

Application of Intracanal Medicaments: A Review

Himadri pal¹, Arpita sarkar², Lopamoodra das³, Subrata saha⁴, Subir sarkar⁵

1&2- 2nd year PGT, Department of pedodontic and preventive dentistry, DR.R.Ahmed dental college and hospital

3-1st year PGT, Department of pedodontic and preventive dentistry, DR.R.Ahmed dental college and hospital

4-Professor, Department of pedodontic and preventive dentistry, DR.R.Ahmed dental college and hospital

5- Professor and H.O.D, Department of pedodontic and preventive dentistry, DR.R.Ahmed dental college and hospital

Corresponding Author: Himadri pal

Abstract: Elimination of microorganisms from the root canal is the main procedure for endodontic treatment. Cleaning and shaping is not so much effective for reducing bacterial count in root canals. This procedure may fail due to survival of resistant microorganisms in dentinal tubules and canals due to inaccessibility of mechanical instrument and irrigation. Non-toxic Intracanal medicament are capable of destroying bacteria, reducing inflammation and stimulating hard tissue formation which is useful in success of root canal treatment after completion of chemomechanical preparation. The antimicrobial activities of medicaments act against obligate and facultative anaerobic bacteria commonly found in root canals. Irrigants and invasive medicaments can be adopted for chemical treatment of root canals. Comprehensive research is required to identify a suitable intracanal medicament because no such medicament completely fulfills all the categories. However, Calcium Hydroxide is a gold standard medicament with many disadvantages.

Keyword: Microorganisms, Intracanal medicament, Chemomechanical preparation, Irrigants, Calcium Hydroxide

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I. Introduction

The main etiological factor of pulp and periradicular diseases is Microorganisms¹. If bacteria invade into root canals, infection, necrosis and apical periodontitis occurs. The first and foremost criterion of endodontic treatment is to remove and deactivate all types of microorganisms in the root canal². There are mainly three stages of endodontic treatment procedure like, biomechanical preparation, disinfection and obturation of the root canal³. During biomechanical preparation disinfection, cleaning & shaping of root canal has to be done. However, its role is secondary while applying controlled asepsis technique in an infected root canal⁴. Different medicaments with different chemical natures are applied to eradicate multiple microorganisms with single dose in different ratio⁵. For disinfecting root canals advanced technology are developed, like, photoactivated disinfection, ultrasonics, endox, ozone, lasers and electrochemically activated water. Long effective intracanal medicaments are applied to inactivate bacterial inflammatory consequences between endodontic appointments.

Justification of intracanal antiseptic medicament:

The main rationale behind intracanal medicament is to kill the bacteria inside the root canal and to avert reinfection. In absence of nutrients, the bacteria remains after obturation in root canal may die. If they survive, they may flourish. The bacteria which remain in dentinal tubules cannot be removed through chemo mechanical preparation. If the root canal is not dressed properly with antiseptic medicaments between the visits, the residual bacteria may increase in same number as it was in the starting stage of treatment. Thus the use of effective intracanal medication for disinfection of root canal is necessitated⁶. Medicament with long effect and least irritated to periradicular tissue has to be introduced to infiltrate the dentinal tubule eliminating bacteria when time does not allow to complete the treatment at one visit.

As the effect of intracanal medicaments is longer than irrigants, it is generally recommended to fill the root canal between appointments with intracanal medicaments.

Ideal properties of intracanal Medicaments:

- It should bear germicide and fungicide effect.
- It should be non-irritating.
- It should act in solution

- d. It should have a long lasting antibacterial effect.
- e. It has to act in presence of blood, serum and protein derivatives of tissue.
- f. It must penetrate the tissue deeply.
- g. It should keep quiet while repairing periapical tissues.
- h. It should leaststrenuous to tooth structure
- i. It should be easily employed into the root canal.
- j. It has to bear characteristic which may keep it inactivated or neutralized in culture medium.
- k. It should prevent coronal microleakage and not diffuse through the temporary restoration⁷.

Objectives of intracanal medicaments

1. **Destruction of micro-organisms:** The main objective is to kill all viable microorganisms or to disinfect all pathogens in the canal space.

