Original Research Article

EFFECT OF THERMOCYCLING ON COLOUR STABILITY OF ALKASITE RESTORATIVE MATERIAL (CENTION N) - AN IN VITRO STUDY

ABSTRACT

Introduction: Cention N is an alkasite based dental restorative material, it is far less expensive unlike composite materials, it has fluoride releasing property and the strength of cention N is comparable to that of dental amalgam restorations. Colour stability is one of the major and important characteristics in dentistry, dental restoration and esthetics. The aim of the study is to evaluate the colour stability of alkasite restorative material (Cention N) before and after thermocycling.

Materials and Methods:

Eight disc shaped samples of alkasite restorative material Cention N with 2 mm of thickness were prepared using a customised mould. After the disc sample preparation, they were numbered for identification and color stability was measured by using Vita easy shade advance spectrophotometer. L, a and b values were obtained before the thermocycling procedure. 1000 cycles of thermocycling was done which is equal to 6 months. The thermocycler used was TC 4 SD Mechatronik. The colour stability value after thermocycling was again determined using the vita easy shade spectrophotometer. Control group samples were not subjected to thermocycling. The colour stability values prior and after thermocycling were obtained and tabulated.

Result: Thermocycled cention N samples had low delta E values when compared to that of non thermocycled samples. Statistical analysis was done using spss software and independent t test was done. P value was found to be 0.616, showing that it is statistically insignificant.

Conclusion: From this research we can conclude that thermocycling procedure has an effect on the colour stability of the cention N material. Thermocycled cention N samples had better color stability when compared to non thermocycled cention N samples.

Keywords: Restorative material, Cention N, Colour stability, Thermocycling, Spectrophotometer, Innovative measurement

Running title : Effect of thermocycling on colour stability of cention N

INTRODUCTION:

Composite resin materials are extensively used for dental restoration these days (1). They contain mineral, glass and resin filler particles(2). The conventional composite material contain large component of amorphous silica or quartz. Composite materials are classified as two types such as chemically and photochemically activated resin material. In dentistry, aesthetics plays a major role(3). Many materials have come into dentistry for restoration material which have a good esthetic such that of the natural tooth and compressive stability of that of amalgam restoration(4,5). Cention N is one such new product which is an alkasite based dental restorative material a resin-based self-curing powder liquid restorative material and it has the fluoride releasing ability which helps in the release of the hydroxyapatite in the tooth and helps in in the repair and remineralisation of the enamel, thus helping to prevent tooth sensitivity(6,7). Cention-N is a novel bulk fill dental restorative material which can be used as self and light cure material. It has got sustained release of hydroxyl and fluoride ions in various conditions (8).

Thermocycling is also known as thermal cycling, a process in which the required substance is processed through a number of cycles between 2 extreme temperatures simultaneously(9-11). Thermocycling is a test done to evaluate the product reliability and strength. In order to maintain a constant temperature, a water bath is needed for thermocycling. Particular standards, universal immersion time and temperature protocol is required for the test. (12-14). Thermocycling is most efficacious technique in the ageing process. The cycle holds alternate high and low temperatures (15).

Colour stability is a significant property of dental resin based materials. Composite resins contains few organic compounds which may lead to internal discoloration(16). Compounds including amines and benzoyl peroxide which are required for the polymerization reaction, and the use of hydroquinone monomethyl ether as an inhibitor in the reaction.(17). A spectrophotometer is used to measure colour changes based on the Commission Internationale de l'Eclairage lab (CIELAB) system in 1976. L stands for perceptual lightness and the values will range from zero to hundred. A value means greenness to redness and b represents blueness to yellowness (18). The human oral cavity is subjected to temperature stress (19). The clinical success of dental restorative materials is related to colour stability. Thermal shocks in the oral

environment can induce material degradation as well as colour shifts in dental materials. As a result, it's crucial to understand how thermocycling affects the colour stability of commonly used dental restorative materials. The aim of the study is to evaluate the colour stability of alkasite restorative material (Cention N) before and after thermocycling.

