to that of NaOCl.*
- In conjunction with NaOCl- bubbling action- release of Nascent Oxygen .
- **No longer recommended as routine irrigant.**

*Schafer E, ENDO 1:11-28,2007

IODINE POTASSIUM IODIDE

- Solution of **2% iodine** in **4% potassium iodide**.
- Used as an **endodontic disinfectant** .
- Excellent **antimicrobial** activity and **low cytotoxicity**.

- Demerits**:**
- **Staining** of dentin
- May act as a severe **allergen**.

Popescu IG, Med Intern 22:195,1984

Schafer E, ENDO 1:11-28,2007

IRRIGANTS & BONDING OF RESIN BASED

- **NaoCl**- strong oxidizing agent, it leaves behind an oxygen rich layer on the dentin surface - reduced bond strengths and increased microleakage.
- ascorbic acid or sodium ascorbate have been shown to completely reverse this reduction in bond strength.

Lai SC, J Dent Res.2001;80:1919–24.

- Similar **inhibitory effects** with- Hydrogen peroxide, RC prep, Electrochemically activated water, Chloroform and halothane.

- **CHX**- autodegradation of collagen matrices in resin infiltrated dentin can be reversed by a synthetic protease inhibitor like CHX.

Richard Schwatrz, J Endod 2006,32:1125-1134

Carriho MR, J Dent Res, 86:90,2007

Interactions between NaOCl and Chelating Agents

- The addition of chelators to NaOCl reduces its pH.
- when mixed in a 1:3 ratio, although with a larger volume of EDTA, the pH value was stable.
- When EDTA is added to NaOCl, chlorine gas can be detected at relatively low levels.
- When CA is used, significantly more chlorine is detectable.
- chemical interactions between chelating agents and NaOCl result in a loss in the free available chlorine (FAC)

- The dramatic reduction of FAC in NaOCl mixtures caused by chemical interactions appears to explain the inability of NaOCl and EDTA mixtures to dissolve soft tissues.
- The degradation and consequent deactivation of EDTA after its interaction with NaOCl is extremely slow.
- It does not compromise its clinical performance with respect to its chelating, smear layer removal, and dentin softening effect.
- NaOCl does not reduce the calcium chelating or smear layer ability of EDTA and CA.

Interactions between NaOCl and CHX

- NaOCl with liquid CHX results in the instant formation of a flocculate or precipitate (Basrani et al).
- most investigations report the presence of parachloroaniline (PCA) in the precipitate, 1 failed to detect its presence.
- PCA was present at concentrations directly related to the NaOCl concentration(Basrani et al).
- PCA has been suggested to be a toxic and carcinogenic substance, hence the significance of this subject.
- CHX breakdown, the products appear to be parachlorophenylurea (PCU) and parachlorophenylguanidyl-1,6-diguanidyl-hexane(PCGH). (Nowicki and Sem et al JOE — Volume 37, Number 7, July

Orange precipitate formed by mixing chlorhexidine with sodium hypochlorite

Interactions between CHX and Chelating Agents

- CHX is easily mixed with CA, and no modification of its demineralizing ability or precipitation occurs.(Akisue et al J Endod 2008)
- It has been shown that it is not possible to obtain a homogenous solution by mixing 17% EDTA and 1% CHX because a highly insoluble pink powdery precipitate forms.(Gonzalez-lopez et al J Endod 2006)

- Over 90% of the precipitate mass was either EDTA or CHX although PCA was not detected.
- It was suggested that the precipitate was most likely a salt formed by neutralization of the cationic CHX by anionic EDTA.(Gonzalez-lopez et al J Endod 2006)
- 15% CA followed by 2% CHX causes the formation of a "milky" solution, which can be easily removed by using further CHX; no precipitation occur

PREVENTIVE STRATEGIES.