2. **Rendering contents of canal inert:** It notifies the activities by using chemical which “mummify” fix or otherwise deactivate the tissue or debris remains in pulp space. If this process applied successfully, it can deactivate those residual bacteria remains in pulp space.

3. **Prevention or control of post-treatment pain:** The main indication is to lessen or alter the inflammatory effect. Medicament will execute this with its antimicrobial action or by pharmacologically altering the inflammatory effect. Pain with inflammation can be reduced by this application. Chemical or pharmacological action of medicament by direct application on sensory nerves in the pulp or periapical tissues may also regulate the pain.

4. **Enhancing Anesthesia:** In the condition when pulp is difficult to anesthetize, suitable agents are being administered to reduce the sensitivity of the inflamed pulp. The pulp could be removed during appointments with less anesthetic difficulty.

5. **Control of persistent periapical abscess:** The sign of an active periapical inflammatory lesion can be identified by significant pain in canal or swelling after treatment or recurrently “weeping” canal. To subside this difficult situation, intra canal medicaments have been suggested. Direct access of this agent is required in the periapical lesions. The agent in the canal space would have direct access to the periapical lesions. For this it can restore a healthy balance⁵.

Factors influencing antiseptic action

Antisepsis is a condition which can prevent or arrest the growth of micro-organisms on living tissues. In case of breach in the chain of asepsis, antiseptic measures are required to prevent infection in vital pulp extirpation. To prevent micro-organisms growth, irrigating solutions and inter appointment dressings with antibacterial effect may be administered⁸. It is evident that the residual microbial population of the canal will increase in number following root canal preparation if intra canal medicament is not used. Antiseptic medicament having capabilities of killing all species of micro-organisms liable to be present is required to be used. The medicaments are required to be active in the presence of protein derivatives and should not limit its own diffusion by precipitation of albumin when tissue fluid may enter through apical foramen. It should also be easily diffusible to reach organisms placed in the minor irregularities of the canal. Diffusion of the agent in an apical direction is obviously suggested⁹.

Drugs (antibiotics):

For root canal antisepsis, highly perform bactericidal antibiotics are used. The selected properties of the antibiotics are:

- 1) In presence of tissue fluid they are not inactive.
- 2) Do not stay in the tooth structure.
- 3) There is no irritation at very high concentration to tissue after placement.

It is seen there is no such single antibiotic effective against all micro-organism present in contaminated root canals. So, a combination of antibiotics or one or more antibiotics with chemical antiseptic is required. But there is some drawbacks of antibiotics:

- 1) Microorganism resistant strains may develop.
- 2) If the patient is sensitive to that antibiotic allergic response may develop.
- 3) Use of an insensitive antibiotic in root canal may become sensitive.

Form of the Drug:

Justified use of antibiotic paste in preference to a chemical antiseptic is little or nil advantageous. For treating root canal infection and periapical irritation, administering antibiotic paste is usually effective than chemical antiseptics as antibiotics are less irritant to periapical tissue. However, it is not clear to use antibiotic paste in widened apical foramen with immature teeth or caused by unintentionally over use of instrumentation. It is evident that chemical antiseptics lose effectiveness more rapidly than antibiotic preparation within a root canal. Hence the use of antibiotic preparation is advantageous when the interval between second last visit and the visit at which the tooth is root filled count as far as 14 days. Considering the allergic reaction, a patient should not be administered a preparation containing an antibiotic which is known to be case sensitive⁹. However, it has observed that Chemo mechanical cleaning with the use of antibiotics/steroids combination or calcium hydroxide as inter appointment medicaments brings similar microbiological results¹⁰.

Micro-organisms:

While selecting intracanal dressings, microbial composition of infected root canals is an important factor. These intracanal medicaments come in contact in different types of micro-organisms. As a result of this it inhibits osteoclastic activities in root resorption and stimulate tissue repair.

Location of micro-organisms:

It is a matter of concern for treating the complexity of an infected pulp necrosis which is related to mere presence of bacterial organisms throughout the pulp chamber and the fact that they may be lodged in areas such as lateral canals, isthmuses, crevices and dentinal tubules where instrument and disinfection could not get access. It is difficult task for a clinician for cleaning the entire circumferences of oval shaped canals due to presence of necrotic tissue and debris. Another difficult task is the bacteria present in dentinal tubules.

