Effectiveness of Nanoparticle based intracanal medicament in reducing E. faecalis count in Comparison to Calcium Hydroxide - A Systematic Review

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STRUCTURED ABSTRACT

AIM: This review is aimed at gathering the evidence on effectiveness of nanoparticle derived intracanal formulations against E. faecalis compared to Calcium Hydroxide.

MATERIALS AND METHODS: A systematic search was conducted in Literature databases to find studies on the nanoparticle based intracanal medicament effectiveness against the E. faecalis compared to the conventional medicaments. The search was conducted on PubMed, Scopus, Google Scholar, Cochrane, and Lilac until December 2023. The studies were screened for eligibility and included in review. Data pertaining to research questions was extracted. The QUIN tool was used to evaluate the risk of bias.

RESULTS: The initial search retrieved 60 records, out of which 7 articles were included in the study.The studies retrieved included countries India, Europe ,Iran and Saudi Arabia . Studies chosen reported the use of nanoparticle based intracanal medicament,its efficacy in reducing E.faecalis in human teeth in comparison to Calcium Hydroxide.Microbial load that is mean colony count (sd) both group was calculated and found to be statistically significant.

CONCLUSION: Nanoparticles based intracanal medicaments and its combination with other lead to synergistic and extended effect in elimination of E.Faecalis strain compared to conventional medicament.

KEYWORDS: Antimicrobial count, Calcium Hydroxide, E.Faecalis,Human extracted teeth, Intracanal Medicament, Nanoparticle

CLINICAL SIGNIFICANCE: This review enlightens the scope of Nanoparticle derived intracanal medicament with greater elimination of bacteria and efficient penetration within the dentinal tubules .

INTRODUCTION

The major factor for failure of primary and secondary endodontic treatment is incomplete elimination of bacterial infection,primarily Enterococcus faecalis.[1,2] Persistent unresolving microbial infection in the intra radticular and extraradicular space is the most important factor for endodontic failures. [3,4,5] The major causative microbial organism for endodontic infection is Enterococcus faecalis, a gram positive cocci which has high virulence and ability to survive even in prolonged duration of starvation and derives its nutrition from the serum released in the Periodontal ligament and bone bridging its binding to Type 1 collagen within the dentinal tubules and the periradicular space,[6] making elimination challenging within the canals. [3]

Calcium hydroxide is the gold standard used as an intracanal medicament.[7] However shown to be very less effective in eradicating E.faecalis due to its low antimicrobial spectrum[8,9] E.faecalis fails to survive over a pH of 11.5 ,[10] but due to the buffering action of the dentin, maintaining high pH of calcium hydroxide for longer duration is challenging [11] .Therefore to eliminate the E.faecalis newer intracanal medicament were formulated such as triple antibiotic paste (TAP),[12] composed of metronidazole, ciprofloxacin, and minocycline,Combination of irrigants and medicaments such as calcium hydroxide with camphorated paramonocholrophenol,[9] use of metapex, addition of stannous fluoride and 2% chlorhexidine in combination have shown better eradication of E. faecalis than Calcium Hydroxide alone.[13] Propolis, a natural substance, comprises resin, balsams, essential oils, flavonoids, phenols, aromatic compounds, wax, pollen, amino acids, and vitamins also shown to have efficient antibacterial properties.[14] Chitosan, naturally occurring copolymer polysaccharide is also used as a carrier or medicament in root canal disinfection.

For complete to maximum elimination of E.faecalis the penetration of the medicament within the dentinal tubules is essential. The use of nano based intracanal medicament is now gaining momentum due to its enhanced physical, chemical, and biological properties.[15] Distinguished by their refined physicochemical properties like ultrasmall size, substantial surface area/mass ratio, and heightened chemical reactivity.[16] Use of nanoparticles mediated intracanal is now being researched. Silver nanoparticles (AgNPs), Zinc oxide Nanoparticles. Green Synthesized nanoparticles, Chitosan nanoparticles, Chlorhexidine nanoparticles and calcium hydroxide nanoparticles are now used within the root canal systems.

