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### RESEARCH ARTICLE

#### COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF TWO ANTIBACTERIAL COMPOSITES AGAINST A COMMERCIAL COMPOSITE - AN IN VITRO STUDY

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#### Abstract

**Introduction:** Antibacterial composites are desirable since it decreases the incidence of secondary caries. The downfall of addition of antimicrobial fillers to a commercial composite is that they may hinder the mechanical properties of the parent material. This study was aimed to compare and evaluate the fracture resistance of modified composite by incorporation of 5wt% ZnO NPs & a novel antibacterial composite - Sri Chitra Thirunal Institute of Medical Science and Technology (SCTIMST) against a commercial composite.

**Materials and Methods:** The three study groups were determined: Group I: Commercial composite without incorporation of ZnO-NPs, Group II: Novel antibacterial composite (SCTIMST) containing Zn<sup>2+</sup>, Group III: Commercial composite + 5wt% ZnO- NPs. 10 cylindrical specimens (2 mm in diameter and 4 mm in height) were prepared using mold from each group of composite. Polymerization was carried out for 40s at the top and at the bottom before removal of specimen. The samples were stored in distilled water at 37°C for 24 h. Compressive strength was evaluated using a universal testing machine (INSTRON) at a cross-head speed of 0.5 mm/min.

**Results:** There was no significant difference ( $p > 0.05$ ) in mean compressive strength values between the study groups, statistically analyzed using independent sample t test.

**Conclusion:** The addition of antibacterial nanoparticles to the commercial composite and the novel antibacterial composite (SCTIMST) did not affect the strength of the composite, rather, it had a

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reinforcing effect as compared to the control material on evaluation of the compressive strength.

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### Introduction:-

Composite resin materials are widely used in the dentistry for conservative replacement of hard tissues<sup>1-4</sup>. Although the mechanical properties and wear resistance of these materials have been improved substantially since their introduction to the dental profession over 50 years ago, their antibacterial properties are still limited<sup>5-9</sup>. These resin based materials accumulate more dental plaque than other restorative materials both in vitro, and in vivo, which may result in development of secondary caries<sup>10-14</sup>. Development of antibacterial composite without hindering its mechanical properties could be a possible solution to overcome this<sup>16-19</sup>.

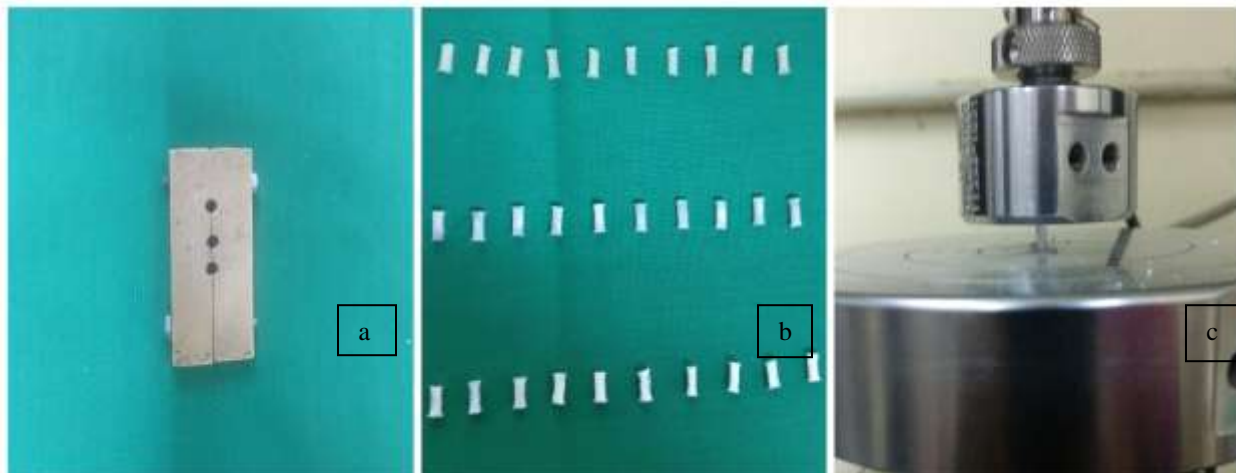
Antibacterial composites are desirable since it decreases the incidence of secondary caries. One method to impart antibacterial property is the addition of antimicrobial filler<sup>17-19</sup>. The downfall of addition of such particles is that they may hinder the mechanical properties of the parent material<sup>17, 18</sup>. Among these properties, compressive strength has a particularly important role in the mastication process since most of the masticatory forces are of compressive nature<sup>20</sup>. Compressive strength after antimicrobial filler addition was investigated in only a few previous works (Hojati et al 2013, Stencil et al 2018)<sup>18, 19</sup>. This study aimed to compare and evaluate the fracture resistance of modified composite by incorporation of 5wt% ZnO NPs & a novel antibacterial composite - Sri Chitra Thirunal Institute of Medical Science and Technology (SCTIMST) against a commercial composite. The null hypothesis was that there was no significant difference in the fracture resistance of Zinc oxide nanoparticle incorporated composite and a novel antibacterial composite (SCTIMST) against a commercial composite.

