International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 9; Issue 01 (A); January 2020; Page No.20896-20900
DOI: http://dx.doi.org/10.24327/ijcar.2020. 20896-20900

Review Article

AN IN VITRO COMPARITIVE EVALUATION OF FRACTURE RESISTANCE OF DENTAL AMALGAM, NANO COMPOSITE FILTEK-Z350 AND CENTION-N IN CLASS II CAVITIES

Jayashankara.C.M, Jameela.V.A*, Paluvary Sharath Kumar, Anil Kumar S, Girish S.A , Mujahid Ahmed and Anand Gowda

Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College, Karnataka, India to be changed as Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College, Karnataka, India
Sri Siddhartha Academy of Higher education .Agalakote, B.H.Road,Tumkur, Karnataka

A R T I C L E I N F O

Article History:
Received 12th October, 2019
Received in revised form 23rd November, 2019
Accepted 7th December, 2019
Published online 28th January, 2020

Key words:
Fracture Resistance, Dental Amalgam, Z350 Composite Resin, Cention-N

A B S T R A C T

Introduction: In posterior tooth restorations, mechanical and physical properties play a vital role as it is subjected to heavy occlusal load. The fracture mainly occurs at the isthmus of a class II restored cavity. Therefore, materials with high fracture resistance are highly recommended in such cases where it is subjected to heavy load as in cases of class II carious teeth within the restoration.

Objectives: To evaluate and compare Cention-N and nanocomposite Filtek Z350 for fracture resistance in class II cavities.

Materials and Methodology: Eighty freshly extracted premolars were collected. Class II mesial box shaped cavities was prepared. The teeth were randomly divided into 4 groups (n=20) .Group I: No cavities were prepared (control). Group III: Cavities were restored with Amalgam. Group IV: Cavities were restored with Filtek Z 350 composite Group V: Cavities were restored with Cention-N. Fracture resistance was tested with a steel ball of 3mm diameter with a cross head speed of 1mm/min in Universal Testing Machine- Instron. The load at which the restorations fractured were noted and recorded and was statistically analysed.

Results: Cention-N material has the highest fracture resistance when compared to the other restorative materials.

Conclusion: Cention-N and Filtek Z350 restorative materials have higher fracture resistance in Class II cavity preparation and restoration but dental amalgam showed comparatively inferior results.

INTRODUCTION

The removal of tooth structure via cavity preparation has been shown to weaken teeth and increase their susceptibility to fracture.[1,2] Depending on the extent of the cavity, restorative treatment is a predisposing factor for an incomplete or complete tooth fracture[3]

Amalgam has traditionally been used as the best build-up material. [4,5]As amalgam is strong in bulk section, but its slow setting process, mercury content and unpleasant colour, were some of the reasons why alternative core build-up materials have been developed. [6] With the decline in popularity of amalgam in recent years, there is a need for an equally strong yet safer replacement.[7]

Corresponding author:* **Jameela.V.A
Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College, Karnataka, India to be changed as Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College, Karnataka, India. Sri Siddhartha Academy of Higher education .Agalakote, B.H.Road,Tumkur, Karnataka

The demand for posterior resin composite restorations has dramatically increased because of their ability to match the tooth colour; biocompatibility and bonding to the tooth structure.[8, 9] The restoration of posterior teeth using resin based materials provide rigidity and increase the fracture resistance by reinforcing unsupported tooth structure.

The use of advanced adhesive systems with improved physical properties are more esthetic and support remaining tooth structure better than amalgam.[10] But the inherent drawback encountered using conventional resin composites are stress development due to polymerization shrinkage. [11]Polymerization shrinkage that leads to the higher stress accumulation on the tooth than on restoration is considered responsible for a series of complications like staining at the margins of restorations, recurrent caries, hypersensitivity and pulp pathology including higher risk of tooth fracture.[12,13]