MATERIALS AND METHOD:

Sample preparation:

The research was done at White Lab, Saveetha Dental College and Hospital, Chennai, India. For this study, cention N restorative material was taken. Eight disc shaped samples of alkasite restorative material Cention N with 2 mm of thickness were prepared using a customised mould. 4 samples in test and 4 samples in control group. Random sampling method was followed and three investigators were involved,

Pre thermocycling color stability testing:

After discs preparation, they were numbered and colour stability was tested using a Vita easy shade advance spectrophotometer, and the pre-color value was measured. Prior to thermocycling, the L, a, and b values were determined.

Thermocycling:

The samples were placed in a thermocycler and subjected to 1000 cycles, which equated to 6 months. When it was cold, it was 10°C, and when it was hot, it was 60°C. The draining time was determined to be 10 seconds and the dwelling time was determined to be 30 seconds. The thermocycler used in this experiment was the CS 4.2-SD Mechatronik. The samples in the control group were not subjected to thermocycling.

Post thermocycling color stability testing:

The colour stability value after thermocycling was again determined using the vita easy shade spectrophotometer. Then the pre and post thermocycling values were compared and delta E values was analysed using the formula: $\Delta E(L^* a^* b^*) = [(\Delta L^*)2 + (\Delta a)2 + (\Delta b)2]$.

Statistical analysis

The delta E values were obtained and the values were tabulated, with the tabulated values "Independent sample t test" was performed using the statistical software "SPSS version 23". P value less than or equal to 0.05 is considered to be significant. The result of the analysis carried out was depicted in the form of bar graphs and tables.

RESULTS AND DISCUSSION:

Table 1: table representing the mean, standard deviations of the control and test groups obtained from pre-thermocycling and post-thermocycling values.

Group	No	Mean value	Standard deviation value	P value
Control group	**4**	**14.3975**	**5.22921**	**0.616**
Test group	**4**	**12.1650**	**3.91078**	

The primary outcome of study is the color stability evaluation of cention N material and effects of thermocycling on the material. From Table 1, the group statistic values were obtained via independent sample t test where the mean, standard deviations, and statistical significance were determined. The mean values of pre-thermocycling (control group) and pos-thermocycling (test group) for the control group was found to be 14.39 while the test group was found to be 12.16 and the standard deviation was 5.22921 and 3.91078 and the *p* value is 0.616 which is greater than 0.05 showing the results are insignificant. Thus, thermocycling group or test group cention N samples showed better color stability values.

Cention N is an alkasite based dental restorative material, it is far less expensive unlike composite materials, it has fluoride releasing property and the strength of cention N is comparable to that of dental amalgam restorations. Thermocycling is one of the procedures used to calculate a variety of factors such as age, colour, and so on (20). The colour of the composite before and after thermocycling was the main focus of this research. A Arikan et al did a study on

pink and white acetal resin with one ordinary polyresin to investigate the colour stability of the resin material after thermocycling. The mean value of the materials was calculated based on the results. On long exposure to 100 hours of simultaneous thermocycling, conventional poly resin exhibited 0.69, white acetal resin showed 0.74, and pink acetal resin showed 0.77. (21). Arregui et al presented a study to explain the colour stability of two self-adhesive composites. After immersing the composites for ten days, the delta E values were recorded. Water had no effect on the colour shift, according to the findings (22).

Bhattacharya conducted another in vitro study on the impact of thermocycling on the colour stability of aesthetic materials. The colour stability of cention N, Fuji IX GP Extra, and Fuji IX GP after thermocycling was compared in this study. A spectrophotometer was used to determine the colour characteristics of the discs. The materials were separated into three categories. From the result he concluded that Cention N had superior color stability when compared to glass ionomer cement material(23). Similarly, our study had better color stability in thermocycled cention N samples.

YK Lee et al conducted a study on the colour stability of flowable composites, in which 5 samples of each composite were taken and exposed to artificial ageing such as thermocycling to observe colour change. Flowable composites were found to have the most colour change (24). Maria et al. presented a study to explain the colour stability of two self-adhesive composites and four methacrylate composites before and after water storage. After submerging the composites for 30 days, the delta E values were recorded (25). However, the current study has limitations, such as a small sample size and the use of only one type of restorative material. Further advanced research about the thermocycling effects on different types of restorative materials can be conducted.

CONCLUSION:

From this research we can conclude that thermocycling procedure has an effect on the colour stability of the cention N material. Thermocycled cention N samples had better color stability when compared to non thermocycled cention N samples. Thus, thermal stresses in oral cavity may have an influence in the color stability of restorative material such as cention N, because we observed an increased color stability in thermocycled restorative material group.