### Methodology:-

**Table 1:-** Study groups.

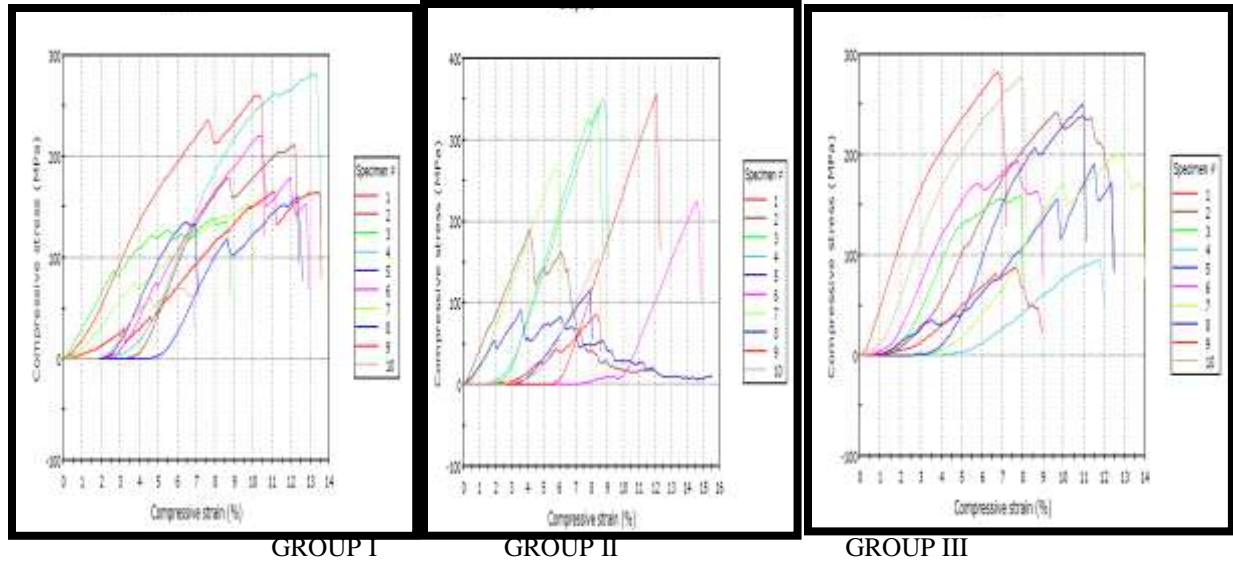
Groups	Description
Group I	Commercial composite restorative material (Tetric-N-Ceram, Ivoclar Vivadent)
Group II	Novel antibacterial composite (SCTIMST)
Group III	Modified composite by incorporation of 5 wt% ZnO NPs

Sample preparation: 10 cylindrical specimens (2 mm in diameter and 4 mm in height) were prepared using mold from each study group. Polymerization was carried out at the top and at the bottom before removal of specimen at 600mW/cm<sup>2</sup> for 40 s each.



**Figure 1:-** A. Mold for specimen preparation b. Specimens prepared for the three study groups c. Compressive strength evaluation using INSTRON universal testing machine.

Fracture resistance evaluation: The samples were stored in distilled water at 37°C for 24 h. Compressive strength test was conducted using a universal testing machine (INSTRON) at a cross-head speed of 0.5 mm/min.



