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Next-Generation Intracanal Medicaments: Deciphering Their Impact

Richa Wadhawan, VyomitaKushwah, Sayma Rizvi, Noor Zuber Mandal, Anand Kumar, Rishav Saha

Professor, Department Of Oral Medicine, Diagnosis & Radiology, PDM Dental College & Research Institute, Bahadurgarh, Haryana, India
General Dentist, Community Health Programs Inc, Massachusetts, United States Of America
Dental Surgeon, District Hospital, Betul, Madhya Pradesh
Dental Surgeon, Dr Zuber's Dental Care, Hojai, Assam
Dental Surgeon, Anandam Dental Clinic, Bhopal, Madhya Pradesh
Dental Surgeon, Saha Oral And Dental Care, Barpeta, Assam

Abstract:
Next-generation intracanal medicaments are set to revolutionize endodontic therapy, effectively overcoming the limitations of traditional treatments. Central to their transformative impact is their unparalleled ability to thoroughly disinfect the root canal and drastically reduce microbial load—key factors for successful treatment outcomes. Calcium hydroxide has long been regarded as the gold standard in endodontic treatment. However, recent innovations have introduced powerful alternatives that significantly improve both antimicrobial effectiveness and biocompatibility.These advanced agents not only target resistant bacterial strains with precision but also promote the healing and regeneration of periapical tissues, paving the way for significantly improved patient outcomes. This review offers a comprehensive examination of the various intracanal medicaments currently available, assessing their effectiveness through robust clinical studies and cutting-edge laboratory research. Ongoing investigations aimed at optimizing these treatments highlight their transformative potential, especially in managing non-vital teeth, periapical diseases, abscesses, and dental trauma. By enhancing disinfection processes and minimizing complications, these innovative medicaments elevate the overall patient experience and outcomes. Ultimately, the evolution of these intracanal agents represents a monumental leap forward in the pursuit of optimal endodontic care, emphasizing the critical need for continuous innovation in dental therapies Embracing these advancements brings us closer to a future where endodontic treatment is not only more effective but also more compassionate, transforming the lives of patients and enhancing their journeys toward oral health.

Keywords: *Intracanal medicaments, Endodontic treatment, Antimicrobial properties, Non-vital teeth, Disinfection, Calcium hydroxide, Triple antibiotic paste*

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I. Introduction:

Pain is defined by the International Association for the Study of Pain (IASP) as an unpleasant sensory emotional experience associated with actual potentialtissue damage or described in terms of such damage. It can greatly disrupt daily life, often leading patients to seek dental treatment for relief.[1]Discomfort between dental appointments is common and can sometimes be unexpected, influenced by various factors related to the patient and the dentist.[2]After endodontic treatment, the level of pain can vary significantly, with reports ranging from 1.7% to 70%.[3]About half of the patients report discomfort after treatment for infected teeth.[4]Factors that contribute to this post-treatment pain include the presence of bacteria, changes in pressure around the tooth, and chemical reactions.[5] Poor disinfection can allow harmful bacteria to survive, highlighting the importance of using intracanal medicaments—substances placed inside the tooth canal to eliminate inflammation and target germs effectively.[6]Common intracanal medicaments include calcium hydroxide, Ledermix paste, triple antibiotic paste, chlorhexidine gel, and various antibiotics (**Figure 1**).[7]

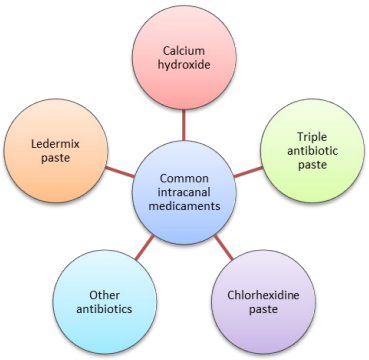

Figure 1: Key intracanal agents: powering successful root canal therapy

These medicaments play a crucial role because bacteria are major contributors to tooth and surrounding tissue diseases.[8] Ongoing infections can lead to tissue death and inflammation at the root tip, putting the root canal treatment at risk.[9]The main goal of root canal therapy is to remove bacteria and leftover materials after cleaning the canal.[10]Successful endodontic treatment depends on three key steps: preparing the canal, thoroughly cleaning it, and properly sealing it afterward (**Figure 2**).[11]

