Wear of nanohybrid and microfilled composite resin in occlusal restoration of first permanent molar tooth

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Abstract

This study compared the wear of nanohybrid and microfilled composite restorative material in occlusal restoration of first permanent molar tooth. In total, 60 first permanent molar teeth having carious lesion without any clinical and radiological indication of pulpal involvement, removal of carious dental hard tissues was performed using round carbide bur and a class I cavity was prepared, rinsed with water and then dried with gentle air. These cavities were filled with either nanohybrid or microfilled composite resin by simple random sampling by lottery method. All teeth were subjected to clinical qualitative and quantitative wear test at baseline, 3, 6 and 9 months observation period. The quantitative wear was analyzed by profile meter. The results showed that the wear depth of microfilled was significant than the nanofilled composite resin. It can be concluded that quantitative wear of microfilled had greater wear than that of nanohybrid composite restorations.

Introduction

The progressive loss of restorative materials from contacting surfaces relative in motion as a consequence of the interaction between surfaces moving in contact, causing gradual removal of material which is usually termed as wear.[1] In the oral cavity, many components are responsible for the wear of enamel and dentin as well as restorative material by chewing on food items (attrition), tooth brushing with toothpaste (abrasion), fatigue and corrosive effects or by acid attacks due to consumption of acidic fruits and beverages (erosion).[2] Wear of restorative material also results in crack formation, increase surface roughness and fracture.[2]

The wear resistance is an important property to be evaluated in materials indicated for posterior tooth. The restoration should not only be satisfactory at the time of placement but it should also remain this way over time. In many cases, the abrasive agent abrades the resin matrix and expose fillers, which may then increase the surface roughness of composite resin restoration. The increase of surface roughness causes accumulation of bacterial biofilm, pigments and food debris, which reduces the longevity of restoration.[3] Therefore, wear of composite restorative material is known to depend on filler particle-related features, particularly on the content and size of the filler reinforcement,[4] and resin formulation.[5] Finer filler particles decreased interparticle spacing and thereby reduced wear.[6-7] Regarding filler content, some *in vitro* studies have revealed that increased the filler content may enhance the wear resistance of dental composite.[8-10] On the other hand, increasing the resin content generally lowers the wear resistance.[11]

First-generation macrofilled composite resin has inferior wear characteristics. The surface becomes rougher as the resin matrix being less hard and wears at a faster rate. After some time, the particles were lost, probably due to either insufficient support of the filler particles from the resin matrix or due to differences in thermal coefficient between fillers and resin.[12-13]

The introduction of microfilled composite resin improved the occlusal wear resistance.[14] Because of less filler content, some of their physical properties are inferior. They have high polishability, low fracture toughness and increased marginal breakdown. However, relatively low tensile strength and modulus of elasticity than those of microfilled material that may lead to the development of fatigue cracks in the resin matrix.[15]

Recently, several new generation restorative materials such as mini-filled, hybrid and nanohybrid composite resin have been introduced based on the philosophy that a high content of

small filler particles improves the wear resistance,[16] and their use in Class I, II, III restorations has been expected in the dental clinic.[17] Furthermore, it is highly polishable and has high wear resistance too.[16] However, previous studies did not analyze the clinical quantitative wear of nanohybrid composite. Therefore, this study was performed to compare the clinical qualitative and quantitative wear of nanohybrid and microfilled composite material in occlusal restoration of first permanent molar tooth.

Materials and Methods

The study population was comprised of participants having a shallow carious lesion in vital permanent teeth irrespective of sex. The inclusion criteria were as follows: The first permanent molar tooth having shallow carious lesion (Figure 1A) ranged between 1.5 to 2.5 mm in depth and the age of the participant fixed to 18 to 40 years. The total 60 teeth were divided into two groups by randomized sampling technique (lottery method): Group I: 30 teeth for nanohybrid composite restorative material and Group II: 30 teeth for microfilled composite restorative material.

Treatment procedure

Class I cavity was prepared following removal of carious dentin by a round diamond bur attached with a low-speed turbine handpiece for removal of carious tissue. The depth of the lesion was dictated by the size of the lesion (Figure 1B). The cavity was restored with one of the material according to manufacturer instructions as follows: All the prepared enamel surface and cavosurface margins of the prepared cavity were acid-etched with 37.5% phosphoric acid for 15 sec, washed with normal saline and dried by oil-free airflow. The primer was applied and wait for 10 sec followed by a bonding agent was applied to the internal surface of cavity utilizing a fine sable brush. According to the manufacturer's instructions, the bonding agent was left in the cavity for 30 sec, then air-dried and light-polymerized for 20 sec with the tungsten halogen light. The resin composite (ivoclar vivadent's Heliomolar) was placed in the cavity layer by layer and polymerized (Figure 1C). The resin composite was polymerized in maximum layers of 2 mm for 40 sec. Finishing of the restoration was carried out by adapting occlusion and articulation using fine-grit diamonds. Finally, the composite restoration was polished using Super snaps polishing kit.