The advances in adhesive restorations have lead to introduction of condensable/packable composites intending to

lower the problems associated with the polymerization shrinkage. But adapting these stiffer materials to the internal cavity walls and cavosurface margins was difficult. [14,15]A new category of resin composites called nanofilled composites was introduced due to increase in the demand of a universal restorative material for all types of direct restorations. [16,17]However, these materials also do exhibit polymerization shrinkage to a certain extent.[18]In posterior tooth restorations, mechanical and physical properties play a vital role as it is subjected to heavy occlusal load.[19] Posterior teeth, have an anatomic shape that makes them more likely to fracture the cusps and ridge due to deflection during mastication under occlusal load.[20] Commonest form of failure of posterior restoration is fracture of restoration.[21] Therefore, materials with high fracture resistance is highly recommended in such cases where it is subjected to heavy load as in cases of class II carious teeth.

Cention-N a tooth colored, dual cure, bulk fill restorative material introduced recently has been recommended by the manufactures for stress bearing areas in class II restorations. It is available in powder and liquid form. The liquid comprises of urethane dimethacrylates and initiators, and the powder contains various glass fillers, initiators and pigments.[9] The silanes bonded to filler particles improve the bond between the inorganic filler and monomer matrix as they are able to establish a chemical bond between glass surface and matrix and thus minimizes the volumetric shrinkage and shrinkage stress. Also, the low elastic modulus of Cention-N which is close to that of dentin contributes to less shrinkage stress within the restoration. [9]However, due to limited data available and paucity of fracture resistance studies evaluating the fracture resistance of Cention-N when used as restorative material for class II cavities. Hence, the purpose of this invitro study is to evaluate and compare Cention-N and nanocomposite Filtek Z350 for fracture resistance in class II cavities.

Aims and Objectives

To evaluate fracture resistance in class II cavity restored with

i. Amalgam
ii. Nanocomposite (Filtek Z350 Universal Restorative).
iii. Cention-N (Ivoclar Vivadent)

Using dye penetration technique along the occlusal and cervical wall, and observation under stereomicroscope with graduated eyepiece.

To compare fracture resistance in class II cavities restored with above said material groups.

Selection criteria

Inclusion criteria

Human extracted premolar teeth with no obvious defects.

Exclusion criteria

Teeth with

1. Caries
2. Restorations
3. Visible cracks
4. Surface defects
5. Developmental anomalies

METHODOLOGY

Eighty freshly extracted intact, non-carious, calculus free human maxillary premolars molars were collected and mounted in self-cure acrylic resin blocks, with the crown uppermost and long axis vertical. The level of the resin was limited to 1.0 mm below the cemento - enamel junction. (Fig 1)