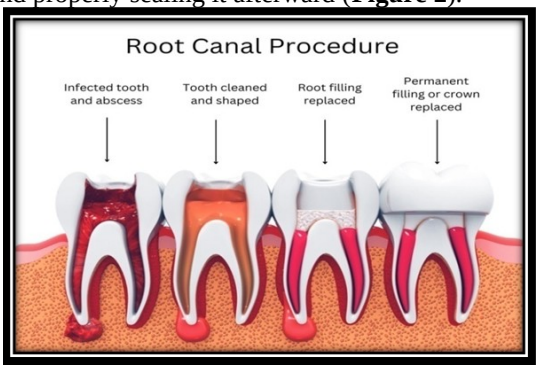

Figure 2: **Mastering Root Canal Therapy: The Triad Of Success**
Courtesy: https://Www.Broadwayfamilydentalpc.Com/General-Cosmetic-Dentist/Root-Canal-Procedure-Specialist-Dentist/

To prevent new infections and ensure effective antibacterial action, intracanal medicaments are essential in modern endodontics.[12] After sealing the canal, any remaining bacteria can rapidly proliferate due to nutrient depletion.[13] Simple cleaning often fails to eradicate bacteria hidden in the tiny tubules within the tooth structure. If antiseptic medicaments aren't correctly applied between visits, surviving bacteria can multiply, undermining treatment success.[14] This underscores the urgent need for effective medicaments that can penetrate these small tubules, eliminate bacteria, and reduce irritation—especially in multi-visit treatments.[15] Recent advancements have led to innovative agents designed to enhance effectiveness, extend their action, and ensure patient safety, ultimately improving success rates in root canal treatments.[16] Severe discomfort and swelling post-treatment, or the presence of a draining canal, may indicate an active infection at the root tip.[17] In these critical circumstances, intracanal medicaments are vital for managing infections, fostering healing, and alleviating pain when applied directly to the infection site.[18] By addressing discomfort and controlling infections, these medicaments promise greater patient comfort and improved clinical outcomes, fundamentally reshaping the landscape of dental care.[19]The primary goal of endodontic treatment is the thorough elimination of bacteria, their byproducts, and pulpal remnants from infected root canals, followed by complete sealing.[20] While historically crucial in bacterial eradication, modern endodontics increasingly emphasizes shaping and cleaning as the foundation of disinfection.[21] Biocompatibility and stability are essential characteristics for these agents, with intracanal dressing primarily serving to prevent coronal leakage.[22]The trend toward single-visit endodontics is gaining traction, with studies indicating comparable clinical outcomes between single- and multiple-visit treatments. Although there's no compelling reason to oppose single-visit procedures, the application of an intracanal medicament is strongly advocated when multiple visits are necessary.[23] Success in endodontic treatment has traditionally relied on debridement, thorough disinfection, and obturation, all equally important (**Figure 3**).[24]

Figure 3: Key Pillars: Debridement, Disinfection, Obturate Success
Courtesy: https://www.Omnidental.Com.Sg/Articles/What-Is-Root-Canal-Treatment/

Today's effective root canal treatment encompasses broader principles, including diagnosis, treatment planning, and anatomical comprehension.[25] The evolution of protocols and enhanced chemomechanical preparation techniques has led to markedly improved outcomes, with access cavity preparation remaining essential.[26]The transition from "Extension for prevention" to "prevention of extension" highlights a focus on minimally invasive dentistry, aimed at conserving tooth structure.[27] Although intracanal medicaments remain crucial, particularly when treatment cannot be completed in one visit, their role has evolved.[28]They help inhibit bacterial regrowth and improve outcomes when strategically applied to reduce pathogen infiltration.[29]In situations involving pulpal necrosis and apical periodontitis, their importance is heightened, as numerous root canals may still contain viable microorganisms despite comprehensive preparation.[30] However, multiple appointments carry risks, such as temporary filling leaks and poor patient adherence.[31]Despite the shift toward single-visit endodontics, research suggests comparable outcomes for both single- and multiple-visit procedures.[32]

If multiple visits are required, the use of intracanal medicaments is highly recommended.[33] Once the "stars" of endodontic treatment, these agents have shifted to a secondary role but still maintain significant importance. As defined by Kawashima et al., intracanal medicaments are biocompatible substances temporarily placed in root canals to thwart bacterial intrusion.[34] The absence of an ideal medicament and variability in clinical practice regarding their application continue to be pertinent challenges in endodontic care.[35]This review article emphasizes the indications and properties of next-generation intracanal medicaments, highlighting their role in improving endodontic outcomes. It discusses their effectiveness in eradicating bacteria, promoting biocompatibility, and facilitating healing. Additionally, the review consolidates the challenges and advancements in their formulation and application. These innovations represent a transformative era in endodontics, enhancing the efficacy of root canal treatments and leading to better patient outcomes.[36]