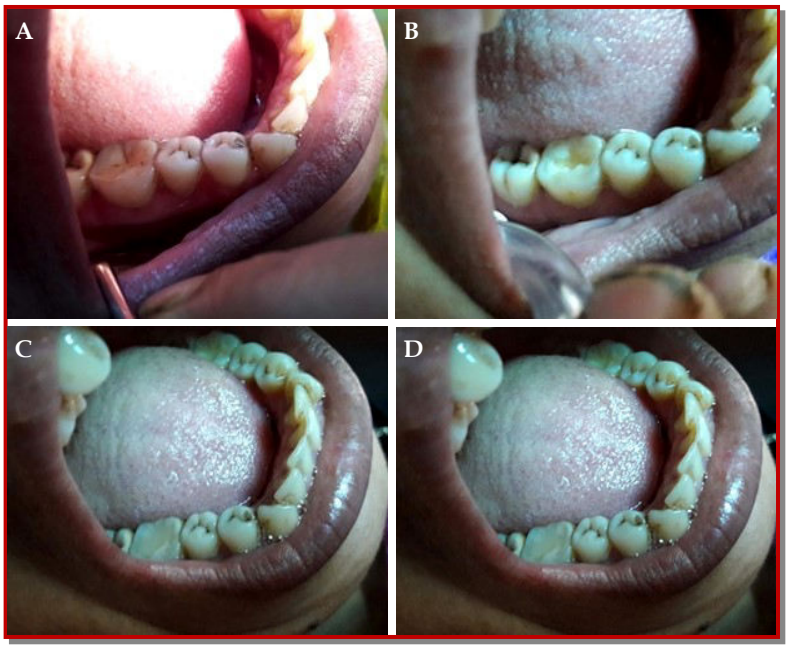

Figure 1: Representative photographs of nanohybrid composite resin. Initial (A); Cavity preparation (B); Application of nanfilled (C); One year follow-up (D)

Evaluation

An impression was taken by alginate impression material and a model was made from the impression by hard plaster at baseline and the patient was advised to maintain good oral hygiene. Each patient was recalled at 3, 6 and 12 months (Figure 1D). The visual examination of the restoration was done by proper exposure of light using mirror, caries probe, magnification of loupe and the condition was noted.[18]

Anatomical form of the restoration was assessed by visual inspection as follows: Restoration's contour is continuous with existing anatomical form and margin (alpha), restoration is slightly over-contoured or under contoured (Bravo), marginal overhang or tooth structure (Charlei). The surface staining was performed as: A: stain present, B: stain absent. An impression followed by model preparation was done in each observation period. Anatomical form was assessed by visual inspection. Restoration's contour is continuous with existing anatomical form and margin. The profilometer was used for quantitative analysis of wear in each observation period. After completion of the restoration, the data were collected at baseline, 3, 6 and 9 months interval by a technician who did not know the true nature of the research. Thus, the evaluation was a blinded method.

Statistical analysis

The collected data was analyzed by computer based statistical software, Statistical Package of Social Science (SPSS) version 19 (SPSS Inc. USA). The result was expressed as mean ± SD (Standard deviation). Student's t-test was applied to assess the difference between wear of nanohybrid and microfilled composite restoration and 95% confident interval (p value <0.05) was followed for the testing level of significance.

Table I

Results of qualitative wear

	Score	Nanohybrid (n=30)				Microfilled (n=30)			
		Baseline	3 month	6 month	9 month	Baseline	3 month	6 month	9 month
Anatomical form	Alpha	30	30	29	28	30	28	28	27
	Bravo	0	0	1	2	0	2	2	3
	Charlie	0	0	0	0	0	0	0	0
Surface staining	Alpha	30	30	30	30	30	30	30	29
	Bravo	0	0	0	0	0	0	0	0
	Charlie	0	0	0	0	0	0	0	1

Results

Table I shows the result of anatomical form that 29 (96.7%) nanohybrid and 27 (90%) microfilled revealed alpha rating at the end of 6 and 9 months, which was not statistically significant. Furthermore, the results of surface staining of 30 nanohybrid and 28 microfilled composite resin restoration demonstrated alpha rating (no stain) at the end of 6 and 9 months. The differences between the two groups were not statistically significant. It was found that 29 nanohybrid and 27 microfilled revealed alpha rating at the end of 9 months, which was not statistically significant. Furthermore, the results of surface staining of 30 nanohybrid and 28 microfilled composite resin restoration demonstrated alpha rating (no stain) at the end of 9 months and the differences between two groups were not statistically significant.

