ORIGINAL ARTICLE

Antimicrobial study of cast post and its surface modification with nanoparticle

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ABSTRACT

A cast post is a one-piece unit that is custom fabricated for the tooth at the dental laboratory. Traditional extracts such as neem and green tea have good antimicrobial and antioxidant activity against pathogens. The empty canal space may provide a suitable environment for promoting bacterial growth. The main aim of the study is to find the antimicrobial activity of the cast post coated with the nanoparticle. Prepared cast post was coated with prepared green tea and neem-mediated zinc oxide (ZnO) nanoparticles. Culture is done in agar media where control is noncoated post and another is nanoparticle coated post was implanted in the agar media. The zone of inhibition was noted and statistical analysis was done. The maximum zone of inhibition found on *Candida albicans* (19.333 2.081) followed by *Enterococcus faecalis* (14.000 3.605), and *Streptococcus mutans* (12.666 2.516). Green tea and neem-mediated ZnO nanoparticle showed good antimicrobial activity against the tester microorganism. Cast post coated with nanoparticles has been proved to be important as it is helpful in the prevention of origin and spread of infection around the canal and through the apical foramen.

Key words: Antimicrobial activity, cast post, innovation, nanoparticle

INTRODUCTION

Oral cavity is the major site for invading these microorganisms. These microorganisms majorly cause dental problems in humans. The most common is the endodontic infections which enter through caries in the tooth into the root canal pulp tissue.[1,2] *Enterococcus faecalis* is the most common bacteria seen in the root canal which has certain virulence factors and maybe the reason for the survival of this micro-organism in the endodontic environment. It has the adhesive property to tooth structures and determinants of antibiotic resistance. It is also called endo pathogens.[3,4]

Root canal treated teeth with less crown structure are most often restored with cast post and core for final restoration. Cast post is mainly used in placing crowns and acts as a support to crown placement. Cast posts are most commonly used because of their physical property and biocompatibility. It is well known that dental posts are used to rebuild a super structure onto a tooth. The apical canal is then fitted, under which a dental post is cemented.[5] Conventionally, a post is either prefabricated or cast to tradition. With a prefabricated post, a core designed to maintain the crown is installed after cementation along the upper portion of the wall.[5] As a result of trauma, severe caries, or reconstruction, most teeth need endodontic care. The determination of the need for a post is based on how

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much natural tooth material exists to maintain a central accumulation and to support caries removal and endodontic care.[6]

In the present studies, production and applications of nanoparticles play an important role because of their unique properties.[7-10] These nanoparticles have associate degrees in an increasing range of applications like in chemical change, electronics, semiconductors, sensors and cosmetics, and also in medical applications. Zinc oxide (ZnO) nanoparticle ZnO's NPS plays a great role in antimicrobial activity against microorganisms.[11] ZnO is an inorganic compound that is commonly used in everyday use. The major methods of synthesizing ZnO nanoparticles are the key characteristics and antimicrobial action mechanisms as well as the impact of integrating them into polymer matrices.[12-21] The green tea extract is usually eaten after every meal. It is believed that drinking green tea cleanses the mouth; some polyphenols in the tea extract have been found to prevent the growth of *Streptococcus mutans*, a cariogenic bacteria.[10] Green tea is one of the most common nutritional supplements used commonly in the United States. It has very good antimicrobial, antioxidant properties.[9] This study will help in finding the antimicrobial activity of prepared nanoparticles by coating it in cast posts. So that the cast post coated with nanoparticles has significant activity against root canals microorganisms. This might help in the longevity of cast post and decrease the possibility of secondary caries.

MATERIALS AND METHODS

Preparation of green tea and neem extract

Green tea leaves and neem leaves were dried for 5 days. Dried neem leaves were made into powder by grinding it. All glassware was properly sterilised and dried in a hot air oven before use.

In the beaker, 0.5 g of green tea leaves and 0.5 g of neem powder were added in 100 ml of distilled water and boiled in a water bath by covering the beaker for 10 min. The mixture is filtered using filter paper and supernatant solution is collected in a separate conical flask. This extract is preserved in sterile container for further procedure [Figure 1].

Preparation of zinc oxide nanoparticle

In a conical flask, 50 ml of distilled water was added and 0.68 g of zinc sulfate was mixed well. 50 ml of prepared green tea and neem extract is added. Magnet is placed inside the conical flask and kept in an orbital shaker for 3 days till the ZnO nanoparticle synthesis occurs. In consequent days, color change was observed visually and photographs were recorded absorbance was noted. After synthesis occurs the extracts were added to six centrifuge tubes and centrifuging was done at 8000 rpm for 10 min using lark refrigerated centrifuge. The supernatant was collected in a beaker and the nanoparticle pellets were collected. The supernatant was kept in a hot air oven for drying [Figure 2].