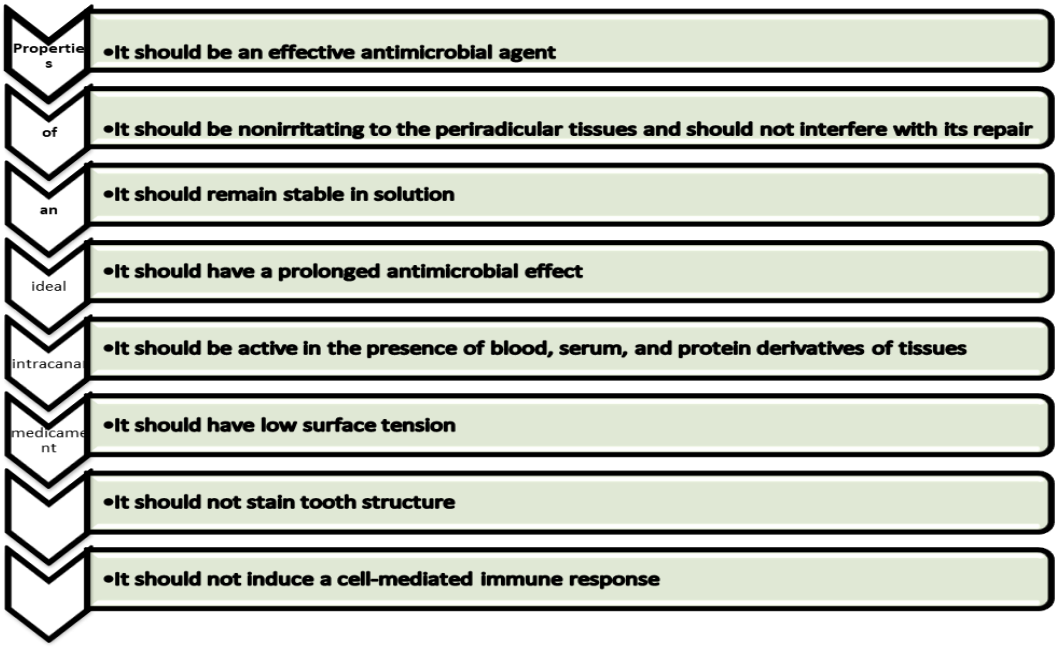

Figure 4: Properties of an ideal intracanal medicament

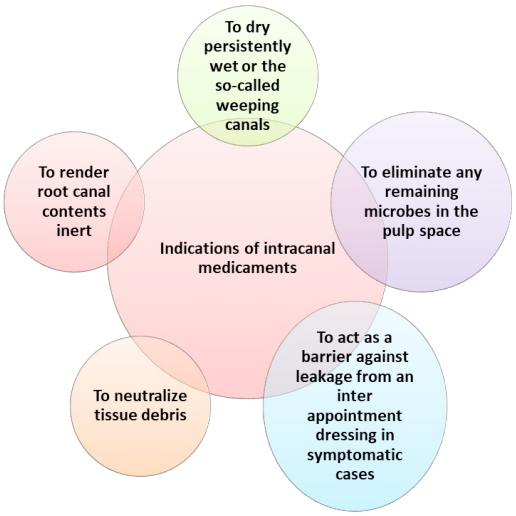

Figure 5: Indications of intracanal medicaments

II. Discussion:

Intracanal medicaments serve several important objectives in endodontic treatment. Firstly, they aim to destroy microorganisms by killing all viable pathogens in the canal space.[37]Secondly, these medicaments render the contents of the canal inert, effectively "mummifying" or deactivating any remaining tissue or debris, which helps eliminate residual bacteria.[38]Thirdly, they play a crucial role in preventing or controlling post-treatment pain by reducing inflammation through their antimicrobial action or by altering the inflammatory response, thereby alleviating pain associated with inflammation.[39] Additionally, they can enhance anesthesia, particularly in cases where the inflamed pulp is difficult to anesthetize, making subsequent procedures less painful.[40] Lastly, intracanal medicaments are vital for managing persistent periapical abscesses; they provide direct access to periapical lesions, helping to restore a healthy balance and alleviate significant pain and swelling that may occur after treatment (**Figure 6**).[41]

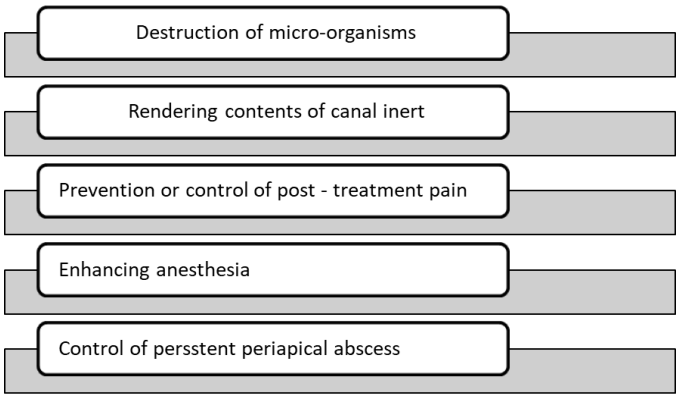

Figure 6: Objectives of intracanal medicaments

Classification:

