



Comparison of the Efficacy and Safety of Composite Dental Filling Materials (Nano-Hybrid and Microhybrid): A Double Randomized Clinical Study in Ulan Bator Hospital, Mongolia

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A B S T R A C T

Introduction: Composite dental filling materials are widely used for dental restoration because of their aesthetic properties and durability. However, the choice of appropriate filling material is still a matter of debate. The aim of this study was to compare the effectiveness and safety of nano-hybrid and microhybrid composite dental filling materials in a double-blind randomized clinical study at Ulan Bator Hospital, Mongolia. **Methods:** A total of 60 patients with posterior dental caries were recruited and randomly assigned to receive nano-hybrid or microhybrid composite dental fillings. Patients were clinically evaluated at 6 months, 12 months, and 24 months after patching to assess patch retention, color change, sensitivity, and other complaints. **Results:** The patch retention rates in the two groups were not significantly different ($p>0.05$). The color change in the nano-hybrid group was less than that in the microhybrid group ($p<0.05$). Tooth sensitivity in the two groups was not significantly different ($p>0.05$). No other complaints were reported by the patient. **Conclusion:** Nano-hybrid and microhybrid composite dental filling materials have equivalent effectiveness and safety within a period of 24 months. However, nano-hybrid showed less color change compared to microhybrid.

1. Introduction

Dental caries, or cavities, are one of the most common dental problems people face. Caries occur as a result of bacteria breaking down tooth enamel and dentin, producing holes that can cause pain, infection, and even tooth loss. Dental fillings are a common solution for caries, where filling material is used to fill the cavity and restore the function and aesthetics of the tooth. Composite dental filling materials consist of two main components: matrix resin and inorganic filler particles. Two commonly used types of composite filling materials are nano-hybrid and microhybrid. Nano-hybrid dental fillings are made from very small filler particles, about 100 nanometers. These tiny filler

particles make nano-hybrid dental fillings stronger and longer lasting than traditional dental fillings. Nano-hybrid dental fillings are also more resistant to discoloration and easier to polish. Microhybrid dental fillings are made from filler particles that are larger than nano-hybrid dental fillings, around 1-10 micrometers. Microhybrid dental fillings are cheaper than nano-hybrid dental fillings but are not as strong or long-lasting. Microhybrid dental fillings are also more susceptible to discoloration and are more difficult to polish.¹⁻³

Dental fillings are one of the most commonly performed dental procedures. It is estimated that approximately 80% of adults have at least one dental

filling. The incidence of dental fillings varies depending on age, race, and lifestyle. Although nano-hybrid and microhybrid dental fillings have been proven to be effective and safe, there are still some problems associated with dental fillings. One problem is that dental fillings can come loose over time. Another problem is that tooth fillings can change color and no longer match the color of natural teeth. Dental fillings can come loose over time, especially if caries are still active or the patient has a habit of grinding their teeth. Dental fillings can change color over time, especially if the patient frequently consumes foods and drinks that contain dyes. Dental fillings can cause teeth to become sensitive to heat and cold. Nano-hybrid dental fillings are generally more expensive than microhybrids. However, there is controversy regarding the effectiveness and safety of nano-hybrid and microhybrid composite filling materials. Some studies show that nano-hybrids have better effectiveness and safety compared to microhybrids, while other studies show conflicting results.⁴⁻⁶ This study aims to compare the effectiveness and safety of nano-hybrid and microhybrid composite dental filling materials in a double-blind randomized clinical study at Ulan Bator, Mongolia.

2. Methods

This study involved 60 patients with posterior dental caries, which means damage to the chewing surface of the back teeth. Patients were recruited from Ulan Bator Hospital, Mongolia, and met the following criteria, aged between 18 and 50 years, had at least one carious posterior tooth requiring a filling, and were free from systemic diseases that could affect dental health, such as diabetes or osteoporosis, were not pregnant or breastfeeding and were willing to participate in the study and follow all necessary procedures. Careful patient selection is important to ensure that the study results can be generalized to the broader patient population. This study used a double-blind, randomized clinical study design with a blind-observer design. This design was chosen to minimize bias and increase the validity of the results. Patients were randomly divided into two groups: nano-hybrid group and microhybrid group. This ensured that the

two groups had balanced characteristics so that differences in study results could be attributed to the type of filling material used and not to other factors. Patients receive one of two types of patch materials: nano-hybrid or microhybrid. This allowed researchers to compare the effectiveness and safety of the two patch materials directly. Neither the patient nor the dental operator who performs the filling knows the type of filling material used. This helps to prevent bias in the evaluation of research results.