Table II shows the quantitative analysis of wear. It was found that vertical loss of nanohybrid composite resin versus enamel was 42.7 ± 1.2 µm at 3 months followed by 53.8 ± 1.0 µm at 6 months and 66.5 ± 0.9 µm. On the other hand, vertical loss of microfilled composite was 44.8 ± 1.6, 61.4 ± 1.5, 82.1 ± 1.8 µm at 3, 6 and 9 months, respectively. Furthermore, there were significant differences between nanohybrid and microfilled with respect to vertical loss (wear).

Table II

Results of quantitative wear (µm)

Vertical volume loss	Nanohybrid (n=30)	Microfilled (n=30)	p value by unpaired t-test
3 months	42.7 ± 1.2	44.8 ± 1.6	<0.001[a]
6 months	53.8 ± 1.0	61.4 ± 1.5	<0.001[a]
9 months	66.5 ± 0.9	82.1 ± 1.8	<0.001[a]
p value by paired t-test			
3 vs 6 months	<0.001[a]	<0.001[a]	
3 vs 9 months	<0.001[a]	<0.001[a]	
6 vs 9 months	<0.001[a]	<0.001[a]	

Data are mean ± SD; [a]statistically significant

Discussion

The present study shows that the overall success rate in maintaining the anatomical form and surface quality of nanohybrid and microfilled was more than 95% which was almost similar to a study of Palaniappan et al. (2012)[19] However, it can consider that the effect of wear on the restoration anatomical form and surface staining was barely visible to the clinical assessment with explorer and naked eye. Therefore, in the present study, the clinical wear was observed by measuring the vertical loss of the restorative material versus enamel from the model analysis. The differences between vertical heights of restorative material versus enamel were considered as wear of restorative material of the present study, which is originally based on a previous study.[20-21]

The results of the vertical loss of restorative materials versus enamel used in the present study revealed that there was statistical significant difference between the nanohybrid and microfilled composite resin restoration. Nanohybrid composite resin showed less wear than the microfilled composite resin and the differences was statistically significant ($p<0.05$). Several *in vivo* and *in vitro* studies have been performed to compare the wear of nanohybrid composite resin with that of microfilled composite resin. The results of the present study had similarities and dissimilarities with those of previous studies. Palaniappan et al. (2012)[19] reported that there are no differences between the clinical-wear performances of nanofilled, microfilled, and conventional hybrids composite resin placed in class I and II cavities. The difference between the present studies with that of the previous study may be due to cavity type which can affect restorations' wear magnitude. One previous study has indicated that the greater the dimensions of restorations, the larger the amount of surface area exposed to the masticator stresses and the faster the restoration will undergo loss of material. Furthermore, the mean occlusal wear of ceramic crowns for molars was 0.3 ± 0.1 µm after one year. This wear volume is lesser than of the restorations in the present study. The difference in

hardness between veneering materials and the composite restoratives could explain the differences in the wear. Therefore, it can be considered that wear of restorative materials depends on several factors such as hardness of the restorative material and cavity design and evaluation time. Handa et al. (2017)[22] reported that the Knoop hardness of nanohybrid restorative material is greater than the microfilled composite resin. This may be the possible causes of the differences between the wear of nanohybrid and microfilled composite restorative material. The results of the present study showed that wear of nanohybrid composite resin was statistically lesser than that of microfilled composite resin.

In this study, nanohybrid composite resin demonstrated significantly better results than that of microfilled composite resin with respect to wear. There are several reasons of better results achieved by nanohybrid composite resin than that of mirofilled composite resin restoration. Nanohybrid composite resin minimizes polymerization shrinkage and increases the wear resistance due to the addition of fillers such as barium aluminum silicate filler, ytterbium trifluoride and mixed oxides.[23] Modern dentistry continues to evolve through innovations in restorative material and conservative preparation technique. The use of nanohybrid composite resin restoration in the posterior teeth of the present study was limited to class I cavities. It can be said that polymerization stresses could be minimum in these restorations. This might be the possible reasons of better clinical results with microfilled composite resin of the present study.

Conclusion

Nanohybrid composite resin is superior to microfilled composite resin in respect to quantitative analysis of wear in class I restorations of permanent molar teeth.