The aim of the current systematic review is to evaluate the effectiveness of nanoparticle based intracanal formulations against the E.faecalis count in comparison to Calcium Hydroxide.

STRUCTURED QUESTION

Is the nanoparticle based intracanal medicaments (I) effective in reducing the E.faecalis count (o) when compared to Calcium Hydroxide (C) as intracanal medicament?

Table 1: PICO STATEMENT

Population	Extracted Human teeth
Intervention	Nano-based Intracanal Medicament
Comparison	Calcium Hydroxide

Outcome	E faecalis Count (Colony Forming Unit,Zone of inhibition)
Study	In-Vitro study

MATERIALS AND METHODS

The Systematic Review was reported according to the Prisma checklist. The SR is registered with PROSPERO with registration ID - CRD42024547566. This Systematic Review emphasizes on nano formulation and its impact in eliminating bacterial biofilm or in antimicrobial load reduction.

ELIGIBILITY CRITERIA

INCLUSION CRITERIA

The studies which compared the reduction in Enterococcus faecalis count using nano based intracanal medicament and compared it to calcium Hydroxide were included. All the studies that evaluated the E.faecalis Count either using microbial load or colony forming unit were included.

EXCLUSION CRITERIA

Literature Reviews, Correspondence , Conference Proceedings and studies where complete data could not be retrieved were excluded . Studies published in languages other than english were excluded.

SEARCH STRATEGY

A thorough search of PubMed, Scopus, Web of Science, and LILACS was done for articles published since inception of database until 31st December 2023 in order to identify all peer-reviewed research pertinent to the review's question.The keywords were combined with Boolean operators and used for electronic searches. The keywords include human teeth, calcium hydroxide, calcium hydroxide dressing ,Intracanal dressing , nanoparticle derived intracanal medicament, nano intracanal medicament, nanoformulations intracanal medicament, E.faecalis count, microbial reduction, biofilm reduction

SCREENING AND SELECTION

All search results were exported into excel sheet .Two reviewers individually screened the articles based on title,abstract and keyword for the eligibility after removing duplicates .full text was retrieved for selected articles for further screening.Finally those articles that fulfilled the eligibility criteria were included in data extraction . Those articles which provided complete data were finally included in the systematic review.Any discrepancy between the two reviewers was resolved with discussion with the third reviewer.

DATA EXTRACTION

Data of the included studies was extracted independently by two reviewers using a customized data extraction and entered into an electronic spreadsheet.Following data was extracted from each articles - Name of the authors, year of publication , Country ,study design , sample , method of microbial evaluation, microbial colony count, Zone of inhibition,Type of nanoparticle Medicament,Comparator Group,Time of Assessment.