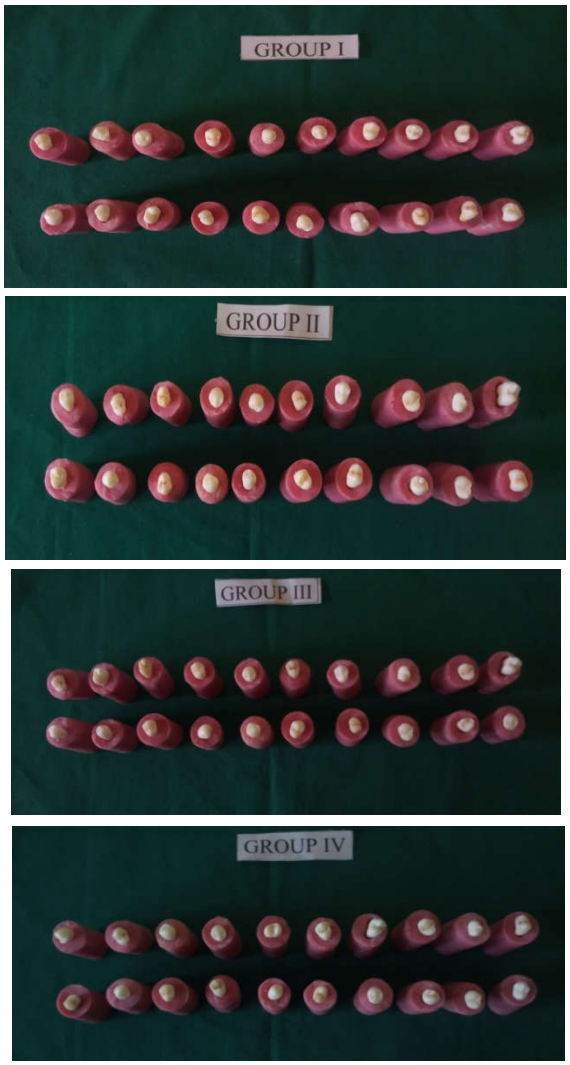


Figure 1 Tooth samples mounted in acrylic block

Figure 2 Cavity preparation

Class II mesial box shaped cavities was prepared using a high-speed hand piece under air-water spray. Bucco-lingual width of the cavity was 1/3 rd of buccolingual width of the tooth with 2 mm axial depth. (Fig 2)All the preparations were done with 245 tungsten carbide bur in a high speed hand piece with copious air water spray.

Table 1 Group wise distribution of the specimens

Groups	No. of teeth (n)	Restorations
Group 1	20	Unprepared tooth.
Group 2	20	Restoration with amalgam.
Group 3	20	Restoration with nanocomposite
Group 4	20	Restoration with Cention-N.

Figure 3 Load applied on the teeth in Universal Testing Machine

Fracture resistance was tested with a steel ball of 3mm diameter with a cross head speed of 1mm/min in Universal Testing Machine- Instron. Each tooth was subjected to vertical load on the occlusal surfaces till the restorations were fractured. The control group (intact teeth without any restoration) was also subjected to vertical load till the teeth fractured (Figure 3). The load was noted and recorded. The load at which the restorations fractured were noted and recorded and was statistically analysed.

RESULTS

The results of this study showed that Cention-N material has the highest fracture resistance when compared to the other restorative materials. The results indicate that teeth restored with amalgam exhibited inferior numerical values of fracture resistance when compared to other groups.

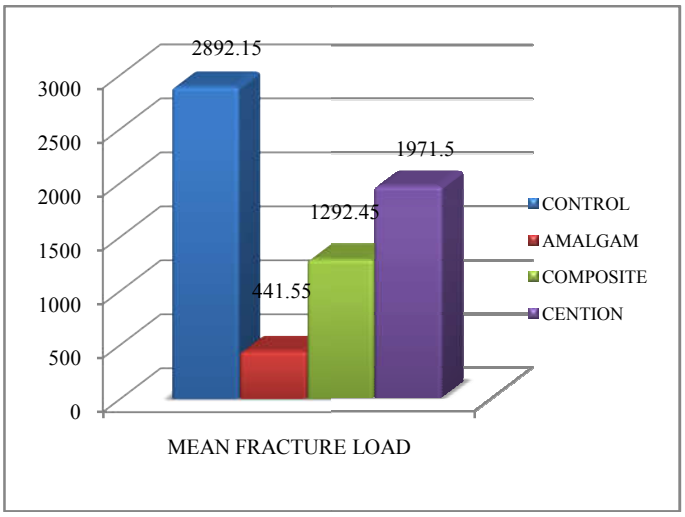
Data was analyzed using one-way analysis of variance (ANOVA) test to access the difference between numerical groups. All statistical analyses were performed using SPSS 20.0 for Windows (SPSS Inc IL, USA) software. The mean fracture load for all groups revealed that there was a highly significant difference between all groups at P **0.000 (H.S).** Additionally, there were highly significant differences in fracture resistance between the prepared, and those restored with Amalgam, Z350 composite or Cention-N restorative material.

Table 2 Shows Mean values of the compression force required for cuspal fracture (N) and standard deviations

Fracture Load	Mean	Standard deviation	F	Significance
Control	2892.1500	36.05153	1184.691	**0.000 (H.S)**
Amalgam	441.5500	114.87544		
Composite	1292.4500	190.73831		
Cention	1971.5000	148.08515		

