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"REINFORCEMENT OF NANOPARTICLES INTO DENTURE BASE RESIN FOR THEIR ANTI-MICROBIAL ACTION "- AN INVITRO STUDY

Dentistry

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ABSTRACT

Acrylic resins are most extensively used for denture fabrication. Dentures have become a well- established treatment modality for numerous incompletely and fully edentulous cases. One of the most extensively used materials in prosthetic dentistry is polymethyl methacrylate (PMMA) a material which has been used for denture base, it was reported that denture stomatitis had come more frequent with wide usages of removable dentures. Newly, nanotechnology invaded the dental field and began investigative exploration systems to explore the possible operations. The present study is to estimate the antimicrobial activity of nanoparticles reinforcement on poly- methylmethacrylate denture base.60 heat-polymerized acrylic resin discs were conventionally made and divided into 4 groups (n 15), control (no filler) and 3 experimental groups 5(Ag), 5.0(TIO2), and 5(ZNO). samples were sterilized, also immersed in cultured yeast (C. albicans), and incubated at 37 °C for 24 hours. After that, discs were irrigated before extracting the clustered pellets of Candida. The attached C. albicans was counted using the direct system after spreading on agar media and incubating for 48 hours. The mean comparison of colony count between the groups was done using the Kruskal- Wallis's test. Comparison between the two groups was done using the Mann- Whitney U test. $P \leq 0.05$ is considered to be statistically significant. Candidal CFU count was reduced the nano silver, followed by nano titanium oxide, nano zinc oxide with significant difference ($p < 0.001$).

KEYWORDS

Denture stomatitis, Candida albicans, Nano titanium oxide, Nano silver oxide, Nano zinc oxide, PMMA.

INTRODUCTION

Polymers such as as poly(methyl) methacrylate (PMMA) is an extensively used in dentistry for the fabrication of removable prostheses.[1,2] The nature of these polymers being porous with rough or irregular surfaces makes them a suitable environment for the adhesion of microorganism. In present era, Nanotechnology is widely used in the dental field and initiated investigative exploration systems to explore the possible implications and anticipated benefits within dentistry[6]. It is of most significate to know the science behind this nanotechnology to know how to use it to our advantage. Of the numerous trials conducted, it has been found that the addition of nanoparticles to materials is known to increase the surface hydrophobicity and reduce the adherence to biomolecules. Various nanoparticles such as aluminium dioxide, cobalt- chromium, silver, zinc oxide, zirconia and utmost generally titanium dioxide have been used in trials to improve the mechanical parcels of PMMA.[6]

Methodology

Acrylic Disc Preparation

A total of 60 discs (22 × 10 x 2.5 mm) were conventionally fabricated of heat- polymerized denture base resin (DPI, India) in split mould flask by using a stainless-steel metal specimen (22 × 10 x 2.5 mm) to create mould space for resin. The samples were separated into 4 groups (n =15) according to the filler concentration (0% without nanoparticle control"),

5%wt. (silver nanoparticle), 5%wt (titanium oxide), and 5 %wt. (zinc oxide). The samples were made in the conventional way of denture fabrication. After polymerization, the samples were cooled, finished using carbide bur, and polished, samples were kept in distilled water at 37 °C for 1 week prior to testing to ensure the release of unreacted monomer and avoid the negative goods on cell viability.

Biofilm Assay of C. albicans.

In advance to biofilm conformation, C. albicans were obtaines from ATCC (American type culture collection) standard candida albicans strains. Colonies were inoculated into the Sabouraud dextrose plates (SDA manufactures) at 37 °C for 24 hours. Single fresh colonies were inoculated overnight in Sabouraud dextrose broth at 37 °C followed by shaking and then standardised by using a spectrophotometer to 1 × 107 cells/ mL. Samples were kept for sterilisation with 70 % alcohol. Each sample was immersed in 200 µL homogenized fungal broth and incubated at 37 °C for 24 hours aerobically to allow biofilm conformation. After incubation, samples were gently irrigated two times by phosphate buffer saline (PBS) to count loose microorganisms, cells which are attached to discs were counted using the direct culture method (colony- forming unit (CFU)), by streaking diluted broth suspension on agar media and incubating aerobically for 24 hours at 37 °C. After 24 hours isolated candidial colonies which are formed on the SDA plates were counted.