The aspects which stimulate the antiseptic action are-

1. **Trauma:** The tooth should be disoccluded at times under treatment.
2. **Devitalized tissue:** It will restrict the disinfection or repair, if present in the root canal or periapical tissue.
3. **Dead space:** The medicament should be applied into the root canal in such a way that it may contact with tissue to be sterilized.
4. **Accumulation of exudate:** As the exudate accumulates, it should be allowed to drain or be removed. It is pertinent to change the root canal dressings once or twice a week for renewing the medication and for removing the exudate by means of absorbent points.
5. **Foreign body:** Root resection or curettage should be executed to eradicate the foreign body present in the periapical tissue⁷. Prevention, minimization and elimination of infection are the principles of judicious endodontic therapy which are difficult tasks within the condition of a canal system¹⁰.

Classification:

According to Grossman⁶ intracanal medicament can be classified as

1. Essential oils
 - Eugenol
2. Phenolic compounds
 - Phenol
 - Parachlorophenol
 - Camphorated parachlorophenol
 - Cresol
 - Formocresol
 - Creosote
 - Cresatin
 - Cresanol
3. N₂
4. Salt of heavy metals
 - Metaphen
 - Merthiolate
 - Mercuriophen
5. Halogens
 - Sodium hypochlorite
 - Iodides
 - Chlorexidine
6. Quaternary ammonium compounds
 - 9-aminoacidine

7. Fatty acids

- Propionic acid
- Caproic acid
- Cuprylic acid

8. Sulphonamides.

Eugenol:

Eugenol is the chemical essence of clove oil and is related to phenol to some extent. It is both an antiseptic and an anodyne and is moderately more irritating than clove oil. It becomes dark with age and is a pale yellow liquid. It has little bit anesthetic as well as antiseptic properties and contain clove like odor⁶.

Phenol:

In 1867, Lord Lister used phenol as medicine which is one of the oldest antiseptic. It is derived from coal tar as white crystalline substance and has a specific odor. By adding camphor, menthol or thymol phenol crystal is become liquefied which consists of 9 parts phenol and 1 part water commonly known as carbolic acid. This phenolic compound is used as sedatives for the pulp tissue, as root canal medications and as disinfection for caries cavity preparation, as disinfection before periapical surgery and for cauterizing tissue tags that resist removal with broaches or files in dental treatment. Phenol is notified as coefficient which is compared with one time antimicrobials for their disinfectant action.

Parachlorophenol:

It turns dark upon exposure to light and is a colourless needle like crystals alike phenol. Chlorine replaces one of the hydrogen atoms of phenol so parachlorophenol (C₆H₄OHCl) compound is formed. Crystals of parachlorophenol are soluble in ether, alcohol, alkalies. It forms an oily liquid when it triturated with gum camphor⁶.

Camphorated parachlorophenol:

In 1891, Walkhoff introduced camphorated parachlorophenol consisting of P-chlorophenol and gum camphor in 2:3 ratio into dentistry as a intra canal antiseptic. It has specific aromatic odor and is transparent light amber coloured oily liquid. The camphor present in camphorated parachlorophenol reduces irritating effect of pure parachlorophenol and acting as a diluent and vehicle. Grossman brought to light the antimicrobial effect of camphorated parachlorophenol compared to some other root canal medicaments. Wantulor and Brown proved that the vapours of camphorated chlorophenol of cresatin has a capability of passing through the apical foramen.

Camphorated Monoparachlorophenol (CMCP):

CMCP is being prepared using the mining crystals which is a compound of paramonochlorophenol and camphor in the ratio of 3:7 when liquefaction happens impulsively. CMPC is less irritant, powerful bactericidal agent than phenol and doesn't coagulate albumin⁷.

Cresol (Tricresol):

It is acquired from coal tar with or without containing a trace of phenol having properties like Ortho, Meta and Para-isomeric cresol. It is found in phenolic odor and is colourless or pinkish liquid in nature. Cresol (C₆H₄OHCH₃) can substitute phenol considering its 3-times more powerful disinfectant capacity⁶.