According to Grossman intracanal medicament can be classified as [42]

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 • Mercurophen
5. Halogens • Sodium hypochlorite • Iodides • Chlorexidine
6. Quaternary ammonium compounds • 9-aminoacidine
7. Fatty acids • Propionic acid • Caproic acid • Cuprylic acid
8. Sulphonamides

Eugenol: It is the primary active ingredient in clove oil and shares some similarities with phenol. It serves as both an antiseptic and an anodyne, though it tends to be slightly more irritating than clove oil itself. Over time, eugenol can darken, appearing as a pale yellow liquid. It has mild anesthetic and antiseptic properties, along with a characteristic scent reminiscent of cloves (**Figure 7**).[43]

Figure7: Eugenol
Courtesy: https://Amplemeds.Com/Product/Vishal-Dentocare-Eugenol-Pure/

Phenol: In 1867, Lord Lister transformed the landscape of medicine by introducing phenol as one of the first antiseptics, marking a groundbreaking shift in infection control. Derived from coal tar, phenol is a white crystalline substance known for its distinct odor and potent antiseptic properties.[44] When combined with camphor, menthol, or thymol, it forms carbolic acid—a powerful solution that has become a cornerstone in both medicine and dentistry. In the realm of dentistry, phenol's versatility is unmatched.[45]It acts as a sedative for pulp tissue, an effective treatment for root canals, and a disinfectant for cavity preparations. Its role extends to pre-surgical disinfection before periapical procedures and cauterizing stubborn tissue tags that defy conventional removal methods.[46] Moreover, phenol sets the standard for assessing the disinfectant efficacy of other antimicrobial agents, affirming its enduring relevance and unparalleled significance in modern dental practice. By revolutionizing infection control, phenol has cemented its legacy as a vital tool in the fight against infections, shaping the future of patient care and safety.[47]

Parachlorophenol: It darkens when exposed to light and appears as colorless, needle-like crystals similar to phenol. Chlorine replaces one of the hydrogen atoms in phenol, leading to the formation of parachlorophenol (C_6H_4OHCl). The crystals of parachlorophenol are soluble in ether, alcohol, and alkalis. When ground with gum camphor, it converts into an oily liquid.[48]

Camphorated Parachlorophenol: In 1891, Walkhoft introduced camphorated parachlorophenol (**Figure 8**), which combines para-chlorophenol and gum camphor in a 2:3 ratio for use as an intracanal antiseptic in dentistry.[49]This formulation is recognized for its distinct aromatic fragrance and appears as a transparent, light amber oily liquid. The camphor helps lessen the irritating effects of pure parachlorophenol, serving as both a diluent and a medium.[50]Grossman highlighted its antimicrobial properties compared to other root canal treatments.[51]Wantulor and Brown demonstrated that the vapors of camphorated chlorophenol from cresatin can penetrate through the apical foramen.[52]

Figure 8: Camphorated Parachlorophenol
Courtesy: https://Thefuturedentistry.Com/Most-Important-Intra-Canal-Medicaments-Frequently-Asked/

Camphorated Monoparachlorophenol (CMCP): It is prepared using mining crystals, which consist of a compound made from paramonochlorophenol and camphor in a 3:7 ratio when liquefaction occurs suddenly (**Figure 9**). This compound is less irritating, a more effective bactericidal agent than phenol, and does not coagulate albumin.[53]

Figure 9: CMCP
Courtesy: https://www.Facebook.Com/Xenonbiomed/Posts/Camphor-X-Cmcp-Camphor-Phenol-For-Intracanal-Medication-It-Has-The-Following-Ben/1233896289960883/?_Rdr

Cresol (Tricresol): It is acquired from coal tar with or without containing a trace of phenol having properties like Ortho, Meta (**Figure 10**) 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 capacity.[54]

Figure 10: Metacresol
Courtesy: https://www.Jaypeedigital.Com/Book/9789352500482/Chapter/Ch12

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 phenol (**Figure 11**).[55]