ASSESSMENT OF RISK BIAS

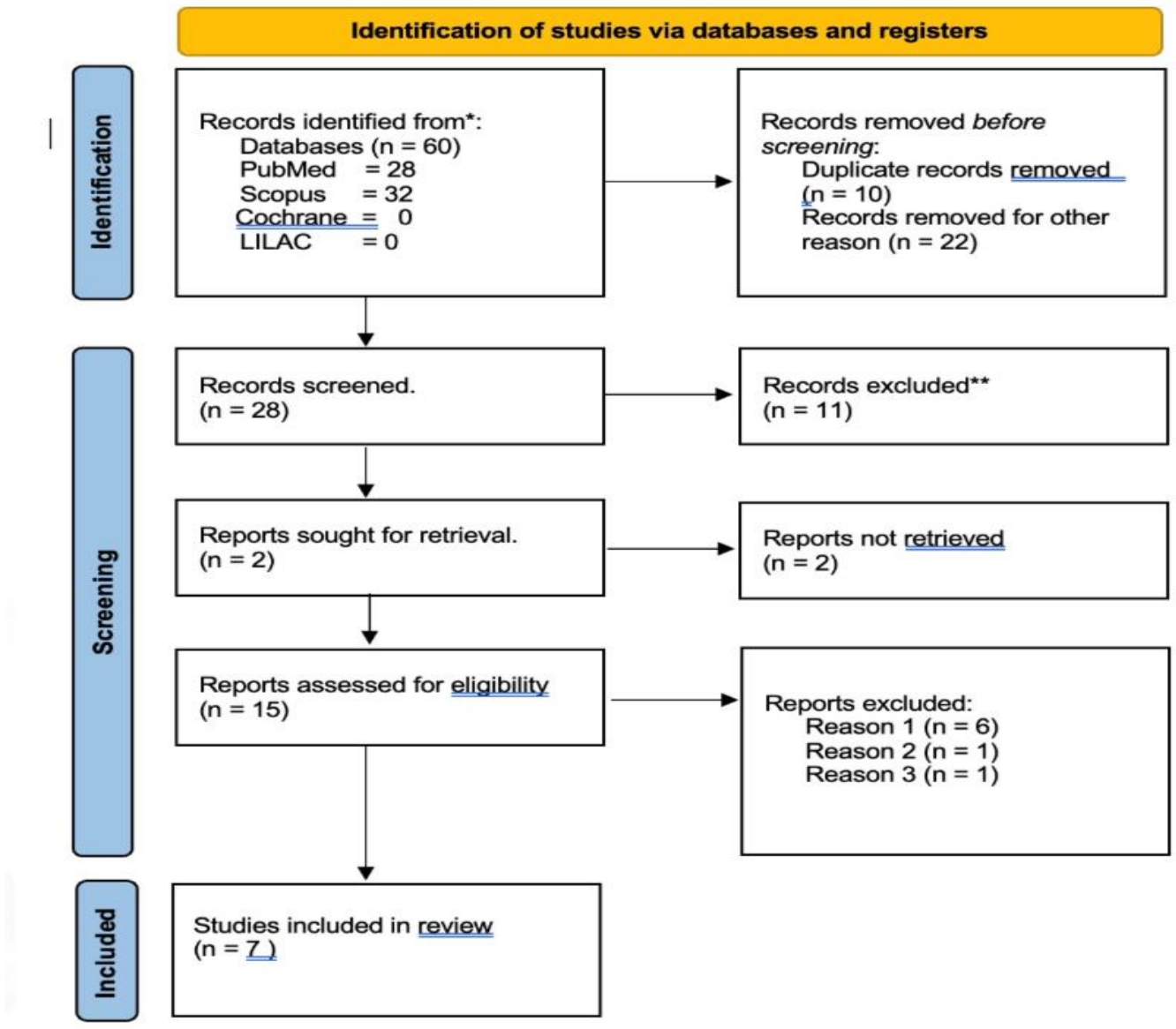
Quality assessment by QUIN tool for in vitro studies.[17] The table of risk assessment has been included in the result section along with the quin tool assessment which uses 12 parameters to assess an in-vitro study.

RESULTS

SEARCH AND SELECTION

On searching the databases ,total of 91 studies were identified .Out of which 28 were retrieved from pubmed and 32 from scopus and 31 from web of Science.. Cochrane and LILAC resulted in 0 output while entering the search terms. 25 of the duplicate records were removed. After reading the title and finding it irrelevant another 37 studies were excluded.Total of 29 records were screened , after which 11 records were excluded based on reading the abstract . 16 articles were selected in read in text . Out of which 9 studies were excluded due to the following reasons -1. Evaluation of antimicrobial assessment not done with E.faecalis 2. Studies comparing other parameters 3. Multi species biofilm Assessment. 4. Use of Bovine teeth instead of using Human Teeth. 5 Nanoform of the medication used rather than the conventional Calcium Hydroxide. The other 7 included studies were read thoroughly and has been presented in the table defining the characteristics of the study,comparison group,evaluation method and the data.

Figure 1: PRISMA 2020 flow diagram for new systematic reviews which includes searches of databases ,registers and other databases.