ACKNOWLEDGEMENT:

We would like to thank our college and management for their constant support in completing this research work.

REFERENCES:

1. Muthukrishnan L. Imminent antimicrobial bioink deploying cellulose, alginate, EPS and synthetic polymers for 3D bioprinting of tissue constructs. Carbohydr Polym [Internet]. 2021 May 15;260:117774. Available from: http://dx.doi.org/10.1016/j.carbpol.2021.117774

2. PradeepKumar AR, Shemesh H, Nivedhitha MS, Hashir MMJ, Arockiam S, Uma Maheswari TN, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis. J Endod [Internet]. 2021 Aug;47(8):1198–214. Available from: http://dx.doi.org/10.1016/j.joen.2021.04.022

3. Chakraborty T, Jamal RF, Battineni G, Teja KV, Marto CM, Spagnuolo G. A Review of Prolonged Post-COVID-19 Symptoms and Their Implications on Dental Management. Int J Environ Res Public Health [Internet]. 2021 May 12;18(10). Available from: http://dx.doi.org/10.3390/ijerph18105131

4. Muthukrishnan L. Nanotechnology for cleaner leather production: a review. Environ Chem Lett [Internet]. 2021 Jun 1;19(3):2527–49. Available from: https://doi.org/10.1007/s10311-020-01172-w

5. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? J Dent Sci [Internet]. 2020 Dec;15(4):562–3. Available from: http://dx.doi.org/10.1016/j.jds.2020.02.009

6. Narendran K, Jayalakshmi, Ms N, Sarvanan A, Ganesan S A, Sukumar E. Synthesis, characterization, free radical scavenging and cytotoxic activities of phenylvilangin, a substituted dimer of embelin. ijps [Internet]. 2020;82(5). Available from: https://www.ijpsonline.com/articles/synthesis-characterization-free-radical-scavenging-and-cytotoxic-activities-of-phenylvilangin-a-substituted-dimer-of-embelin-4041.html

7. Reddy P, Krithikadatta J, Srinivasan V, Raghu S, Velumurugan N. Dental Caries Profile and Associated Risk Factors Among Adolescent School Children in an Urban South-Indian City. Oral Health Prev Dent [Internet]. 2020 Apr 1;18(1):379–86. Available from: http://dx.doi.org/10.3290/j.ohpd.a43368

8. Sawant K, Pawar AM, Banga KS, Machado R, Karobari MI, Marya A, et al. Dentinal Microcracks after Root Canal Instrumentation Using Instruments Manufactured with Different NiTi Alloys and the SAF System: A Systematic Review. NATO Adv Sci Inst Ser E Appl Sci [Internet]. 2021 May 28 [cited 2021 Aug 5];11(11):4984. Available from: https://www.mdpi.com/2076-3417/11/11/4984

9. Bhavikatti SK, Karobari MI, Zainuddin SLA, Marya A, Nadaf SJ, Sawant VJ, et al. Investigating the Antioxidant and Cytocompatibility of Mimusops elengi Linn Extract over Human Gingival Fibroblast Cells. Int J Environ Res Public Health [Internet]. 2021 Jul 4;18(13). Available from: http://dx.doi.org/10.3390/ijerph18137162

10. Karobari MI, Basheer SN, Sayed FR, Shaikh S, Agwan MAS, Marya A, et al. An In Vitro Stereomicroscopic Evaluation of Bioactivity between Neo MTA Plus, Pro Root MTA, BIODENTINE & Glass Ionomer Cement Using Dye Penetration Method. Materials [Internet]. 2021 Jun 8;14(12). Available from: http://dx.doi.org/10.3390/ma14123159

11. Rohit Singh T, Ezhilarasan D. Ethanolic Extract of Lagerstroemia Speciosa (L.) Pers., Induces Apoptosis and Cell Cycle Arrest in HepG2 Cells. Nutr Cancer [Internet]. 2020;72(1):146–56. Available from: http://dx.doi.org/10.1080/01635581.2019.1616780

12. Ezhilarasan D. MicroRNA interplay between hepatic stellate cell quiescence and activation. Eur J Pharmacol [Internet]. 2020 Oct 15;885:173507. Available from: http://dx.doi.org/10.1016/j.ejphar.2020.173507