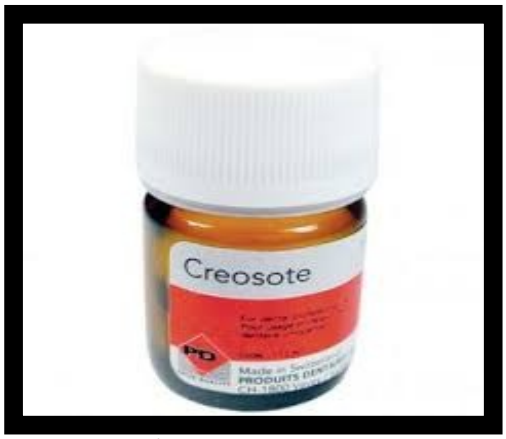

Figure 11: Creosote
Courtesy: https://Dental.Bintangsaudara.Com/Product-Category/Endodontics/Endodontic-Medicament/Root-Canal-Treatment-Disinfection-Material/

Cresatin: Metacresyl acetate, also referred to as cresatin (**Figure 12**), is a clear, stable, low-volatility oily liquid with a phenolic acetic scent. It acts as both an antiseptic and analgesic, exhibiting improved antibacterial effects due to its low surface tension and low vapor pressure, which prolongs its efficacy.[56] Research by Grossman suggests that cresatin's antimicrobial properties are less significant compared to other agents in its category. It is non-caustic, less irritating, and does not precipitate albumin.[57]

Figure 12: Cresatin
Courtesy: https://www.Humayundental.Com/Product/Tehno-Dent-Cresotin-Liquid-No-1-15ml/

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. [58]

N2: It is used as intracanal medicament and as a sealer containing paraformaldehyde and phenyl mercuric borate as demonstrated by Sargenti and Richter.[59] 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 days. [60]

Aldehydes

Formocresol: Introduced by Buckley in 1905, this compound typically contains a mixture of formaldehyde, cresol (in a 1:1 to 1:2 ratio), and glycerin, forming a transparent reddish liquid with a distinctive odor. The formulation often includes around 19% formaldehyde, 35% cresol, and 46% glycerin with water (**Figure 13**).[61]

Figure 13: Formecresol
Courtesy: https://Dentestore.Com/Itemview/3550-0101008001/Maquira

Heavy Metal Salts: Salts of heavy metals are protoplasmic poisons that can precipitate albumin, leading to staining of tooth structures. Historical use of ammoniated silver nitrate (**Figure 14**) for disinfecting root canals has diminished due to its staining effects.[62]

Figure 14: Silver Nitrate
Courtesy: Https://Www.Indiamart.Com/Proddetail/Silver-Nitrate-16534314073.Html?Mtd=1
Organic Mercurial Salts: Compounds like Metaphen, Merthiolate, and Mercurophen are strong disinfectants but are limited in endodontic use due to their potential to stain.[63]

Halogens: Halogens, particularly chlorine, are renowned for their exceptional disinfectant properties. Among them, chlorine stands out as the most effective; making sodium hypochlorite (**Figure 15**) and chloramines vital in dental practices.[64] Sodium hypochlorite is the go-to irrigating solution in modern dentistry, utilized in concentrations ranging from 0.5% to 5.25%.[65] Its unmatched ability to dissolve necrotic tissue and debris during the biomechanical cleansing of root canals positions it as an indispensable tool in endodontics. By ensuring thorough disinfection and effective removal of harmful pathogens, sodium hypochlorite not only enhances treatment outcomes but also significantly contributes to the overall health and safety of patients.[66] Incorporating sodium hypochlorite into root canal procedures exemplifies how harnessing the power of halogens can lead to more effective and efficient dental care, setting a standard for excellence in infection control.[67]

Figure 15: Sodium Hypochlorite
Courtesy: https://Www.Dentganga.Com/Product/Sodium-Hypochorite-500ml-Pack-Of-5

Chloramine T: It is a potent active chlorine-releasing compound, boasts remarkable antimicrobial properties that make it a valuable asset in dental care. For patients with a history of iodine sensitivity, Chloramines at a concentration of 5% offers an excellent alternative for intracanal dressing, combining effectiveness with low toxicity.[68]Not only does Chloramine T (**Figure 16**)excel in treating root canals, but it is also effective for disinfecting gutta-percha points. Its versatile application underscores its importance in maintaining optimal hygiene and ensuring patient safety. By choosing Chloramine T, dental professionals can provide a reliable solution that addresses both infection control and patient comfort, making it an essential component of modern endodontic practice.[69]

Figure 16: Chloramine T
Courtesy: https://www.Indiamart.Com/Proddetail/Chloramine-T-Sd-500-Gm-23990048255.Html?Mtd=1

Iodine: It has been recognized for its gentle effect on living tissue for many years. Iodine tincture, at a concentration of 5% in alcohol, is used to disinfect endodontic surgical fields, while iodine potassium iodide, consisting of 2% iodine, 4% potassium iodide, and 94% distilled water, is employed for intracanal medication. These are the two most common formulations of iodine used in dentistry.[70]