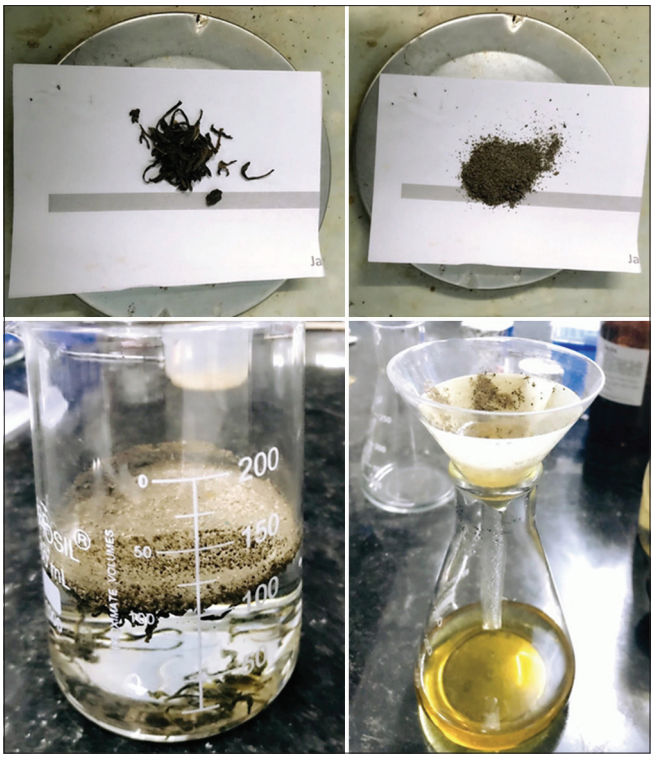

Figure 1: The preparation of green tea and neem extract

Coating of nanoparticle to post

The post was fabricated by waxing and casting. And the 3 posts were added to a beaker. The prepared Nanoparticle was loaded to the beaker and kept in a magnetic stirrer for 24 h to coat the post by ZnO nanoparticle [Figure 3].

Test pathogens

The antimicrobial activity of the synthesized ZnO nanoparticles was tested against a variety of pathogenic microorganisms present in the root canal space. The test pathogens were collected from a microbiology lab. For observing the antimicrobial activity, species such as *S. mutans*, *Candida albicans,* and *E. faecalis*.

Antimicrobial activity

The test organisms *S. mutans*, *C. albicans*, and *E. faecalis* are kept in nutrient broth for 24 h and used for further experimental procedures. The agar nutrient media was prepared and autoclaved and poured in agar plates and solidified later. In each plate, one sterile post and nanoparticle coated post were implanted in the agar plate and incubated at 37°C for 24 h. After the incubation period, the appearance of a clear zone around each post depicts the confirmation of bactericidal property. The zones were measured and mean values for each organism were recorded and represented [Figure 4].

RESULTS

The maximum zone of inhibition found on *C. albicans* (19.333 2.081) followed by *E. faecalis* (14.000 3.605), and *S. mutans* (12.666 2.516). Green tea and neem-mediated ZnO nanoparticle showed good antimicrobial activity against the tested microorganism.

S. mutans has a mean value of 12.66, standard deviation value of 2.51 and SE value of 1.45, *E. faecalis* has a mean value of 14, Standard deviation of 3.60 SE value of 2.081 and *C. albicans* has a mean value of 19.3, Standard deviation value of 2.081 and SE value of 1.201 [Table 1].

S. mutans have a mean of the zone of inhibition of 12.6. *E. faecalis* has a mean of the zone of inhibition of 14 and *C. albicans* has a zone of inhibition of 13.3. So, thus *C. albicans* show more zones of inhibition than *S. mutans* and *E. faecalis* [Figure 5].