RISK OF BIAS ASSESSMENT

S.no	QUIN TOOL CRITERIA	Parolia et al 2020	Wassel et al 2023	Samiei et al 2018	Balto et al 2020	Rami et al 2022	Elgarhy et al 2023	Soha et al 2022
1	Clearly stated aim/objective	2	2	2	2	2	2	2
2	Detailed explanation of sample size calculation	2	2	2	2	2	2	2
3	Detailed explanation of sampling technique	2	1	1	2	2	2	2
4	Details of comparison group	2	2	2	1	1	2	1
5	Detailed explanation of methodology	2	2	1	2	2	1	1
6	Operated details	1	2	2	2	2	1	1
7	Randomisation	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
8	Method of measurement of outcome	2	1	2	2	2	2	1
9	Outcome assessor details	2	2	1	2	1	1	2
10	Blinding	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
11	Statistical analysis	2	1	1	2	1	0	1
12	Presentation of results	2	2	2	1	2	2	1

Inference: Table 2 representing Quin Tool Assessment and Scoring

QUIN assessment tool, two independent authors evaluated each of the 12 criteria as S#

- Adequately specified -2 points.
- Inadequately specified = 1 points.
- not specified = 0 points.

Then , the scores were summarized to obtain a total score of a particular in vitro study. The scores thus obtained were used to grade the in vitro study as high, medium or low risk (>70%= low risk of bias, 50% to 74% medium risk of bias and <50% = high risk of bias).

S.No	Author And Year	Score	Percentage	Risk Of Bias
1	Parolia et al 2020	19/24	79.1%	Low Risk of Bias
2	Wassel et al 2023	17/24	70.8%	Low Risk of Bias
3	Saimei et al 2018	16/24	66.6%	Medium Risk of Bias
4	Balto et al 2020	19/24	79.1%	Low Risk of Bias
5	Rami et al 2022	17/24	70.8%	Low Risk of Bias
6	Elgarhy et al 2023	15/24	62.5%	Medium Risk of Bias
7	Soha et 2022	14/24	58.3%	Medium Risk of Bias

Table 3 : Risk of Bias evaluation

Title	Author and Year	Reason for Exclusion
1. Antibiofilm Efficacy of Silver Nanoparticles alone or Mixed with Calcium Hydroxide as Intracanal Medicaments	Almaha et al 2022	Evaluation of antimicrobial assessment not done with E.Faecalis.
2. Effect of nanoparticle based intra canal medicaments on root dentin microhardness	Iffat Nasim et al 2022	Evaluation of antimicrobial assessment was not done.
3. Effect of silver nanoparticle intracanal -based medicament on the microhardness of human radicular dentin	R Hassan et al 2018	Evaluation of antimicrobial assessment was not done.
4. Comparative Evaluation of Antimicrobial efficacy of three Different Intracanal Medicaments against Candida Albicans:An in vitro study	JS Sivakumar 2020	Antibacterial parameter was not assessed.
5.Evaluation of tooth discoloration following the use of silver Nanoparticle based intracanal medicament -An in vitro Study	I Nasim et al 2021	Antibacterial parameter not assessed.
6.Efficacy of calcium Hydroxide-loaded poly(lactic-co-glycolic acid)biodegradable nanoparticles as an intracanal medicament against endo pathogenic microorganisms in a multi-species biofilm model	Warat et al 2023	Multi-species biofilm model assessed.
7.Antimicrobial Activity and pH of Calcium Hydroxide and Zinc oxide Nanoparticles Intracanal Medication and association with chlorhexidine	Alana et al 2015	Bovine teeth were used instead of Human teeth.
8. Calcium Hydroxide -loaded PLGA biodegradable nanoparticles as an intracanal medicament	Firas et al 2021	E.faecalis assessment not done.
9.Comparative Evaluation of Nano Inorganic Metal oxides as Intracanal Medicaments for Cytotoxicity and Antimicrobial Activity in the Root Canal System	Barge et al 2023	Nanoform has been used as a mode of medicament rather than conventional Calcium Hydroxide.