Patients were clinically evaluated at 6 months, 12 months, and 24 months after patching to assess: Patch retention: The percentage of the patch surface that is intact. This is an important indicator of the durability and effectiveness of the patch. Discoloration: The degree of discoloration of a filling compared to the color of the natural tooth. Dental fillings can change color over time, and this can affect the aesthetics of the tooth. Tooth sensitivity: The degree of tooth sensitivity to hot, cold, or sweet foods. Tooth sensitivity can be an undesirable side effect of dental fillings. Other complaints: Patients are asked about other complaints they may have after the filling, such as pain, discomfort, or difficulty eating. Filling retention: Visually assessed by a trained dentist. Discoloration: Graded using the Vita Shade Guide scale, which is a standard system for measuring tooth color. Tooth sensitivity: Assessed using a questionnaire that asks patients about their level of sensitivity to various stimuli. The collected data was analyzed using appropriate statistical tests, such as the independent t-test and Chi-square test. This statistical test is used to determine whether there is a statistically significant difference between the nano-hybrid and microhybrid groups in terms of filling retention, discoloration, tooth sensitivity, and other complaints. A p-value < 0.05 was considered statistically significant. This means that there is less than a 5% chance that the observed differences between the two groups occurred by chance.

3. Results and Discussion

Table 1 shows that this study involved 60 patients with posterior dental caries who were recruited from Ulan Bator Hospital, Mongolia. Respondents consisted

of 30 men (50%) and 30 women (50%). Respondents' ages varied between 18 and 50 years, with the 26-35 year age group (33%) being the most numerous. In terms of education, 25 respondents (42%) had a senior high school education level, 20 respondents (33%) had a bachelor's degree, 15 respondents (25%) had a junior high school education, and 5 respondents (8%) had an elementary school education. The majority of

respondents (83%) have jobs, with 20 respondents (33%) working as private employees, 15 respondents (25%) as government employees, 10 respondents (17%) are entrepreneurs, and 10 respondents (17%) are still students/college student. All respondents (100%) did not have systemic diseases that could affect their dental health and were not pregnant or breastfeeding.

Table 1. Characteristics of respondents.

Characteristics	Frequency	Percentage
Gender		
Male	30	50%
Female	30	50%
Age (years)		
18-25	15	25%
26-35	20	33%
36-45	15	25%
46-50	10	17%
Education		
Primary school	5	8%
Junior high school	10	17%
Senior high school	25	42%
Bachelor's degree	20	33%
Occupation		
Student/college students	10	17%
Private employee	20	33%
Civil servants	15	25%
Self-employed	10	17%
Systemic diseases		
No	60	100%
Pregnancy/breastfeeding status		
Not pregnant/breastfeeding	60	100%

This study compared the effectiveness and safety of two composite dental filling materials, nano-hybrid and microhybrid, in 60 patients with posterior dental caries at Ulan Bator Hospital, Mongolia. Patients were randomly assigned to receive nano-hybrid or microhybrid fillings and were evaluated clinically at 6 months, 12 months, and 24 months after patching. Patch retention in the two groups did not differ significantly ($p>0.05$) at all evaluation times (6 months, 12 months, and 24 months). This suggests that both patch materials were equally effective in maintaining patch integrity over 24 months. Color changes in the nano-hybrid group were less than those in the microhybrid group ($p<0.05$) at all evaluation times (6 months, 12 months, and 24 months). The

average color change value in the nano-hybrid group was lower than the microhybrid group at all evaluation times. This suggests that nano-hybrid fillings are more resistant to discoloration compared to microhybrid fillings, resulting in better aesthetics in the long term. Tooth sensitivity in the two groups did not differ significantly ($p>0.05$) at all evaluation times (6 months, 12 months, and 24 months). This shows that both filling materials do not significantly increase tooth sensitivity. Patients in both groups did not report significant complaints of tooth sensitivity. No other complaints were reported by patients in either group at all evaluation times. This indicates that both patch materials were well tolerated by patients and did not cause significant side effects.

Table 2. Comparison of the efficacy and safety of composite dental filling materials (nano-hybrid and microhybrid).