DISCUSSION

In this study, the metal cast post was prepared by preparing the tooth, wax patterning, and then casting was done. The prepared metal cast post was coated with green tea and neem mediated ZnO nanoparticle after which the post was subjected to microorganisms to assess the antimicrobial activity of the root canal against the test pathogens such as *C.albicans*, *E. faecalis*, and *S. mutans*. The assessment of antimicrobial activity provides various advantages like prevention of the incidence of retrograde caries which further prevents the progression of secondary caries which helps in the preservation of the remaining tooth structure. From this study, it is evident that *C. albicans* shows the maximal zone of inhibition (antimicrobial activity) when compared to other microorganisms when coated with green synthesized plant-mediated ZnO nanoparticles. Hence, the green tea and neem-mediated silver nanoparticle is shown to exhibit good antimicrobial activity against the root canal pathogenic species.[22]

Figure 2: The preparation of zinc oxide nanoparticles

Various researchers showed antimicrobial changes in bacteria are caused by ZnO nanoparticles. The antibacterial behavior of green tea extract with ZnO-NPs has been related to a variety of concerns, but the exact toxicity process is not completely illuminated and still in progress, as there are several interrogations within the antibacterial behavior. With rising concentrations of ZnO nanoparticles in the range tested, the circular inhibition zone is shown to increase. It is also found that the region for inhibition is *E. faecalis* is greater than the S-inhibition region antimicrobial activity of ZnO nanoparticles against Bacillus subtilis shows highest the inhibition zone (mm) scale. Since green tea has the main component such as catechins polyphenols which helps in antibacterial and antifungal activity. This helps in antimicrobial effect.

Higher antibacterial activity against *S. aureus* and *Escherichia coli* and lower antibacterial activity against Salmonella paratyphi is shown by ZnO nanoparticles in another investigation. ZnO NPs break the cell wall, causing disruption to the membrane. That contributes to bacteria destruction. Green synthesized f neem extract with ZnO NPS is useful as an antibacterial active ingredient. Antibacterial properties of ZnO and zinc nanoparticles is used in different medical branches.[23,24] Green tea is a good bactericidal metal since it is nonpoisonous to animal cells but very hazardous to bacteria and destroys them.[25] Green tea extract with ZnO NPs produces hydrogen peroxides which interact chemically with membrane proteins and lipid bilayers.[26] These NPs may have an antimicrobial activity that includes both the development of reactive oxygen species and the aggregation of NPs at the outer membranes of the cytoplasm.[27,28] The main component in neem such as quercetin and sitosterol

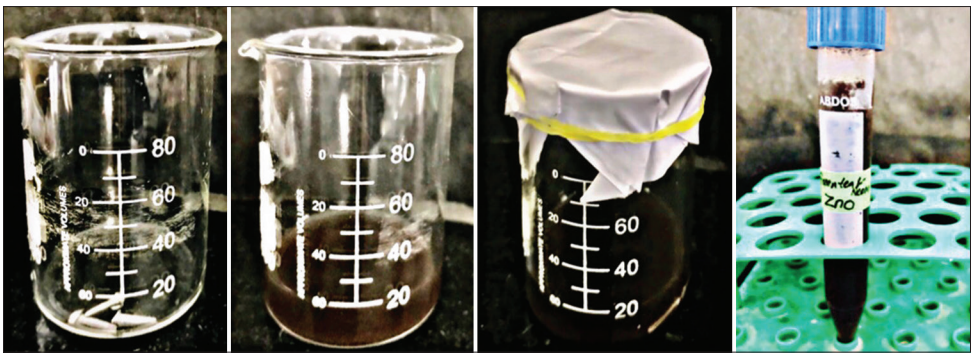

Figure 3: The fabrication of cast posts and coating of green tea and neem mediated zinc oxide nanoparticles

Figure 4: The zone of inhibition of microorganisms such as *Candida albicans*, *Streptococcus mutans*, and *Enterococcus faecalis*

Table 1: The statistical analysis of the groups

Group	Mean	SD	SE
Streptococcus mutans	12.666	2.516	1.452
Enterococcus faecalis	14.000	3.605	2.081
Candida albicans	19.333	2.081	1.201

SD: Standard deviation, SE: Standard error

helps in antibacterial and antifungal effects against the pathogens. Since the neem nanoparticles showed inhibitory action against *Staphylococcus aureus*, *E. coli*, and *Pseudomonas aeruginosa* which was previously reported.[29] Nanoparticles were then tested for antimicrobial activity showing that chemically synthesized ZnO nanoparticles show strong inhibition compared to other synthesized variants of nanoparticles.[29] The preprosthetic treatment of a root-filled tooth consists primarily of rebuilding lost tooth structure using an alloplastic material to provide a preparation with adequate frictional surfaces for retaining a crown or bridge.[30]

CONCLUSION

This study concerns the antimicrobial activity of nanoparticles coated in cast post against root canal microorganisms so that there would be a low chance of secondary caries and retrograde infection. The nanoparticle has more zone of inhibition against root canal microorganisms. It can be used effectively in dentistry. The green tea and neem-mediated ZnO nanoparticles showed greater antimicrobial activity. Thus this nanoparticle can be used as reinforcement by coating the cast post with nanoparticles, which inhibits the growth of microorganisms inside the root canal and prohibits retrograde infection.