Table 3 Shows pairwise comparison among groups

		Mean difference	Standard error	Significance	95% Confidence Interval	
					Lower bound	Upper bound
Control	Amalgam	2450.6000.0	42.66333	0.000 (H.S)	2338.5321	2562.6679
	Composite	1599.70000	42.66333	0.000 (H.S)	1487.6321	1711.7679
	Cention	920.65000	42.66333	0.000 (H.S)	808.5821	1032.7179
Amalgam	Composite	-850.90000	42.66333	0.000 (H.S)	-962.9679	-738.8321
	Cention	-1529.95000	42.66333	0.000 (H.S)	-1642.0179	-1417.8821
Composite	Cention	-679.05000	42.66333	0.000 (H.S)	-791.1179	-566.9821



Bar Graph 1 Shows Mean values of compression force required for cuspal fracture (N)

DISCUSSION

The present invitro study was conducted to evaluate and compare fracture resistance of Amalgam, Cention-N and nanocomposite Filtek Z-350 when used as class II restorative material. A fracture is a complete or incomplete break in a material resulting from the application of excessive force. [3] Masticatory forces on restored or unrestored teeth have a tendency to deflect the cusps under stress. [21] A restored tooth tends to transfer stress differently than an intact tooth. Any force on the restoration produces compression, tension or shear along the tooth/ restoration interface. Most of the restorations are designed to distribute stresses onto sound dentin, rather than to enamel to resolve the stresses in a manner similar to a normal tooth.[22]

Silver amalgam was widely advocated for posterior teeth before the advent of composite resins. The discoloration exhibited by this material was shown to be a major disadvantage however, its inability to bond to dental hard tissues which necessitates the use of macro mechanical retentive features further weakens the remaining tooth structure.[22]Since the introduction of composite resin restorative materials in the 1960, these widely used materials have been the subject of numerous studies to improve their properties.[3]The recent advances in resin adhesives and

restorative materials as well as an increased demand for aesthetics have prompted an increase in the use of resin based composites in the posterior teeth. [23] The advent of composite resins brought about several advantages such as tooth reinforcement and improved bonding. [24]

Filtek Z350 Universal Restorative is a visible light-activated composite designed for use in anterior and posterior restorations. It is based on nanofiller technology with nanofiller *size* range less than 100 nm (0.1um) which allows increased filler volume and increased fracture resistance.[19]Cention-N a subgroup of resin composite which is introduced recently has been recommended as a posterior restorative material in stress bearing areas like class II restorations. It is available in powder and liquid form and can be used as bulk fill restorative material. The liquid comprises of dimethacrylate and initiators and the powder contains various alkaline fillers like fluoride, hydroxyl and calcium. [25]

Urethane dimethacrylate (UDMA) is the main component of the monomer matrix. It exhibits moderate viscosity and yields strong mechanical properties. The initiator system enables good chemical self-curing as well as light curing property thus enabling dual cure property. [25]Chowdhary *et al*. in their study compared the fracture resistance of amalgam, Filtek Z350 nanofill composite resin and Cention-N restorative material in a class II cavity. According to the results Cention-N and Z350 restorative material had high fracture resistance than amalgam.[19]

Ankita Sharma *et al* in their study compared the fracture resistance of endodontically treated premolars restored by alkasite cement (Cention N), composite resin, and glass ionomer cement (GIC).According to the results of their study composite restoration had highest fracture resistance followed by Cention-N.[26] However, there are no consensus and limited data to evaluate the fracture resistance of Cention-N when used as restorative material in class II cavities. Thus is the need for the study.

In the present study, there is statistically high significant difference in the fracture resistance values between specimens restored with amalgam, Cention-N, Filtek Z-350 and hence the null hypothesis is rejected.