- **NAOCL AND EDTA**:
- Rinse out with copious amounts of NaOCl making sure that fluid exchange occurs at all levels in the canal to prevent stratification of the solutions through the canal
- This will lead to different mixtures of the Irrigants at different levels
- Alternatively, evacuation or drying before the placement of the next Irrigants can also help

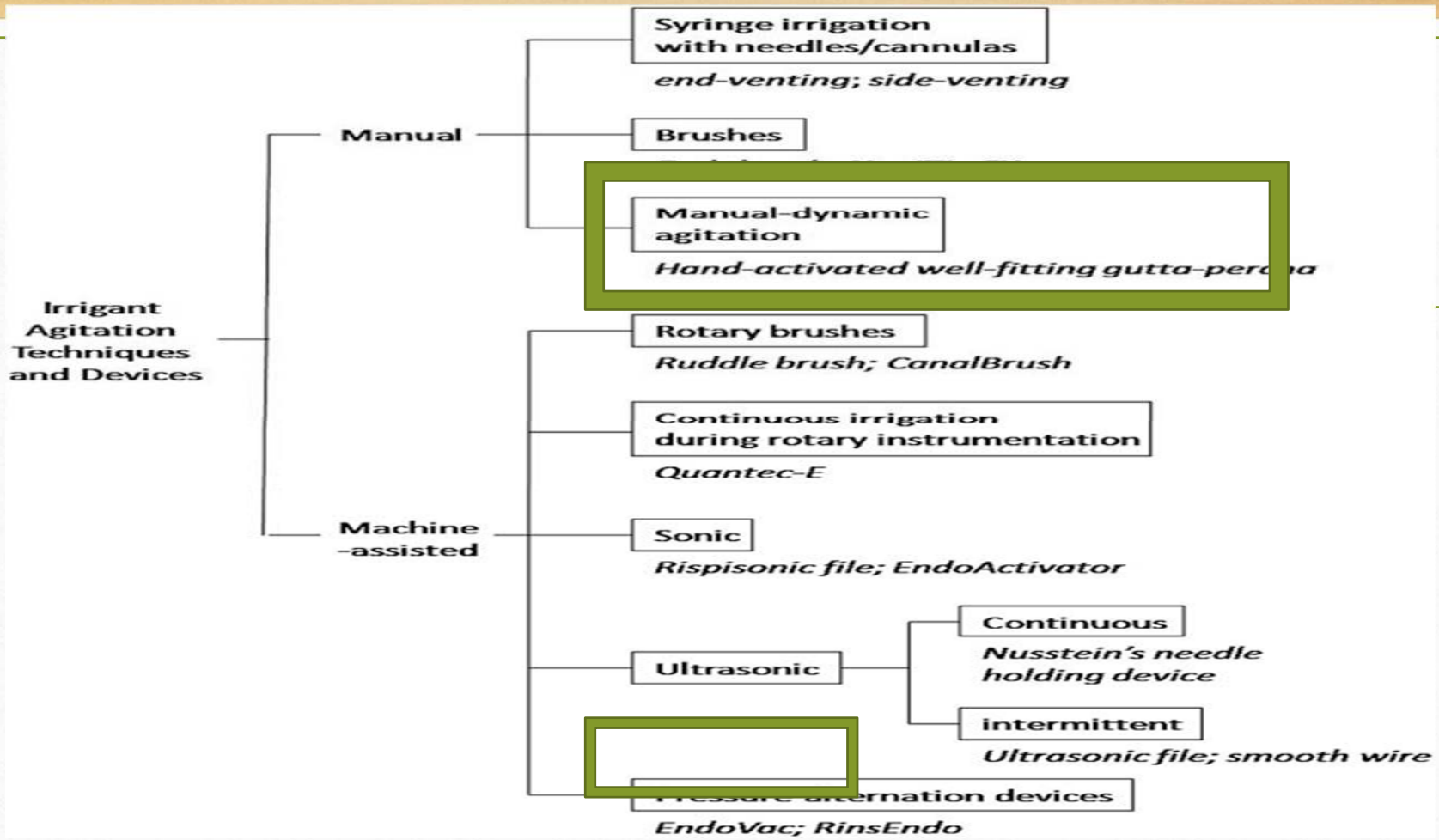
- **NAOCL AND CHX:**
- to prevent the formation of a precipitate associated with CHX and NaOCl interactions, a rinse with intermediate solutions.
- They include

- Saline (Valera et al, OOOE 2010)
- Water (Bui et al,J Endod 2008)
- Alcohol (Marchesan et al OOO 2007)
- Isopropyl alcohol (Krishnamurthy et al,J Endod 2010)
- CA (Akisue et al,J Endod et al 2010)
- EDTA (Marchesan et al OOO 2007)
- Acetic acid can be used to dissolve the precipitate (Basrani et al,J Endod 2007).