13. Romera A, Peredpaya S, Shparyk Y, Bondarenko I, Mendonça Bariani G, Abdalla KC, et al. Bevacizumab biosimilar BEVZ92 versus reference bevacizumab in combination with FOLFOX or FOLFIRI as first-line treatment for metastatic colorectal cancer: a multicentre, open-label, randomised controlled trial. Lancet Gastroenterol Hepatol [Internet]. 2018 Dec;3(12):845–55. Available from: http://dx.doi.org/10.1016/S2468-1253(18)30269-3

14. Raj R K, D E, S R. β-Sitosterol-assisted silver nanoparticles activates Nrf2 and triggers mitochondrial apoptosis via oxidative stress in human hepatocellular cancer cell line. J Biomed Mater Res A [Internet]. 2020 Sep;108(9):1899–908. Available from: http://dx.doi.org/10.1002/jbm.a.36953

15. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. J Periodontol [Internet]. 2019 Dec;90(12):1441–8. Available from: http://dx.doi.org/10.1002/JPER.18-0673

16. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species [Internet]. Vol. 94, Archives of Oral Biology. 2018. p. 93–8. Available from: http://dx.doi.org/10.1016/j.archoralbio.2018.07.001

17. Uma Maheswari TN, Nivedhitha MS, Ramani P. Expression profile of salivary micro RNA-21 and 31 in oral potentially malignant disorders. Braz Oral Res [Internet]. 2020 Feb 10;34:e002. Available from: http://dx.doi.org/10.1590/1807-3107bor-2020.vol34.0002

18. Gudipaneni RK, Alam MK, Patil SR, Karobari MI. Measurement of the Maximum Occlusal Bite Force and its Relation to the Caries Spectrum of First Permanent Molars in Early Permanent Dentition. J Clin Pediatr Dent [Internet]. 2020 Dec 1;44(6):423–8. Available from: http://dx.doi.org/10.17796/1053-4625-44.6.6

19. Chaturvedula BB, Muthukrishnan A, Bhuvaraghan A, Sandler J, Thiruvenkatachari B. Dens invaginatus: a review and orthodontic implications. Br Dent J [Internet]. 2021 Mar;230(6):345–50. Available from: http://dx.doi.org/10.1038/s41415-021-2721-9

20. Kanniah P, Radhamani J, Chelliah P, Muthusamy N, Joshua Jebasingh Sathiya Balasingh E, Reeta Thangapandi J, et al. Green synthesis of multifaceted silver nanoparticles using the flower extract of Aerva lanata and evaluation of its biological and environmental applications. ChemistrySelect [Internet]. 2020 Feb 21;5(7):2322–31. Available from: https://onlinelibrary.wiley.com/doi/10.1002/slct.201903228

21. Ozkan Y, Arikan A, Akalin B, Arda T. A study to assess the colour stability of acetal resins subjected to thermocycling. Eur J Prosthodont Restor Dent [Internet]. 2005 Mar;13(1):10–4. Available from: https://www.ncbi.nlm.nih.gov/pubmed/15819144

22. Arregui M, Giner L, Ferrari M, Mercadé M. Colour Stability of Self-Adhesive Flowable Composites before and after Storage in Water [Internet]. Vol. 631, Key Engineering Materials. 2014. p. 143–50. Available from: http://dx.doi.org/10.4028/www.scientific.net/kem.631.143

23. Bhattacharya S, Purayil TP, Ginjupalli K, Kini S, Pai S. Effect of Thermocycling on the Colour Stability of Aesthetic Restorative Materials: An in-vitro Spectrophotometric Analysis [Internet]. Vol. 20, Pesquisa Brasileira em Odontopediatria e Clínica Integrada. 2020. Available from: http://dx.doi.org/10.1590/pboci.2020.020

24. Yu B, Lee Y-K. Differences in color, translucency and fluorescence between flowable and universal resin composites [Internet]. Vol. 36, Journal of Dentistry. 2008. p. 840–6. Available from: http://dx.doi.org/10.1016/j.jdent.2008.06.003

25. Maria A. Masking the Discolored Enamel Surface with Opaquers before Direct Composite Veneering [Internet]. Vol. 3, Journal of Dentistry, Oral Disorders & Therapy. 2015. p. 01–8. Available from: http://dx.doi.org/10.15226/jdodt.2015.00143