In the present study the specimens restored with Cention-N exhibited the highest fracture resistance after intact unprepared teeth which are followed by the specimens restored with nanocomposite Fliltek Z 350 and amalgam. Ragauska A *et al* and Panahandeh N *et al* in their study evaluated the fracture resistance of composite fillings in premolars, the results of their study was similar to our study. [22, 25]
Indrajit Biswas *et al*. in their study evaluated the fracture resistance of mandibular first molars with class I occlusal preparations restored with light cured composite Dyract XP, silver amalgam and Cention N in comparison with intact and unrestored teeth. The results exhibited the teeth restored with Cention N showed highest fracture resistance value compared to Dyract Xp light cure Composite and Silver Amalgam restoration.[31s]

The highest fracture resistance of the specimens restored with alkasite cement (Cention-N) as observed in the present study might be attributed to the,

1. The presence of barium aluminum silicate glass and calcium aluminum silicate glass fillers that render strength to the material.
2. The degree of polymerization over the complete depth of restoration due to the presence of stable self cure initiator.
3. The high flexural strength of Cention N (>110 MPa) is due to the presence of highly cross linked polymer structure which makes it more suitable and a long-lasting material in the stress-bearing posterior region. [25]

Cention N is also a tooth-colored material and has a transparency of 11% which is higher than GIC (4%).[30] All the properties of Cention N along with the ease of manipulation, handling characteristics and fracture resistance, almost like the composite resin, give a promising scope as a posterior restorative material.

However, the in vitro condition of the study limits the clinical relevance due to the variability in the study design and restorative protocol.

The specimens being not subjected to thermocycling process may be another limitation of our study which would have mimic the variations in the clinical situation.

CONCLUSION

Within the limitation of the study, under compression loading, Cention-N and Filtek Z350 restorative materials has higher fracture resistance in Class II cavity preparation and restoration but dental amalgam showed comparatively inferior results?

Cention-N a subgroup of composite material can be considered as a promising option for the restoration of posterior class II cavities.

References

1. Joynt RB, Davis EL. Fracture resistance of posterior teeth restored with glass-ionomer-composite resin system, J Prosthet Dent. 1989; 62:28-31.
2. Stephan EW, Staninec M, Lacy AM. Effect of bonded amalgam on the fracture resistance of teeth, J Prosthet Dent. 1992; 68:257-260.
3. Hamouda IM. Fracture resistance of posterior teeth restored with modern restorative materials, J of Biomed Res. 2011; 25(6):418-424.
4. Van Nieuwenhuysen JP, D'Hoore W, Carvalho J, Qvist V. Long-term evaluation of extensive restorations in permanent teeth, *Journal of Dentistry*. 2003; 31(6):395-405. 9.
5. Wassell RW, Smart ER. Cores for teeth with vital pulps, British Dental Journal. 2002; 192:499-502, 505-509.
6. Petronijević B. Fracture resistance of restored maxillary premolars Contemporary Materials 2012; 3(2):219-225.
7. Uday Kamath, Dr. Afna SalamFracture resistance of maxillary premolars with mod cavities restored with Zirconomer: An in vitro comparative study, *International Journal of Applied Dental Sciences* 2016; 2(2): 77-80
8. Herrero AA, Yaman P, Dennison JB. Polymerization shrinkage and depth of cure of packable composites. Quintessence International. 2005 Jan 1;36(1).