**Figure 2:-** Compressive strength evaluation graph. a. Group I: Commercial composite restorative material b. Group II: Novel antibacterial composite (SCTIMST) c. Group III: Modified composite by incorporation of 5 wt% ZnO NPs

### Results:-

**Table 2:-** Mean and standard deviation of compressive strength evaluation of study groups.

Groups	Number	Minimum	Maximum	Mean compressive strength (Mpa)	Std. Deviation
Group I (CONTROL)	10	160.48	280.48	216.32	48.69
Group II	10	189.60	355.41	288.61	78.05
Group III	10	192.16	281.46	240.61	37.46

There was no significant difference ( $p > 0.05$ ) in mean compressive strength evaluation values between the groups, tested using independent sample t test. On statistical analysis, it was confirmed that addition of ZnO nanoparticles achieved higher mean compressive strength values though not statistically significant. The novel antibacterial composite containing  $Zn^{2+}$  (SCTIMST) had higher mean compressive strength values though not statistically significant.

### Discussion:-

Dental resin composites are at present the most popular restorative material owing to its superior aesthetics and adhesive property<sup>1</sup>. Despite its popularity, factors like polymerization shrinkage with subsequent micro leakage and sequelae of secondary caries, water sorption and inadequate degree of conversion have been the major hurdles in providing a clinically long- serving restoration.<sup>14</sup>

Literature studies have shown that ZnO-NPs had been incorporated as radiopaque reinforcing fillers and to impart antibacterial properties<sup>17, 18</sup>. In this study, the weight % of ZnO-NPs was optimized by analyzing the consistency of the mix on addition of 1 wt. % increments of ZnO-NPs to a known weight of commercial composite. On addition of ZnO-NPs beyond 5 wt. % concentration, the working characteristics of the parent composite material was found to be inferior and the material was no longer pliable. Thus, 5 wt. % ZnO-NPs was determined as the optimal concentration of ZnO-NPs to be added to the commercial composite. These modified composites were stored in completely opaque bottles until the test was performed.

The higher compressive strength values obtained for Group III, Commercial composite with 5wt% ZnO- NPs may be attributed to the increased filler content as compared to the control group. Miyazaki et al in 1991 stated that higher bond strength was obtained with the composite with the higher filler content.<sup>21</sup> ZnO-NPs exhibited 5-10 times more antibacterial property as compared to  $SiO_2$  depending on the microorganism type. Therefore, fillers containing ZnO-NPs in addition to silica nanofillers could be an advantageous approach for plaque inhibition [Sevinc & Hanley

2010].<sup>17</sup> ZnO-NPs are insoluble and ZnO-NPs incorporated composites should not lose their antibacterial effect over time due to lower release rates. ZnO-NPs can be used as filler particles in addition to nanosilica fillers in order to reinforce the composite [Imazato et al 2003].<sup>16</sup>

The higher compressive strength values obtained for Group II, novel antibacterial composite (SCTIMST) containing Zn<sup>2+</sup> may be attributed to the presence of inorganic-organic hybrid resins as compared to the control group. In inorganic-organic hybrid resins, organic polymer (methacrylate group) components bring good elasticity, tenacity, ductility and low density, while the inorganic components (Si, Zn<sup>2+</sup>) increases the hardness, stiffness and resistance to elevated temperature [Vibha C et al 2015].<sup>22</sup>

The present study is an in-vitro one evaluating limited properties of two novel experimental composite materials. Composite restorative materials and its clinical success depend on a multitude of factors. Further studies have to be done to evaluate various mechanical properties, curing aspects and adhesive characteristics of these materials. Clinical studies are warranted to achieve a more accurate evaluation and validation of the findings of this study.

### Conclusion:-

Within the limitations of this study, it can be concluded that addition of antibacterial nanoparticles to the commercial composite and the novel antibacterial composite (SCTIMST) did not affect the strength of the composite, rather, it had a reinforcing effect as compared to the control material on evaluation of the compressive strength.

### Conflicts of interest:

The authors declare that they have no competing interest.