RESULTS

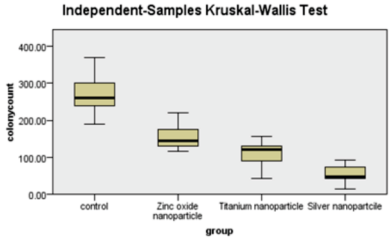
The means and Standard deviations SD) C. albicans (CFU/ mL) are summarised in Table 1. Results were found up to be significant between different groups ($P < 0.001$). The control resin samples show the topmost candida count value with gradational drop of candida count seen with different nanoparticles. The samples with tableware nanoparticles show smallest candida count compared to other 2 groups. Regarding conformation of candida colonies, large number of colonies were formed on the face of control case. On the other hand, lower colonies were observed with corroborated samples, the number of attached cells is dropped with 5 padding contents. The bar illustration shows the CFU per mL of broth (Figure 1).

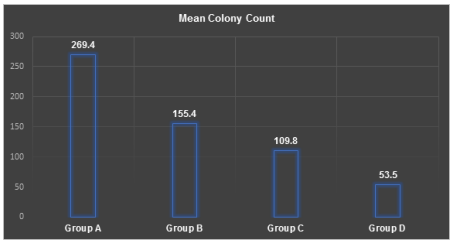
Statistical Analysis:

The examiner entered the data in the Microsoft Excel sheet and analyzed it using the Statistical Package for Social Sciences (SPSS) package version 22 (IBM Corp. in Armonk, New York, USA). The normality of the data was tested using the Shapiro-Wilk test and was a non-normality distribution. The mean comparison of colony count between the groups was done using the Kruskal-Walli's test.

Table 1: Mean comparison of colony counts between groups

Groups	n	Minimum	Maximum	Mean	SD	Test statistic	P value
Group A	15	190.00	370.00	269.4000	55.91167	48.956	**<0.001***
Group B	15	115.00	220.00	155.4667	34.95071		
Group C	15	43.00	157.00	109.8667	33.95137		
Group D	15	15.00	93.00	53.5333	23.88923		





Graph 1: Mean comparison of colony counts between groups (Box Plot)

DISCUSSION:

A various study was carried out in the past to investigate different ways to overcome Denture stomatitis such as surface coatings and antimicrobial filler incorporation.[4] In this study, the intention was to estimate the effect of nano- particle addition to heat- polymerized PMMA on C. albicans biofilm.[4]The results of this study indicated that different nanoparticles of 5% nano silver, nano titaniumoxide, nano zinc oxide patches added to heat- polymerized acrylic resin had the capability to dropped the Candida count,it can be noticed that there was a reduction in the number of cells with the modified samples. It's believed that the nanoparticles will assume one of the following mechanisms of action to fight Candida; they will induce reactive oxygen species, conjugate with the cell membrane, disrupt cell wall/ membrane exertion, or release substance ions. Silver nanoparticles show further reduction of candida followed by titanium oxide, zincoxide nanoparticles. Suganya S[8] et al 2014 in their study the addition of Ag ° to heat cure polymethylmethacrylate yielded fungicidal effect for the reference strain C. albicans. Rebecca et al (2020) [13] in their study that TiO 2 nanoparticles displayed anticandidal effect indeed at low attention and that its exertion increases as the attention of the nanoparticle increases. Pushpalatha C, et al (2022)[9], reviewed those different operations of zno nanoparticle in dentistry. The result of the present study shows that Ag ° incorporated denture base resin acts as a potent anticandidal agent and could be used as material of choice for immunocompromised cases and for cases resistant to conventional remedy of denture stomatitis. still, further studies are demanded to clarify the exact medium of action of silver nanoparticle, its long- term effect on tissues and its systemic effects due to ionic release for a safer implication. The limitation of Ag reinforced denture base resin is its esthetics due to its color.

CONCLUSION

Within the limitations of this study, it could be concluded that the addition of nano-silver particles to PMMA produced significant reduction in C. albicans count, compared to titanium oxide, zincoxide nanoparticle.

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