Ethical Issue

The research protocol was approved by the committee and permission for the study was taken from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University (BSMMU/2017/1998).

Conflict of Interest

The authors declare no conflict of interest.

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References

1. Mair LH, Stolarski TA, Vowles RW, Lloyd CH. Wear: Mechanisms, manifestations and measurement. Report of a workshop. J Dent. 1996; 24: 141-48.
2. Smith BG, Bartlett DW, Robb ND. The prevalence, etiology and management of tooth wear in the United Kingdom. J Prosthet Dent. 1997; 78: 367-72.
3. Bayne SC. Dental composites/glass ionomers: Clinical reports. Adv Dent Res. 1992; 6: 65-77.
4. Turssi CP, De Moraes Purquerio B, Serra MC. Wear of dental resin composites: Insights into underlying processes and assessment methods – A review. J Biomed Mater Res B. 2003; 65: 280–85.
5. Lambrechts P, Braem M, Vuylsteke-Wauters M, Vanherle G. Quantitative *in vivo* wear of human enamel. J Dent Res. 1989; 68: 1752-54.
6. Söderholm KJ, Richards ND. Wear resistance of composites: A solved problem? Gen Dent. 1998; 46: 256-65.
7. Turssi CP, Ferracane JL, Vogel K. Filler feature and their effects on wear and degree of conversion of particulate dental resin composites. Biomaterials 2005; 26: 4932-37.
8. Condon JR, Ferracane JL. *In vitro* wear of composite with varied cure, filler level, and filler treatment. J Dent Res. 1997; 76: 1405-11.
9. Torii Y, Itou K, Itota T, Hama K, Konishi N, Nagamine M, Inoue K. Influence of filler content and gap dimension on wear resistance of resin composite luting cements around a CAD/CAM ceramic inlay restoration. Dent Mater J. 1999; 18: 453-61.
10. Lim BS, Ferracane JL, Condon JR, Adey JD. Effect of filler fraction and filler surface treatment on wear of microfilled composites. Dent Mater. 2002; 18: 1-11.
11. Musanje L, Ferracane JL, Ferracane LL. Effects of resin formulation and nanofiller surface treatment on *in vitro* wear of experimental hybrid resin composite. J Biomed Mater Res B. 2006; 77: 120-25.
12. Power JM. Legal guidelines for standards of care. N Y State Dent J. 1980; 46: 584-86.
13. Leinfelder KF, Roberson TM. Clinical evaluation of posterior composite resin. Gen Dent. 1983; 31: 276–80.
14. Jörgensen KD, Hørsted P, Janum O, Krogh J, Schultz J. Abrasion of class I restorative resins. Scand J Dent Res. 1979; 87: 140-45.
15. Braem M, Lambrechts P, Vanherle G, Davidson CL. Stiffness increase during the setting of dental

composite resins. J Dent Res. 1987; 66: 1713–16.

16. Hörsted P, Borup J. *In vivo* abrasion of profile and adaptic composite resins. Scand J Dent Res. 1984; 92: 249–52.

17. Ali H, Abdin MJ, Akhter NJ, Hossain M. Nano-hybrid and microfilled composite resin in class II restoration of permanent molar teeth. Bangabandhu Sheikh Mujib Med Univ J. 2019; 12: 94-98.

18. Milicich G. Clinical applications of new advances in occlusal caries diagnosis. N Z Dent J. 2000; 96: 23-26.

19. Palaniappan S, Elsen L, Lijnen I, Peumans M, Van Meerbeek B, Lambrechts P. Nanohibrid and microfilled hybrid versus conventional hybrid composite restorations: 5-year clinical wear. Clin Oral Investig. 2012; 16: 181-90.

20. Hudson JD, Goldstein GR, Georgescu M. Enamel wear caused by three different restorative materials. J Prosthet Dent. 1995; 74: 647–54.

21. Ramp MH, Ramp LC, Suzuki S. Vertical height loss: An investigation of four restorative materials opposing enamel. J Prosthodont. 1999; 8: 252-57.

22. Handa K, Murakami N, Yamazaki T, Takahashi H, Wakabayashi N. The ball-on-disk cyclic wear of CAD/CAM machinable dental composite and ceramic materials. J Oral Sci. 2017; 59: 589-96.

23. Caracostea A, Morar N, Florea A, Soanca A, Badea ME. Two-body wear simulation influence on some direct and indirect dental resin biocomposites: A qualitative analysis. Acta Bioeng Biomech. 2016; 18: 61-72.