Table 4 : Risk of included Studies

DESCRIPTION OF THE INCLUDED STUDIES

TABLE 6 CHARACTERISTICS OF THE INCLUDED STUDY

S. No	Author	Year	Test Specimens	Comparison	Time Intervals for Specimen Collection	Intervention	Evaluation methods	Outcome Measures	Results	Inference
1	Parolia et al	2020	240 extracted human teeth further sectioned. Maxillary anterior teeth and mandibular canines with complete root formation,inoculated with E.Faecalis.	Calcium Hydroxide	1,3 days and 7 days	Chitosan-Propolis Nanoparticle Chlorhexidine Propolis	Dentinal Shaving Collections Colony Forming units SEM CLSM	Residual E.Faecalis Count	Chitosan Propolis Nanoparticle(250µg/ml)showed 100% inhibition on the seventh day	Chitosan Propolis nanoparticle are efficacious IM compared to Chlorhexidine or propolis alone.
2	Wassel et al	2023	63 Mandibular second primary molarMesial roots of Primary Molars infected with E.faecalis and Candida albicans.	Direct and Residual antimicrobial effect of 2 % CHX gel,DAP,CS-CHX NPs for 3 days and 7 days	3 and 7 days	CS-CHX NPs	Microbiological sample obtained using paper points in 3 and 7 day interval.	Microbial Count Reduction (%)	CS-CHX NPs and CHX significantly higher reduction .	CS-CHX NPs are more efficient in reducing bacterial count on comparison with CSNPs,CHX and DAP groups.
3	Samiei et al	2018	132 single rooted extracted teethAll teeth were inoculated with E.faecalis	Calcium Hydroxide mixed with 0.12% Chlorhexidine Gel	3,7 and 14 days	Zinc Oxide Nanoparticle gel(50ppm) Zinc Oxide Silver nanoparticle (1ppm)Gel	SEM for E.faecalis formation Dentinal Shavings Paper point evaluation	Reduction in Colony Counts (%)	Calcium Hydroxide in combination with CHX had significant reduction in the colony count in both the intervals.	Gel form of Zno based nanoparticle seemed to be less effcient. Similar reduction of bacterial count was noted at 3,7,14 days interval.
4	Balto et al	2020	90 Dentin disk prepared from single rooted human extracted teeth	Triple Antibiotic Paste Calcium Hydroxide Silver Nanoparticles	2 and 4 weeks	Calcium Hydroxide mixed with 0.02% AgNPs. (Ratio 1:1)	Confocal Laser Scanning Microscopy Stained with fluorescent live/dead bacteria using Fiji software	Effect On E.Faecalis Biofilm	TAP and a mixture of Calcium Hydroxide showed greater proportions of dead cells	High antibiofilm efficacy noted with TAP is attributed to its active antibiotic ingredients.Ca(OH)2 had residual biofilm left,whereas AgNPs alone could not destroy biofilm even after 4 weeks.
5	Rami et al	2022	66 human mandibular molars were contaminated with E.Faecalis Each Group comprised of 10 tooth further subdivided based on contact time of 2 days and 7 days	CHX-AgNPs Calcium Hydroxide Nanoparticles Chlorhexidine -Chitosan Nanoparticles	2 days and 7 days	Calcium Hydroxide Chlorhexidine	Colony Forming Units Scanning Electron Microscope	Bacterial Percentage Reduction	CHX-AgNPs showed maximum reduction in the bacterial count followed by Calcium Hydroxide followed by Chlorhexidine Nanoparticle format.	Incorporation of nano sized particle presented a higher antibacterial efficacy compared to the normal sized medicament.In normal sized chlorhexidine is more efficacious than calcium hydroxide.
6	Elgarhy et al	2023	40 single rooted extracted human teeth	Calcium Hydroxide	7days	Calcium Hydroxide AgNps Chitosan Nanoparticles	Confocal laser Scanning Microscopy	Percentage of bacterial count	Calcium Hydroxide with silver nanoparticle has shown maximum reduction in bacterial count	Combination of Calcium Hydroxide with other vehicles such chlorhexidine or silver nanoparticle improves its antibacterial efficacy
7	Soha et al	2022	30 extracted single rooted human teeth inoculated with E.faecalis	Calcium Hydroxide	7days	Silver Nanoparticles Silver nanoparticles with Curcumin	Sample collected before and after placement of medicament in one week duration. CFU were statistically analyzed	Bacterial Count using Colony Forming Unit	AgNPs with Curcumin has shown the minimum E.faecalis count and minimum inhibition noted in Calcium Hydroxide alone.	The following study indicates synergistic effect of herbal mediated silver nanoparticle has great inhibition on E.faecalis count.