Creosote:

It filled the air of most dental orifices having sharp pungent aromatic odor in the form of clear yellowish oily liquid. Only the beechwood variety of creosote should be used in dentistry due to its better disinfectant, less irritant, and less toxic effect than phenol⁶.

Cresatin:

Acetic acid ester of metacresol is recognized as Metacresylacetate or cresatin. It is antiseptic/analgesic and clear stable oily liquid of low volatility having phenolic acetic odor. Due its low surface tension, its antibacterial effect is increased and its effect gets lengthy owing to its low vapour pressure. Grossman has proved that the antimicrobial effect of cresatin is not as mark as other medicaments of its group. It is non-caustic, less irritating and does not have the ability to precipitate albumin.

Cresanol:

It is a compound of cresatin, P-chlorophenol and camphor in 1:1:2 ration. It is found more effective than cresatin as an antiseptic and less irritating than chlorophenol.

N2:

It is used as intracanal medicament and as a sealer containing paraformaldehyde and phenyl mercuric borate as demonstrated by Sargenti and Richter. The properties present in N2 have permanent disinfectant action and unusual antiseptic agent that are irritating and toxic with high degree of antimicrobial activity. It has been observed that the antibacterial effect of N2 is of short duration and degenerate in about 7 to 10 days⁶.

Aldehydes

Formocresol:

It is a compound of formalin and cresol in the ratio varies from 1:2 to 1:1 being introduced by Buckley in 1905. It has distinctive odor and found in the form of transparent reddish liquid which is mixture of 3 isomers. It is a compound of 19% Formaldehyde, 35% cresol and 46% Glycerin with water.

Heavy metal salts:

The salts of the heavy metals are protoplasm poisons which precipitate albumin and produce new compounds that stain tooth structure. Ammoniated silver nitrate was applied for disinfecting the root canals long ago and considering its effect resulting stain to tooth structure its application is now become limited. Metaphen, Merthiolate, mercuraphen etc. are strong disinfectants organic mercurial salts having lesser tendency to precipitate albumin. Its application is limited in endodontic treatment considering its staining proclivities.

Halogens:

Disinfectant action of the halogens is related its atomic weight and its action is inversely proportional. Chlorine is having greatest disinfectant action among the members of this group also having lowest atomic weight. Sodium hypochlorite and Chloramines are the source of active chlorine which is used for short term dressing of the root canal⁷.

Sodium hypochlorite:

In today's dentistry, it is the foremost choice of application as irrigating solution. It is applied in concentration from 0.5 to 5.25%. Sodium hypochlorite exploited in biomechanical cleansing of root canals which is dissolvent of necrotic tissue and debris.

Chloramine T:

One of the active chlorine releasing compound is Chloramine T which has excellent antimicrobial qualities. In case of Iodine compound sensitivity considering allergic history, Chloramines (5%) is a good medicaments in intracanal dressing having low toxicity. For disinfecting gutta-percha points, this compound is also used⁹.

Iodine:

Iodine is acknowledged for its mild effect on living tissue for many years. Iodine tincture (5% in alcohol) is used for disinfection of endodontic surgical fields and iodine Potassium iodide (Iodine 2%, potassium iodide 4%, distilled water 94%) is used for intracanal medication are the two most common preparation of Iodine which are used in dentistry⁶.

Chlorhexidine:

It consists of two symmetric 4-chlorophenyl rings two bis-guanide groups connected by a central hexamethylene chain acting as synthetic cationic bis-guanides. It is a molecule with positive hydrophobic and lipophilic that interacts with phospholipids and lipopolysaccharides on cell membrane of bacteria and penetrates into the cell through some type of passive or active transport mechanism. As it interacts with the positive charge of the molecule and negatively charged phosphate groups, its effectiveness on microbial cell walls resulting cell osmotic equilibrium. Its effect increases the permeability of cell wall causing Chlorhexidine molecule enters into the bacteria¹¹.

Quaternary ammonium compounds:

It is cationic detergent and wetting agent compound which is a mildly effective disinfectant. It could be used for irrigating root canals without any inflammation of the periapical tissue. It is considered as foaming

detergent and practically it is non-irritating in weak solution (1:20000 – 1:50000). It is more effective in alkaline than acid media. It is colourless and odorless stable compound with lower surface tension in solutions⁶.