### References:-

1. Ferracane JL. Resin composite—State of the art. *Dent Mater.* 2011 Jan 1;27(1):29–38.
2. Ritter AV. Posterior Resin-Based Composite Restorations: Clinical Recommendations for Optimal Success. *J Esthet Restor Dent.* 2001;13(2):88–99.
3. Bayne SC, Heymann HO, Swift JE. Update on dental composite restorations. *J Am Dent Assoc* 1939. 1994 Jun; 125(6):687–701.
4. Ilie N, Hickel R. Resin composite restorative materials. *Aust Dent J.* 2011;56 (1):59–66.
5. Svanberg M, Mjör IA, Ørstavik D. Mutans Streptococci in Plaque from Margins of Amalgam, Composite, and Glass-ionomer Restorations. *J Dent Res.* 1990 Mar 1; 69(3):861–4.
6. Ferracane JL. Resin-based composite performance: Are there some things we can't predict? *Dent Mater.* 2013 Jan 1;29(1):51–8.
7. Metz I, Rothmaier K, Pitchika V, Crispin A, Hickel R, Garcia-Godoy F, et al. Risk factors for secondary caries in direct composite restorations in primary teeth. *Int J Paediatr Dent.* 2015 Nov;25(6):451–61.
8. Busscher HJ, Rinastiti M, Siswomihardjo W, van der Mei HC. Biofilm Formation on Dental Restorative and Implant Materials. *J Dent Res.* 2010 Jul; 89 (7):657–65.
9. Mjör IA, Toffentti F. Secondary caries: A literature review with case reports. *Quintessence Int.* 2000; 31(3).
10. Moraschini V, Fai CK, Alto RM, Dos Santos GO. Amalgam and resin composite longevity of posterior restorations: A systematic review and meta-analysis. *J Dent.* 2015 Sep;43(9):1043–50.
11. Beyth N, Domb AJ, Weiss EI. An in vitro quantitative antibacterial analysis of amalgam and composite resins. *J Dent.* 2007 Mar; 35 (3):201–6.
12. Opdam NJM, Bronkhorst EM, Loomans BAC, Huysmans M-CDNJM. 12-year Survival of Composite vs. Amalgam Restorations. *J Dent Res.* 2010 Oct 1;89(10):1063–7.
13. Thomas RZ, Mei HCVD, Veen MHVD, Soet JJD, Huysmans MCDNJM. Bacterial composition and red fluorescence of plaque in relation to primary and secondary caries next to composite: an in situ study. *Oral Microbiol Immunol.* 2008;23(1):7–13.
14. Bernardo M, Luis H, Martin MD, Leroux BG, Rue T, Leitão J, et al. Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial. *J Am Dent Assoc.* 2007 Jun 1; 138 (6):775–83.
15. vanGroeningen G, Jongbloed W, Arends J. Composite degradation in vivo. *Dent Mater Of Publ Acad Dent Mater.* 1986 Oct;2(5):225–7.

16. Imazato S. Antibacterial properties of resin composites and dentin bonding systems. *Dent Mater.* 2003;19(6):449-57
17. Aydin Sevinc B, Hanley L. Antibacterial activity of dental composites containing zinc oxide nanoparticles. *Journal of Biomedical Materials Research Part B: Applied Biomaterials* 2010;94:22–31
18. Tavassoli Hojati S, Alaghemand H, Hamze F, AhmadianBabaki F, Rajab-Nia R, Rezvani MB, Kaviani M, Atai M. Antibacterial, physical and mechanical properties of flowable resin composites containing zinc oxide nanoparticles. *Dent Mater.* 2013;29(5):495-505
19. Stencil R, Kasperski J, Pakieła W, Mertas A, Bobela E, Barszczewska-Rybarek I, Chladek G. Properties of Experimental Dental Composites Containing Antibacterial Silver-Releasing Filler. *Materials.* 2018 Jun;11(6):1031.
20. Galvão MR, Caldas SG, Calabrez-Filho S, Campos EA, Bagnato VS, Rastelli AN, Andrade MF. Compressive strength of dental composites photo-activated with different light tips. *Laser Physics.* 2013 Feb 21;23(4):045604.
21. Miyazaki M, Hinoura K, Onose H, Moore BK. Effect of filler content of light-cured composites on bond strength to bovine dentine. *J Dent.* 1991;19(5):301- 303.
22. Vibha C., Lizymol P.P Effect of Inorganic Content on Thermal Stability and Antimicrobial Properties of Inorganic-Organic Hybrid Dimethacrylate Resins. *International Journal of Scientific Research* 2015;4(8):59-60.