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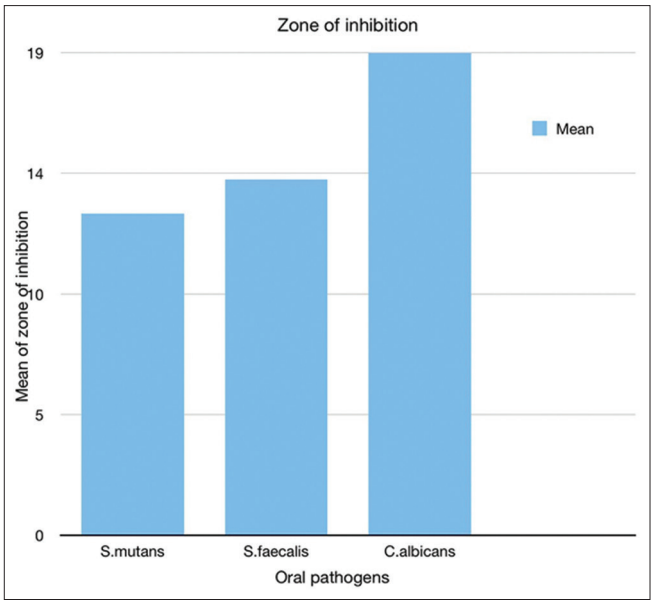

Figure 5: The mean value for the zone of inhibition of the oral pathogens such as *Candida albicans*, *Enterococcus faecalis*, and *Streptococcus mutans*

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Orozco EI, Toia CC, Cavalli D, Khoury RD, Cardoso FG, Bresciani E, *et al.* Effect of passive ultrasonic activation on microorganisms in primary root canal infection: A randomized clinical trial. J Appl Oral Sci 2020;28:e20190100.
2. Paula-Silva FW, Ribeiro-Santos FR, Petean IB, Manfrin Arnez MF, Almeida-Junior LA, Carvalho FK, *et al.* Root canal contamination or exposure to lipopolysaccharide differentially modulate prostaglandin E 2 and leukotriene B 4 signaling in apical periodontitis. J Appl Oral Sci 2020;28:e20190699.
3. Sasser L. Endodontic disinfection for orthograde root canal treatment in veterinary dentistry. J Vet Dent 2020;37:35-40.
4. Bicego-Pereira EC, Barbosa-Ribeiro M, de-Jesus-Soares A, Zaia AA, Ferraz CC, Almeida JF, *et al.* Evaluation of the presence of microorganisms from root canal of teeth submitted to retreatment due to prosthetic reasons and without evidence of apical periodontitis. Clin Oral Investig 2020;24:3243-54.
5. Tanvir H. Use of cast post core as foundation restoration in a patient with chronic depression. J Med Sci Clin Res 2020;8:10-12. [Doi: 10.18535/jmscr/v8i5.47].
6. Adarve R, Seong WJ. Self-guided instructional material: Cast post and core restoration. MedEdPORTAL 2010;6:9-12. [Doi: 10.15766/mep_2374-8265.8203].
7. Maiti S. Antimicrobial efficacy of temporary and permanent denture soft lining material modified by titanium – Dioxide nanoparticles – An *in-vitro* study. Int J Dent Oral Sci 2020;6:21-6. [doi: 10.19070/2377-8075-si02-05005].
8. Maiti S. Antimicrobial activity of soft liner incorporated with ocimum sanctum extract. Int J Dent Oral Sci 2020;7:15-20. [Doi: 10.19070/2377-8075-si02-05004].
9. AlShabib A, Brindley S, Satterthwaite J. Evaluation of the efficacy of two fibre-reinforced post removal techniques. Eur J Prosthodont Restor Dent 2022;24:553-7. [Doi: 10.1922/EJPRD_02101AlShabib06].