9. Hilton TJ, Schwartz RS, Ferracane JL. Microleakage of four Class II resin composite insertion techniques at intraoral temperature. Quintessence International. 1997 Feb 1;28(2).·
10. Keith H. S. Chan,Yanjie Mai,[2] Harry Kim, Keith C. T. Tong, Desmond Ng, and Jimmy C. M. Hsiao Review: Resin Composite Filling, 2010 Feb; 3(2): 1228–1243.
11. Kumar A, Tekri S. A comparative evaluation of flowable composite and a core.
12. Berry FA, Tjan AH. Microleakage of amalgam restorations lined with dentin adhesives. *American Journal of Dentistry*. 1994;7:333-.
13. Castelnuovo J, Tjan AH, Liu P. Microleakage of multi-step and simplified-step bonding systems. *American journal of dentistry*. 1996 Dec;9(6):245-8.
14. Raju KR, Vishwanath BT, Shivanna V. Comparative Microleakage Evaluation Of A Flowable Composite Versus An Injectable Glass Ionomer Cement In Class II Slot Preparations-An In Vitro Study. *Journal of Conservative Dentistry*. 2003 Apr 1;6(2):65.
15. Simi B, Suprabha BS. Evaluation of microleakage in posterior nanocomposite restorations with adhesive liners. *Journal of conservative dentistry*: JCD. 2011 Apr;14(2):178
16. Cetin AR, Unlu N. One-year clinical evaluation of direct nanofilled and indirect composite restorations in posterior teeth. *Dental Materials Journal.* 2009;28(5):620-6.
17. Dresch W, Volpato S, Gomes JC, Ribeiro NR, Reis A, Loguercio AD. Clinical evaluation of a nanofilled composite in posterior teeth: 12-month results. Operative Dentistry. 2006 Jul;31(4):409-17.
18. Karaman E, Ozgunaltay G. Polymerization shrinkage of different types of composite resins and microleakage with and without liner in class II cavities. Operative dentistry. 2014 Apr;39(3):325-31.
19. Chowdhury D, Guha C, Desai P. Comparative evaluation of fracture resistance of dental amalgam, Z350 composite resin and cention-N restoration in class II cavity. J Dent Med Sci. 2018;17(4):52-6. Ingraham R. The application of sound biomechanical principles in design of inlay, amalgam and gold foil restorations. J Am Dent. 1950;40:402–413.
20. Montagner, *et al* . Survival, Reasons for Failure and Clinical Characteristics of Anterior/Posterior Composites: 8-Year Findings. *Brazilian Dental Journal*, *29*(6), 547-554
21. Jagadish S, Yogesh BG. Fracture resistance with class II silver amalgam, posterior composite and glass–ionomer cement restorations Opera Dent 1990; 15:42-47.
22. Solomon P, Krishna G, Parameswaran A, Pradeep G, Kandaswamy D. Fracture resistance of premolar teeth with class II preparations restored with light cured composite with beta quartz inserts, light cured' composite and silver amalgam in comparison with intact unrestored teeth - An in vitro study. J Conserv Dent 2007;10:122-8
23. Bohaty BS, Ye Q, Misra A, Sene F, Spencer P. Posterior composite restoration update: focus on factors influencing form and function. Clinical, cosmetic and investigational dentistry. 2013;5:33.
24. Khatib MM, Sarvesha B, Mahajan V. Evaluation of compressive load required to fracture premolar restored with different restorative materials-an in vitro. Int J Med and Dent Sci 2016;5(2):1236-1240.
25. Ivoclar Vivadent AG R & D Scientific Service. Cention N Scientific Documentation [Internet]. Schaan Liechtenstein: Joanna-C. Todd: 2016 Oct. Available from: http://www.ivoclarvivadent.in/en-in/p/all/cention-n.
26. Sharma A, Das S, Thomas MS, Ginjupalli K. Evaluation of fracture resistance of endodontically treated premolars restored by alkasite cement compared to various core build-up materials. *Saudi Endodontic Journal*. 2019 Sep 1;9(3):205.
27. Ragauska A, Apse P, Kasjanovs V, Berzina-Cimdina L. Influence of ceramic inlays and composite fillings on fracture resistance of premolars *in vitro*. Stomatologija 2008;10:121-6
28. Panahandeh N, Johar N. Effect of different cusp coverage patterns on fracture resistance of maxillary premolar teeth in MOD composite restorations. J Islam Dent Assoc Iran 2014;25:228-32.
29. Biswas I, Shil R, Mazumdar P, Desai P. Comparative evaluation of fracture resistance of dental amalgam, dyract-xp composite resin and cention-n restoration in class i cavity. *International journal of innovative research in dental sciences*. 2018 Apr 30;3(2):9.
30. Mazumdar P, Das A, Guha C. Comparative evaluation of hardness of different restorative materials (restorative gic, cention n, nanohybrid composite resin and silver amalgam) – An *in vitro* study. Int J Adv Res 2018;6:2320-5407

How to cite this article:

Jayashankara.C.M *et al* (2020) ' An In Vitro Comparitive Evaluation of Fracture Resistance of Dental Amalgam, Nano Composite Filtek-Z350 and Cention-N in Class II Cavities', *International Journal of Current Advanced Research,* 09(01), pp. 20896-20900. DOI: http://dx.doi.org/10.24327/ijcar.2020. 20900.4093

****