Table 5 : Characteristics of the Included Studies

Description of the Included study

In the study done by Parolia et al , 240 extracted maxillary anterior teeth and mandibular canine was taken .A total of 240 dentine blocks were randomly allocated into eight groups (n=30) based on the intracanal medicament applied: Group I received saline, Group II was treated with chitosan, Group III with propolis at a concentration of 100 µg/ml (P100), Group IV with propolis at a concentration of 250 µg/ml (P250), Group V with chitosan-propolis nanoparticles at a concentration of 100 µg/ml (CPN100), Group VI with chitosan-propolis nanoparticles at a concentration of 250 µg/ml (CPN250), Group VII with calcium hydroxide (CH), and Group VIII with 2% chlorhexidine gel (2% CHX) using Consepsis V® (Ultradent, UT, USA).Following this, every group underwent additional division into three subgroups, distinguished by the time periods (day one, three, and seven) during which the intracanal medicament was administered.Points were collected by obtaining samples of dentinal shavings from all groups after one day, three days, and seven days of exposure. The collection of dentinal shavings was carried out using a peeso reamer.Various magnifications and images were examined to assess the qualitative reduction of E. faecalis. The evaluation of microbial coverage on SEM images of the canal walls utilized a four-score scale system based on the percentage of residual isolated microbial cells. This scoring system categorized dentine as either clean or exhibiting residual isolated microbial cells covering less than 5% of the dentine, covering 5% to 33% of the dentine, covering 34% to 66% of the dentine, or covering 67% to 100% of the dentine.CFLM analysis aimed to assess the effectiveness of CPN250 and CPN100 as intracanal medicaments by examining the viability profile. The proportion of live and dead bacteria was determined through fluorescent staining, followed by imaging.On both day one and day three, at depths of 200 and 400 µm within the dentinal tubules, CPN250 demonstrated a significant mean reduction in CFUs ($p<0.05$) compared to all other groups. Additionally, on both day one and day three, at 200 and 400 µm depths, CPN100 exhibited a statistically significant mean reduction in CFUs ($p<0.05$) compared to other groups except CPN250 and 2% CHX. On day seven, at a depth of 200 µm, CPN250 displayed a statistically significant mean reduction in CFUs compared to all other groups[18]

In the study by Wassel et al mesial roots of primary molars were employed to evaluate the efficacy of the experimental medicaments. This choice was made considering that primary molars often feature accessory canals and horizontal anastomoses.In this study, the groups were categorized as follows:Group Ia: CS-CHX NPs (3 days)Group Ib: CS-CHX NPs (7 days)Group IIa: CHX (3 days)Group IIb: CHX (7 days)Group IIIa: DAP (3 days)Group IIIb: DAP (7 days)Group IVa: CSNPs (3 days)Group IVb: CSNPs (7 days)Group V: Control group, wherein teeth were infected, irrigated with saline, and sampled at 3- and 7-days post-infection.Specimens were acquired at distinct intervals during the research.T3: Specimens were collected three days after placing the medicaments from groups Ia, IIa, IIIa, IVa, and the control group.T7: Specimens were obtained seven days after placing the medicaments from groups Ib, IIb, IIIb, IVb, and the control group.Furthermore, following each medication period, an additional sample was procured:T3': Samples were collected from groups Ia, IIa, IIIa, IVa seven days after removing the medicaments.T7': Samples were collected from groups Ib, IIb, IIIb, IVb seven days after removing the medicaments.The results of this investigation indicated that both CS-CHX NPs and CHX were highly effective against C. albicans at both time points. In the case of E. faecalis, CS-CHX NPs demonstrated the greatest impact after 3 days, equivalent to DAP and significantly surpassing the effectiveness of CHX and CSNPs. However, all medicaments showed a similar effect against E. faecalis after 7 days, with CS-CHX NPs and DAP still exhibiting the highest efficacy.[19]