Calcium hydroxide:

In 1920, Herman applied calcium hydroxide in dental treatment which is highly alkaline substance (pH- 12.5). It stimulate had tissue formation.

Uses:

1. Prevention of root resorption
2. Repair of Iatrogenic perforation
3. Treatment of horizontal root fracture
4. Apexification
5. Apexogenesis
6. Root resorption
7. in weeping canal

PBSC:

Grossman has indicated the wide use of PBSC by dentists.

Sodium caprylate has been substituted by Nystatin as the antifungal agent in a similar medicament PBSC. Both the medicaments in paste form may be injected into the root canals or impregnated on the paper points. For getting desired effect, the drug must be placed in the canal considering its stability. PBSC may interfere the successive culturing procedure and inactivate penicillin. Penicillinase is required to be added. It has to be transformed on the paper point taken to incubate. The usage of PBSC has become obsolete considering the potential for sensitivity due to topical use of antibiotics and deteriorating in popularity of intracanal medicament¹².

Ledermix paste:

It is considered to be a compound of glucocorticoid antibiotic developed by Schroeder and Tridon in 1960. For controlling pain and inflammation, ledermix paste is used. Ledermix mixing with antibiotic component can compensate the possible corticoid induced reduction in the host immune response. Now, Ledermix is available in a polyethylene glycol form combining tetracycline antibiotics, demeclocycline, HCL (at a concentration of 3.2%) and corticosteroid triamcinolone acetoxide (concentration 1%).

Sulphonamides:

The sulphonamides interfere with bacterial metabolism due to its bacteriostatic characteristics rather than bactericidal agents and thereby reduce the micro-organisms more susceptible to destruct by the defensive mechanism of the body. It is used by placing a moistened paper points into a fluffed jar containing the powder or by adding with sterile distilled water. It is reported that after usage of sulphonamides, tooth become yellowish discolour. The medication is recommended for using at the moment of closing the teeth that had been left open on account of acute periapical abscess. In presence of pus, protein breakdown products, tissue debris and p-aminobenzoic acid, the effect of sulphonamides are not fruitful⁶.

Mode of application:

Mode of application is an important aspect in the selection of an intracanal medicament. Two methods are basically followed for placement.

1. The medicament can be placed in the pulp chamber by placing it on a cotton pellet
2. Prepared medicament can be flooded in the root canal.

The pulp chamber in the root canals should be dried up with the help of sterile cotton pellets and paper points after the final recapitulation of medicament. At the using the medicament, the containing bottle should be reversed in order to allow the medicaments to adhere to the side near the mouth of the bottle. After removing the cover, the sterile cotton pellet is required to be wiped on the inside for picking liquid medicament. The cotton pellet containing medicament is required to be squeezed in a sterile gauze sponge. The remaining amount of medicament in the pellet is placed in the pulp chamber which is enough to reduce its temporary antibacterial action. The root canal flooded with the prepared medicament is the method for treatment. The canal filled with paste transferring to pulp chamber with a plastic instrument and apically propelling it along the root canal with a plastic carrier. While sealing the pulp chamber, considerable care should be taken in order to prevent recontamination from marginal leakage or actual loss of seal before next appointment⁷.

Recent advancement in intracanal medicaments and techniques:

Triple antibiotic paste:

Polymicrobial comprising both aerobic and anaerobic bacterial species is responsible for root canal infection. The usage of single antibiotic may not be effective to kill the microbes in root canal system. A combination of antibiotic is required to be applied for getting suitable result which may also decrease the probability of developing resistant bacterial strains. Combining metronidazole, ciprofloxacin and minocycline might bring promising result in killing bacteria in the deep layers of root canal in dentin has been assessed by Sato et al. After the application of the triple antibiotic paste, no bacteria were recovered within 24 hrs. from the infected dentin of the root canal wall in situ¹⁷.

Medicated gutta-percha:

New gutta-percha points containing Ca(OH)_2 in a 50% to 51% concentration in place of zinc oxide is available in the market which makes easier placement and removal of Ca(OH)_2 ¹⁸.