Chlorhexidine: Chlorhexidine digluconate (**Figure 17**) is a potent synthetic cationic bis-guanide, consisting of two symmetric 4-chlorophenyl rings linked by a hexamethylene chain. Its unique positive, hydrophobic, and lipophilic properties allow it to effectively interact with the negatively charged phosphate groups of phospholipids and lipopolysaccharides in bacterial cell membranes.[71] This interaction increases cell wall permeability, enabling Chlorhexidine to penetrate bacterial cells and disrupt osmotic balance.[72] Clinically, it has become a top choice for root canal irrigation and intracanal medication, particularly in its 2% gel form or when combined with calcium hydroxide.[73] Research by Lindskog et al. emphasizes its therapeutic potential in reducing inflammatory root resorption in replanted infected teeth, showing significant improvements compared

to non-medicated controls.[74] Additionally, a study by Jose F. Siqueira et al. demonstrated that a mixture of Chlorhexidine and zinc oxide effectively eliminates Candida albicans infection from radicular dentin. These compelling findings highlight the efficacy of Chlorhexidine as a vital adjunct in endodontic therapy, transforming patient care and outcomes in dental practice.[75]

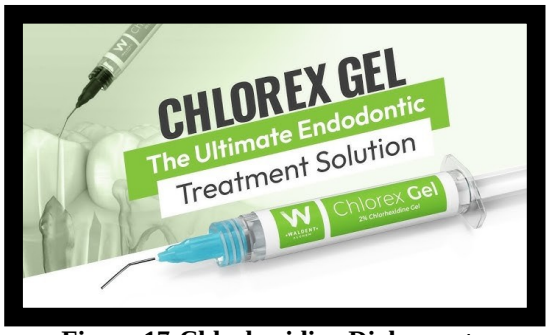

Figure 17:Chlorhexidine Digluconate
Courtesy: https://www.Youtube.Com/Watch?App=Desktop&V=Otjdrcautfk

Quaternary ammonium compounds: It is a cationic detergent and wetting agent that serves as a mildly effective disinfectant. It can be used for irrigating root canals without causing inflammation of the periapical tissue. It is considered foaming and is practically non-irritating in weak solutions at concentrations of 1:20,000 to 1:50,000. Its effectiveness is greater in alkaline media than in acidic conditions. This colorless and odorless stable compound has a lower surface tension in solutions. [76]

Calcium hydroxide: In 1920, Hermann revolutionized dental treatment with calcium hydroxide (**Figure 18**), a highly alkaline compound known for promoting tissue formation. This medicament is invaluable for preventing root resorption, repairing perforations, treating horizontal root fractures, apexification, apexogenesis, and managing weeping canals.[77]Grossman also highlighted p-chloro-phenol-sodium caprylate (PBSC) in dental practice, which is now often replaced by Nystatin in formulations, resulting in p-chloro-phenol-sodium Nystatin (PBSN).[78] Both PBSC and PBSN can be injected into root canals or applied with paper points, requiring careful placement for effectiveness.[79]However, PBSC can interfere with culturing processes and inactivate penicillin, leading to decreased use due to sensitivity concerns and a decline in popularity of intracanal medicaments. This shift underscores the need for safe and effective treatment options in modern endodontics.[80]

Figure 18: Calcium Hydroxide
Courtesy: https://Thefuturedentistry.Com/Most-Important-Intra-Canal-Medicaments-Frequently-Asked/

Ledermix paste: Developed by Schroeder and Tridon in 1960, Ledermix (**Figure 19**) is a revolutionary glucocorticoid antibiotic compound that plays a pivotal role in managing pain and inflammation in dental treatments.[81]By combining Ledermix with an antibiotic, this formulation effectively mitigates potential corticosteroid-induced reductions in the host's immune response, ensuring comprehensive patient care.[82]Formulated in polyethylene glycol, Ledermix features 3.2% demeclocycline hydrochloride and 1% triamcinolone acetoxide, creating a potent synergy that significantly enhances its efficacy against dental infections.[83] In contrast, sulfonamides act as bacteriostatic agents, disrupting bacterial metabolism and making pathogens more vulnerable to the body's natural defenses.[84]These medications are easily applied using moistened paper points or mixed with sterile distilled water. However, clinicians should note that sulfonamides may cause yellowish discoloration of teeth and are particularly effective for closing teeth left open due to acute periapical abscesses.[85] Despite their benefits, the effectiveness of sulfonamides can diminish in the presence of pus, protein breakdown products, tissue debris, and p-aminobenzoic acid.[86] Recognizing these limitations is

crucial for the optimal use of these therapeutic agents, ultimately enhancing patient outcomes in endodontic practice. This holistic approach highlights the transformative potential of innovative treatments in advancing dental care, reinforcing the commitment to providing the highest quality of patient-centered treatment.[87]