The positive charge of both chitosan and CHX enables them to adhere to the negatively charged dentin. [20] Consequently, when microorganisms attempt to reinfect the root canal, the positively charged agents interact with the negatively charged microbial cell wall, leading to their destruction.[21] CSNPs were noted for their ability to diminish the mass of formed biofilms by effectively penetrating the

channels within the biofilm .[22] Another influential factor is the diminutive particle size of CS-CHX NPs, given that particles smaller than 500 nm are recognized to access dentinal tubules and disrupt dental biofilms . [23]

In the study done by Balto et al ,A significantly greater proportion of deceased cells was observed in the samples treated with 1 mg/mL TAP (90.39% and 99.41%) and the mixture of Ca(OH)2 and AgNPs (90.85% and 98.49%) compared to those treated with Ca(OH)2 alone (76.14% and 91.71%) and AgNPs alone (62.83% and 88.07%) at 2 and 4 weeks, respectively.After 4 weeks, confocal laser scanning microscopic images revealed that E. faecalis biofilms were nearly eradicated in the samples treated with 1 mg/mL TAP and the combination of Ca(OH)2 and AgNPs.In the Ca(OH)2 group, residual biofilm structure persisted on the dentin surface.In this study, the antibiofilm effectiveness of 0.02% AgNPs combined with Ca(OH)2 against E. faecalis was assessed using CLSM.

In the study conducted by Soha et al , Silver nanoparticles AgNPs , silver nanoparticles AgNPs with curcumin and calcium hydroxide was used in comparison to Calcium Hydroxide.The highest bacterial reduction was reported in Silver nanoparticles (AgNPs) with curcumin (Group B), followed by Silver nanoparticles (AgNPs) alone (Group A). In contrast, the least bacterial reduction was observed in Ca(OH)2 when in contact with the intracanal medicament for a period of 7 days.This results of the above study was in agreement with the Javidi et al. (2013), who demonstrated that Ca(OH)2 alone cannot completely eliminate E. faecalis after 1 week. However, the addition of silver nanoparticles to Ca(OH)2 was shown to be effective in killing Enterococcus faecalis after 7 days.

In the study done by Saimei et al ,Four dressing materials were employed at distinct time intervals: a combination of calcium hydroxide (Prevest Denpro, Golchai, Iran) and 0.12% CHX a gel containing ZO nanoparticles (50 ppm); a gel incorporating nanoparticles of ZO (50 ppm) and silver (1 ppm); and a normal saline solution (as the negative control group

The study conducted by Elgarhy et al compared Ca(OH)2 mediated silver nanoparticles with chitosan calcium hydroxide.It also combined chlorhexidine along with calcium hydroxide as concluded improves the bacterial efficacy and results in reduced bacterial count.[24]

Discussion

The primary objective of this review was to evaluate the different nanoparticle based intracanal medicament effectiveness in reducing antimicrobial load and to compare it with the conventional medicament.

This phenomenon may elucidate the observed residual effect associated with CSNPs, CS-CHX NPs, and CHX.The apparent synergistic effect observed may be attributed to the antibiofilm potential of CSNPs, as previous studies have indicated their capability to hinder biofilm formation by suppressing the synthesis of extracellular polysaccharides . [25]
Parolia et al demonstrated the efficacy of chitosan-propolis nanoparticles in reducing the count of E. faecalis within dentinal tubules at depths of 200 and 400 μm. In contrast, the prolonged 7-day use of CHX and DAP enhanced the lasting impact against E. faecalis while diminishing it against C. albicans. Previous research has indicated the residual antimicrobial effects of both 2% CHX and DAP . [26]
Correspondingly, akin to our study, Valera et al. found that 2% CHX displayed a more pronounced residual effect against E. faecalis compared to its effect on C. albicans.