Bioactive glass:

The use of bioactive glass as an intracanal medicament is a matter of research. It has been published in a study where the used glass was consisting of 53% SiO_2 , 23% Na_2O , 20% CaO and 4% P_2O_5 was prepared from reagent grade Na_2CO_3 , CaHPO_4 , $2\text{H}_2\text{O}$, CaCO_3 and Belgian sand. It has been found that the bio-active glass is effective to disinfect bacteria from root canals but the action was not pH related and the dentin did not seem to alter its effect¹⁸.

NISIN:

Nisin produced by strains of *Lactococcus lactis* and it was discovered in 1928. It is a naturally occurring antimicrobial peptide and class I bacteriocin. Nisin has been used extensively over 40 years as food preservative which is safe to human being. Due to interaction with the phospholipid membrane of the target bacterial cell, the mode of action of Nisin is undiscoverable. It can interrupt the cellular membrane by persuading leakage of small intracellular contents from the cell¹⁹.

PAD:

Photosensitization technique has been used in medicine for some time. Tolonium chloride and photoactive agent are abundance in PAD. It is used in endodontic application considering its antimicrobial effectiveness. Red laser emitting radiation of wavelength 635 nm is used to activate photosensitizer molecule. The light is inserted into the root canal by directing it to the tip of a small flexible optical fibre with maximum power of 100 m W that ensures harmless to the adjacent tissue. The strong oxidizer can act on multiple targets in a microbial cell generated during the process resulting in membrane damage, enzyme inactivation and genomic and plasmid DNA damage causing instantaneous death. One of the potential medical application of LAT (Light activated therapy) is fighting bio-film medicated localized human infection¹⁸.

ENDOX:

By emitting high frequency electrical impulses, endox endodontic system sterilizes the root canal. Endox endodontic system can eliminate both pulp and bacteria from the entire root canal as claims by manufacture and sterilization happens as a result of fulguration. It has been reported citing a recent study that without mechanical cleaning, the unit was not able to eliminate pulp tissue from the root canal. The authors realize that the unit may be utilized as a substitute to traditional cleaning and shaping without recommending high frequency electric pulses as a sole endodontic treatment¹⁹.

Chlorhexidine Digluconate:

It has been recommended that Chlorhexidine Digluconate can be used both as a root canal irrigant and an intracanal medicament in the form of 2% Chlorhexidine gel, Mixture of Chlorhexidine and Ca(OH)_2 . The therapeutic effect of a 4 week intracanal uses of Chlorhexidine gel on inflammatory root resorption in replanted infected teeth of monkeys has been observed by Lindskog et al. As suggested, Chlorhexidine may be a useful adjunct in the treatment of inflammatory root resorption which can reduce the inflammatory resorption significantly compared to non-medicated teeth¹⁸. Jose F Siqueira et al had conducted a study on the elimination of candida albicans infection of the radicular dentin by applying Chlorhexidine mixed with zinc oxide which observed highly effective in killing candida albicans within dentin. It is obvious considering the findings of the clinical effect of this study that Chlorhexidine is an effective intracanal medicament²¹.

Technique

Injection syringe system:

1. Intracanal medicaments can be placed using injection syringe system.
2. To ensure the insertion of medicament into the apex, the needle should be placed well.
3. It had been declared that the filling could be placed with a syringe system into the Straight or slightly curved root canal prepared upto at least size 50.

It has been published that canal preparation with an apical size 40 was more homogenous than injection syringe system and less taper the application of medicaments with a lentulospiral by a study conducted on calcium hydroxide dressings using different preparation and application modes, density and dissolution by stimulated tissue pressure.

II. Conclusion

The uses of intracanal medicaments in endodontics have number of reason considering its ill effects such as mutagenic, carcinogenic and periradicular tissue irritation. The treatment aspect of this medicaments has been improved to certain extent by culture tests taking into account of the sensitivity of the drugs to certain groups of bacteria but not its by-product. It is ineffective to use in certain situation considering development of drug resistance and cost factor. From the start of extirpation of the pulp to the obturation, disinfection process is followed continuously applying intracanal medicaments to disinfect the canal, make it inert, dry, reduce post-operative pain and prevent re-infection. The recent advances in intracanal medicaments suggest the combined application of physical and chemical methods. In present day dental practice, intracanal medicaments are being applied in certain conditions for gaining utmost success of root canal treatment.

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