Figure 19: LedermixPaste
Courtesy: https://Dentverses.Com/Ledermix-Paste-2

Mode of application: The mode of application is a critical factor in selecting an intracanal medicament, with two primary methods for placement that can significantly impact treatment outcomes.The first method involves placing the medicament in the pulp chamber on a cotton pellet.[88] This requires careful preparation: the pulp chamber and root canals must be dried using sterile cotton pellets and paper points after the final recapitulation. To apply the medicament, the bottle is inverted to allow the liquid to adhere to the inside near the opening.[89] After removing the cap, a sterile cotton pellet is wiped against the interior to absorb the liquid, which is then squeezed onto a sterile gauze sponge.[90]The medicament remaining in the pellet is adequate for providing temporary antibacterial action when placed in the pulp chamber.[91]The second method consists of flooding the root canal with the prepared medicament. A plastic instrument is used to transfer the paste into the pulp chamber, and it is then propelled apically with a plastic carrier. It's crucial to take precautions when sealing the pulp chamber to prevent recontamination due to marginal leakage or loss of the seal before the next appointment.[92] Both methods require precision and care, as the effectiveness of the intracanal medicament hinges on proper application. This attention to detail not only enhances the medicament's antibacterial action but also safeguards the integrity of the treatment, ultimately leading to improved patient outcomes in endodontic practice.[93]

Recent Advances in Intracanal Medicaments and Techniques:

1. Triple Antibiotic Paste: Root canal infections are often polymicrobial, necessitating a combination of antibiotics for effective treatment. The innovative use of metronidazole, ciprofloxacin, and minocycline has demonstrated remarkable efficacy in eliminating bacteria from deep dentin layers.[94] Research by Sato et al. revealed that after applying this triple antibiotic paste, no bacteria were recovered within 24 hours from the infected dentin, significantly reducing the risk of developing antibiotic-resistant strains (**Figure 20**).[95]

Figure 20: Triple Antibiotic Paste
Courtesy: https://Www.Youtube.Com/Watch?App=Desktop&V=Mcuptn1-Ptm

2. Medicated Gutta-Percha: New gutta-percha points (**Figure 21**) infused with calcium hydroxide (50-51% concentration) has revolutionized root canal procedures. This advancement simplifies the placement and removal of calcium hydroxide, enhancing treatment efficiency.[96]

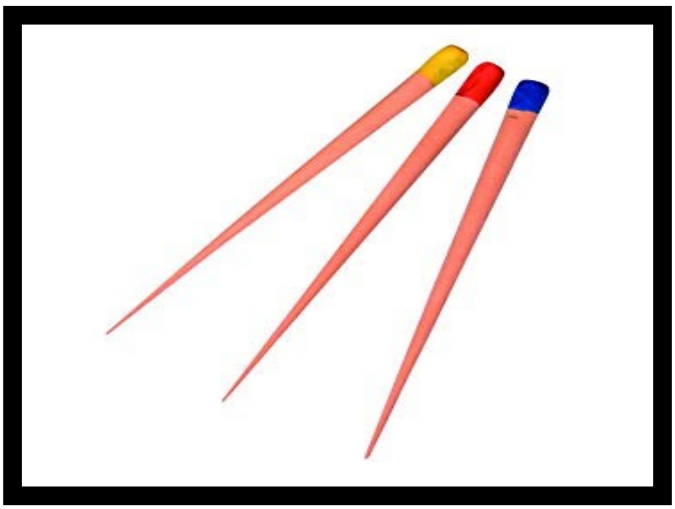

Figure 21: Medicated Gutta Percha Points
Courtesy: http://Bsdinhvietthang.Com/100-2/

3. Bioactive Glass: Bioactive glass is emerging as a promising intracanal medicament, consisting of 53% SiO2, 23% Na2O, 20% CaO, and 4% P2O5. It has demonstrated effective disinfection properties in root canals, and notably, its antimicrobial action is not dependent on pH. This characteristic suggests its potential for widespread use in endodontics.[97]

4. Nisin: This natural antimicrobial peptide, derived from Lactococcus lactis, has been used as a food preservative for over 40 years. Nisin (**Figure 22**) works by disrupting bacterial cell membranes, leading to the leakage of intracellular contents. Its safety and effectiveness position it as a strong candidate for applications in endodontics.[98]