- **<u>CHX AND CHELATING AGENTS</u>**:

- CA can be used in association with CHX because no interactions occur .
- Alternatively, maleic acid can be used because it has been shown that this combination does not cause the formation of a precipitate.

- *Gonzalez-lopez et al,J Endod 2006.*


Irrigant Agitation Techniques and Devices
Manual
Machine -assisted
Syringe irrigation with needles/cannulas
end-venting; side-venting
Brushes
Manual-dynamic agitation
Hand-activated well-fitting gutta-perc a
Rotary brushes
Ruddle brush; CanalBrush
Continuous irrigation during rotary instrumentation
Quantec-E
Sonic
Rispisonic file; EndoActivator
Ultrasonic
Continuous
Nusstein's needle holding device
intermittent
Ultrasonic file; smooth wire
ernation devices
EndoVac; RinsEndo

- **sonic irrigation**
- Tronstad et al (84) were the first to report the use of a sonic irrigation
- sonic irrigation operates at a lower frequency (1–6 kHz) and produces smaller shear stresses compared to ultrasonic's.
- 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear layer and biofilm

Cohen's Pathways of pulp-tenth edition

Lasers in irrigation

- LAI techniques with erbium lasers (Er:YAG or Er,Cr:YSGG) for 20 seconds (4times for 5 seconds) are as efficient as passive ultrasonic irrigation with the intermittent flush technique (3times for 20 seconds).

De Moor et al. JOE — Volume 36, Number 9, September 2010

- Efficacy of laser-driven irrigation versus ultrasonic in removing an airlock from the apical third of a narrow root canal
- PUI FOR 60s,LAI-60s
- insertion of irrigation needle is shorter than the working length, air entrapment may develop in the apical third, but the use of laser-driven irrigation is completely effective in removing it.

- **Manual-Dynamic Irrigation**
- gently moving a well-fitting gutta-percha master cone up and down in short 2- to 3-mm strokes within an instrumented canal.
- the frequency of push-pull motion of the gutta-percha point -3.3 Hz, 100 strokes per 30 seconds.

Wong R, Dent Clin North Am 2004;48:265–89.

- **Passive ultrasonic irrigation-** Weller et al
- without simultaneous instrumentation, so called passive ultrasonic irrigation (PUI).
- Transmission of acoustic energy from an oscillating file or smooth wire to an irrigant in the root canal
- DURATION- Sabins et al.(2003) found 30s of PUI

3 times for 20 seconds according to van der Sluis

Gauge-30
Notched open end-2mm short of WL
Closed end side vented-to be used 1mm short of WL

Boutsioukis et al. JOE — Volume 36, Number 5, May 2010

Irrigation in c-shaped canals

- An increased volume of irrigant.
- deeper penetration with small instruments using sonics or ultrasonics may allow for more cleansibility in fan-shaped areas of the C-shaped canal.

Melton DC, J Endod 1991;17:384–8.

- Sodium hypochlorite is the preferred choice of irrigant.
- ultrasonic preparation may effectively remove tissues from narrow C-shaped canal ramifications, aggressive instrumentation may cause perforation

Jerome CE. Gen Dent 1994;42:424 –7.

IRRIGATION REGIMEN

- **5.25 % Sodium hypochlorite** :-Canals should always be filled with sodium hypochlorite.
- **17 % EDTA-** Rinsing with 5 to 10ml for 1 min followed by NaOCl as final rinse.
- **Prior to obturation/ CHX interim dressing/Re-treatment cases-** Final rinse with 2% Chlorhexidine solution.

Zehnder M, Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;96:608 –13

Thank you