The residual effect of an antimicrobial agent pertains to its capacity to attach to tooth structure and gradually release over an extended period in an active state.[13] This lingering effect of antimicrobials can effectively hinder the re-infection of root canals by microorganisms residing within dentinal tubules.[27] I
In the study done by Saimei et al reported that CHX exhibited a more robust antibacterial effect when compared to calcium hydroxide. Additionally, the incorporation of calcium hydroxide into chlorhexidine did not enhance its antibacterial activity. However, the incorporation of CHX into calcium hydroxide resulted in an increased antibacterial activity.

In study done by Balto et al the outcomes of the study demonstrated that the blend of Ca(OH)2 and 0.02% AgNPs exhibited notable antibacterial efficacy against 3-week-old E. faecalis biofilms. Surprisingly, this effectiveness was not significantly different from that observed with 1 mg/mL TAP at the two evaluated time points.

The study conducted by Elgarhy et al concluded In the domain of intracanal medicaments, the synergy between chitosan nanoparticles (CSNPs) and chlorhexidine (CHX) demonstrated substantial efficacy against both C. albicans and E. faecalis at different intervals. Remarkably, CS-CHX nanoparticles (NPs) exhibited results comparable to CHX against C. albicans and demonstrated effectiveness similar to triple antibiotic paste (TAP) against E. faecalis.

Jenks et al. contributed insights into the efficacy of a 500 mg/ml concentration of doxycycline (DAP) applied onto radicular dentin for one week against a 3-week-old E. faecalis biofilm. This concentration not only demonstrated effective antibacterial results but also exhibited significantly greater residual antibiofilm activity against E. faecalis compared to concentrations typically used for regeneration.Afkhami et al.'s study on the combination of silver nanoparticles (AgNPs) and calcium hydroxide (Ca(OH)2) as intracanal medicaments highlighted a lack of significant change in tooth color compared to the application of Ca(OH)2 alone. This underscores the potential of AgNPs as an adjunct to Ca(OH)2 without compromising aesthetic considerations.

Additionally, investigations into the antibacterial effectiveness of silver nanoparticles (AgNPs) paste and a combination of silver nanoparticles (AgNPs) plus curcumin paste revealed superior outcomes compared to Ca(OH)2 paste when used as root medication. The amalgamation of silver nanoparticles with curcumin emerged as a particularly promising choice, demonstrating remarkable efficacy against the most resistant microorganisms in root canals.Nano formulation of Calcium Hydroxide when combined with chlorhexidine shows improved bacterial reduction. Chitosan propolis nanoparticle when used at a higher concentration that is 250μg/m showed better reduction in the bacterial count.Calcium hydroxide when combined with silver nanoparticle did not show any discoloration , whereas doxycycline in TAP is reported to cause discoloration.

Conclusion

Evidence shows that nanoparticle based intracanal medicament is more efficient in reducing E.faecalis count than the conventional Calcium Hydroxide and equally efficient to triple antibiotic paste. Gel based nanoparticles although are easily introduced within the canal system , their penetration within the dentinal tubules is lesser compared to paste form.Triple Antibiotic paste was equally efficacious or slightly better than calcium hydroxide incorporated with silver nanoparticles..The overall study concludes that nanoformulations of the gel are more effective in reducing E.faecalis count when used synergistically . Herbal based medicament such as curcumin concluded the same in the study.On comparing with the gold standard that is calcium hydroxide,these articles broaden the horizon on application of nano derived intracanal medicament.

CONFLICT OF INTEREST

No conflict of interest was noted.

Fundings -Nil

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