Figure 22: Nisin
Courtesy: https://www.Semanticscholar.Org/Paper/ANTIMICROBIAL-EFFICACY-OF-DIFFERENT-INTRACANAL-ON-%E2%80%93-Anirudhan/Ca572dcbef914412ede659e2875e0e10026fc001

5. Photodynamic Therapy (PAD): Leveraging tolonium chloride activated by a 635 nm red laser, PAD generates reactive oxygen species that target and damage microbial cells. This technique offers a powerful approach to combat biofilm-associated infections, enhancing overall treatment outcomes.[99]

6. ENDOX System: This innovative endodontic system uses high-frequency electrical impulses to sterilize the root canal effectively. While it shows promise in eliminating pulp and bacteria, it is recommended as an adjunct to traditional mechanical cleaning rather than a standalone treatment.[100]
7. Curcumin: Derived from turmeric, curcumin (**Figure 23**) possesses notable antimicrobial and anti-inflammatory properties. Recent studies suggest its potential as a viable alternative to triple antibiotic paste, particularly when combined with photoactivation to boost its antibiofilm effects.[101]

Figure 23: Curcumin
Courtesy:https://www.Academia.Edu/34836856/An_Investigation_Into_The_Potential_Use_Of_Dennkur_As_An_Intra_Canal_Irrigant_And_Medicament_In_Endodontics

Syringe Injection Technique: Intracanal medicaments can be effectively delivered using an injection syringe system, ensuring precise placement within the root canal. To guarantee optimal insertion of the medicament into the apex, proper needle placement is crucial. Research has shown that filling can be achieved using this syringe system in straight or slightly curved root canals prepared to at least size 50.[102] Notably, studies indicate that canal preparation with an apical size of 40 yields a more homogeneous distribution compared to the injection syringe method, resulting in less taper.[103] Furthermore, a study on calcium hydroxide dressings highlighted the differences in preparation and application modes, demonstrating that density and dissolution are enhanced by stimulated tissue pressure. These findings underscore the importance of careful technique in the application of intracanal medicaments for improved treatment outcomes.[104]

Future Prospects: The field of endodontics is rapidly evolving with the introduction of next-generation intracanal medicaments. These advanced treatments promise improved efficacy in managing dental infections and promoting healing. Understanding their current impact and future prospects is essential for dental professionals and researchers alike.

1. **Enhanced Efficacy:** New medicaments demonstrate superior antimicrobial activity, effectively targeting resistant bacteria and biofilms.
2. **Improved Healing:** Many formulations support tissue regeneration, leading to better healing outcomes post-treatment.
3. **Patient Comfort:** Reduced side effects and irritation enhance patient experience during and after endodontic procedures.
4. **Biomimetic Approaches:** Future medicaments may mimic natural healing processes, incorporating biomaterials that encourage regeneration and repair.
5. **Personalized Medicine:** Tailoring treatments based on individual patient profiles and microbiomes could optimize outcomes.
6. **Nanotechnology:** The integration of nanoparticles may enhance drug delivery systems, improving penetration and sustained release within the canal.
7. **Smart Therapeutics:** Development of responsive medicaments that activate under specific conditions within the canal may revolutionize treatment.
8. **Integration with Digital Technologies:** Combining intracanal therapies with advanced imaging and diagnostic tools could facilitate more effective treatment planning and monitoring.

Next-generation intracanal medicaments hold significant promise for the future of endodontics. As research progresses, these innovations are expected to enhance treatment efficacy, patient comfort, and overall outcomes in dental care. Embracing these advancements will be crucial for dental professionals aiming to provide the best possible care.[105]

III. Conclusion:

Next-generation intracanal medicaments represent a transformative leap in endodontic therapy, significantly improving treatment outcomes for patients facing non-vital teeth, periapical diseases, abscesses,

and trauma-related complications. These innovative medicaments are designed to effectively disinfect the root canal and reduce microbial load, thereby enhancing the prognosis for affected teeth. While calcium hydroxide has long stood as the gold standard due to its remarkable antimicrobial properties, its limitations have sparked a quest for more advanced alternatives. Recent breakthroughs in intracanal medicaments are addressing these challenges, equipping dental professionals with powerful tools that elevate root canal therapy to new heights. This review showcases the array of medicaments currently available for root canal treatment, underscoring the critical need for continuous research and development in this field. As advancements unfold, the integration of cutting-edge therapeutic agents promises to not only boost the efficacy of endodontic procedures but also to profoundly improve patient outcomes, revolutionizing the landscape of dental care. For dental practitioners, embracing these innovations is not just beneficial—it is essential. The future of endodontics hinges on the adoption of these advanced solutions, enabling practitioners to provide optimal care in an ever-evolving field. The potential for improved patient experiences and treatment success is immense, marking a new era in dental health.

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