Parameter	Nano-hybrid group	Microhybrid group	p-value
Patch retention			
6 months	98%	96%	0.32
12 months	96%	94%	0.48
24 Months	94%	92%	0.61
Discoloration			
6 months	0.25	0.35	0.02
12 months	0.50	0.65	0.01
24 Months	0.75	1.00	0.00
Tooth sensitivity			
6 months	10%	15%	0.28
12 months	5%	10%	0.17
24 months	0%	5%	0.35
Other complaints	No	No	-

Composite dental fillings are one of the most common types of dental fillings used today. These fillings are made of two main components: a resin matrix and filler particles. The resin matrix is a plastic material that functions to hold the filler particles together and provide strength and durability to the filling. The resin matrices commonly used in composite dental fillings are bisphenol A-diglycidyl methacrylate (Bis-GMA) and triethylene glycol dimethacrylate (TEGDMA). Filler particles are inorganic materials that provide strength and stability to the filling. Filler particles can be a variety of materials, such as silica, zirconia, and alumina. Filler particle sizes can vary, and this can affect the physical and mechanical properties of the filling. Nano-hybrid and microhybrid are two types of composite dental fillings that differ based on the size of the filler particles: 1. Nano-hybrid: These fillings have very small filler particles, less than 100 nanometers in diameter. This small particle size results in better physical and mechanical properties, such as strength, wear resistance, and adhesion to the tooth. 2. Microhybrid: These fillings have larger filler particles, between 100 nanometers and 1 micrometer in diameter. This larger particle size may cause microhybrids to be more susceptible to discoloration over time. The main difference between nano-hybrid and microhybrid lies in the size of the filler particles. Patch retention is the percentage of the patch surface that is still intact. Nano-hybrid and microhybrid had similar patch retention at 24 months. Nano-hybrids have less color change compared to microhybrids. This makes the nano-hybrid more aesthetically durable.

Nano-hybrid and microhybrid do not significantly increase tooth sensitivity.⁸⁻¹⁰

Nano-hybrids have smaller filler particles, with a diameter of less than 100 nanometers, while microhybrids have larger filler particles, with a diameter of between 100 nanometers and 1 micrometer. Smaller nano-hybrid particles are distributed more evenly in the resin matrix, resulting in a more compact and strong structure. This increases the compression strength of the patch, making it more resistant to compression and fracture. Nano-hybrids also have better wear resistance, making them more resistant to wear and abrasion from clashing teeth. The wider surface area of nano-hybrid particles increases the contact area with dentin and tooth enamel. This increases the adhesion strength of the filling to the tooth, making it more durable and reducing the risk of microleakage. Small nano-hybrid particles are less visible than larger microhybrid particles. This results in a smoother, more natural appearance of the filling, especially on the more visible front teeth. Several studies have shown that nano-hybrids have better biocompatibility with dental tissue compared to microhybrids. This means the nano-hybrid is less likely to cause irritation or inflammation of the dental pulp.¹¹⁻¹³

Microhybrids are a type of commonly used composite dental filling. These patches are made of larger filler particles compared to nano-hybrids, with diameters between 100 nanometers and 1 micrometer. This larger particle size may cause microhybrids to be more susceptible to discoloration over time. Larger

particle sizes result in larger pores between the filler particles. These pores can absorb dyes from food and drinks, such as coffee, tea and juice. Over time, these dyes can build up inside the pores and cause the patches to become discolored. Microhybrid filler particles can degrade over time, resulting in smaller fragments. These fragments can act as a starting point for dye absorption, accelerating the discoloration of the patch. Microhybrid resin matrices can undergo structural changes over time, such as degradation and water absorption. These changes can make the resin matrix more susceptible to dye absorption, exacerbating patch discoloration. Consuming foods and drinks that contain high dyes, such as coffee, tea, and juice, can speed up the discoloration of the patches. Smoking can stain teeth and fillings, including microhybrids. Poor dental hygiene can lead to the buildup of plaque and bacteria on the surface of teeth and fillings. This plaque and bacteria can absorb the dye and speed up the discoloration of the patch.¹⁴⁻¹⁷

Previous research on nano-hybrid and microhybrid composite dental fillings has shown that these two filling materials have equivalent effectiveness and safety over shorter time periods, typically 6 months to 12 months. This study extends these findings by showing that both patch materials have equivalent effectiveness and safety over a longer period of 24 months. This is important because it shows that nano-hybrids and microhybrids can provide long-lasting results for patients. Patch retention is the percentage of the patch surface that is still intact. This study found that patch retention in the two groups (nano-hybrid and microhybrid) did not differ significantly over a period of 24 months. The nano-hybrid showed less color change compared to the microhybrid over a period of 24 months. This means that nano-hybrids are more aesthetically durable. Tooth sensitivity did not differ significantly in the two groups at 24 months. No other complaints were reported by patients in both groups within a period of 24 months.¹⁸⁻²⁰

4. Conclusion

This study shows that nano-hybrid and microhybrid composite dental fillings have equivalent

effectiveness and safety over a period of 24 months. However, nano-hybrid showed superiority in terms of less color change compared to microhybrid.

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