10. Barreto JR, de Moura Martins L, Chui FM, Pontes DG, Sponchiado EC Jr., Silva LM. The influence of final endodontic irrigation techniques and irrigants on the push-out resistance of glass fiber posts. Gen Dent 2022;70:46-50.
11. Ahmad P, Alyemeni MN, Al-Huqail AA, Alqahtani MA, Wijaya L, Ashraf M, *et al.* Zinc oxide nanoparticles application alleviates arsenic (As) toxicity in soybean plants by restricting the uptake of as and modulating key biochemical attributes, antioxidant enzymes, ascorbate-glutathione cycle and glyoxalase system. Plants (Basel) 2020;9:825.
12. Aparna J, Maiti S, Jessy P. Polyether ether ketone – As an alternative biomaterial for metal richmond crown-3-dimensional finite element analysis. J Conserv Dent 2021;24:553-7.
13. Merchant A, Ganapathy DM, Maiti S. Effectiveness of local and topical anesthesia during gingival retraction. Braz Dent Sci 2022;25:e2591.
14. Kasabwala H, Maiti S, Ashok V, Sashank K. Data on dental bite materials with stability and displacement under load. Bioinformation 2020;16:1145-51.
15. Agarwal S, Maiti S, Ashok V. Correlation of soft tissue biotype with pink aesthetic score in single full veneer crown. Bioinformation 2020;16:1139-44.
16. Maiti S. Assessment of microbial adhesion on provisional crown material after polishing with different polishing agents – An *in-vitro* study. Int J Dent Oral Sci 2020;7:27-31. [Doi: 10.19070/2377-8075-si02-05006].
17. Maiti S, Comparative analysis of abrasion resistance in relation to different temporary acrylic crown material using toothbrush simulator – An *in-vitro* study. Int J Dent Oral Sci 2021;9:2153-7. [Doi: 10.19070/2377-8075-21000425].
18. Agarwal S, Ashok V, Maiti S. Open- or closed-tray impression technique in implant prosthesis: A dentist's perspective. J Long Term Eff Med Implants 2020;30:193-8.
19. Siqueira JF Jr., Rôças IN. Present status and future directions: Microbiology of endodontic infections. Int Endod J 2022;55 Suppl 3:512-30.
20. Santos JM, Diogo P, Dias S, Marques JA, Palma PJ, Ramos JC. Long-term outcome of nonvital immature permanent teeth treated with apexification and corono-radicular adhesive restoration: A Case Series. J Endod 2022;9:825.
21. Bruhnke M, Wierichs RJ, von Stein-Lausnitz M, Meyer-Lückel H, Beuer F, Naumann M, *et al.* Long-term survival of adhesively luted post-endodontic restorations. J Endod 2022;48:606-13.
22. Ghasempour M, Moghadamnia AA, Abedian Z, Amir MP, Feizi F, Gharekhani S. *In vitro* viability of human periodontal ligament cells in green tea extract. J Conserv Dent 2015;18:47-50.
23. Zhang P, Wu G, Zhao C, Zhou L, Wang X, Wei S. Magnetic stomatocyte-like nanomotor as photosensitizer carrier for photodynamic therapy based cancer treatment. Colloids Surf B Biointerfaces 2020;194:111204.
24. Sarcan F. ZnO nanoparticles-based vacuum pressure sensor. Nanotechnology 2020;31:435502.
25. Jarrar Y, Al-Doaiss A, Alfaifi M, Shati A, Al-Kahtani M, Jarrar B. The influence of five metallic nanoparticles on the expression of major drug-metabolizing enzyme genes with correlation of inflammation in mouse livers. Environ Toxicol Pharmacol 2020;80:103449.
26. Bacchi A, Dos Santos MB, Pimentel MJ, Caetano CR, Sinhoreti MA, Consani RL. Influence of post-thickness and material on the fracture strength of teeth with reduced coronal structure. J Conserv Dent 2013;16:139-43.
27. Chang CW, Kao YH, Shen PH, Kang PC, Wang CY. Nanoconfinement of metal oxide MgO and ZnO in zeolitic imidazolate framework ZIF-8 for CO_2 adsorption and regeneration. J Hazard Mater 2020;400:122974.
28. Padmanabhan P. A comparative evaluation of the fracture resistance of three different pre-fabricated posts in endodontically treated teeth: An *in vitro* study. J Conserv Dent 2010;13:124-8.
29. Barzinjy AA, Hamad SM, Abdulrahman AF, Biro SJ, Ghafor AA. Biosynthesis, characterization and mechanism of formation of ZnO nanoparticles using petroselinum crispum leaf extract. Curr Org Synth 2020;17:558-66.
30. Brisebois PP, Izquierdo R, Siaj M. Room-temperature reduction of graphene oxide in water by metal chloride hydrates: A cleaner approach for the preparation of Graphene@Metal Hybrids. Nanomaterials (Basel) 2020;10:1255.