

Senior Honors Thesis

**A Comparison of the Durability and Longevity of Dental Amalgam
and Dental Composite in the Restoration of Posterior Teeth**

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Many advances have been made in dentistry over the last twenty years. One of these advances is the development of composite filling material, which is used for the white fillings that are most commonly used in dental offices today. Because composite fillings are more aesthetically pleasing than the traditional silver amalgam fillings, many believe that the use of silver amalgam as a filling material is becoming obsolete.

Patients receiving dental care are often unaware that amalgam is even an option for their fillings because they believe that it has been completely replaced by the white composite filling material. The use of composite as a filling material has become increasingly popular among dentists and patients alike. Patients prefer composite fillings because they maintain the natural color and texture of the tooth. Some dentists prefer composite because they truly believe it to be superior to amalgam in maintaining the structure and longevity of the tooth. However, far too many dentists choose composite simply because it is easier and takes less time to apply and because they can charge more for composite fillings.

Many dentists use composite fillings to restore decay in any and every situation. However, there are cases, specifically involving the restoration of posterior teeth, which require the strength and durability that only amalgam can provide. There are also dentists who stand by amalgam as the better choice for repairing deep decay in posterior teeth. They believe that amalgam is the stronger and long lasting option. They also provide amalgam as an option of treatment to their patients because it is more affordable than composite. Opinions vary greatly on the use of amalgam, and it seems that most dentists either passionately support or avidly reject the use of amalgam.

There has been controversy among members of the dental community on the safety of using amalgam due to the mercury used in the material. Some claimed that the mercury in the amalgam was causing harmful side effects to patients. Although this theory has since been disproven, it still affects the decisions of some dentists and patients. This is unfortunate because many dentists are beginning to see that over time amalgam is outlasting composite and is resulting in less secondary decay. Amalgam has also been shown to be stronger and withstand more pressure than composite, which is most important in the posterior teeth that are under constant pressure. Another benefit to using amalgam is the bacteriostatic and bacteriocidal properties found in the mercury and silver components of the material.

Amalgam

Amalgam has been used as a filling material in dental restorations for over a century. The material was developed in France and brought to America in 1833. Its durability and strength made it very popular among dentists and it soon became the most common choice for repairing decay. The type of amalgam used for dental fillings is made up of a solid alloy component which is mixed with a liquid mercury component to form the amalgam. The solid alloy consists of mostly silver with smaller amounts of tin and copper. This solid alloy is mixed with an equal amount of liquid mercury to form a putty-like material that is used to fill the cavity. To prepare a tooth, the dentist will remove the decay and some healthy tooth structure to create a space large enough to keep the amalgam filling in place. Amalgam does not bond directly to the tooth like composite so it requires a larger preparation site that is designed to hold the filling by mechanical retention.

Composite

Composite fillings were developed in the late 1980's. They were very prone to severe leakage and breakage at that time so they were not used often by most dentists. By the 1990's more durable types of composite had been developed and the material began to gain popularity due to its aesthetic appeal. Composite is a synthetic resin that typically contains Bis-GMA monomers. Composites also contain a filler material such as silica and a photoinitiator that allows the material to be cured or hardened using a light that produces a certain blue wavelength. When preparing the tooth for a composite filling the dentist can remove a smaller amount of tooth structure. This is because a bonding agent is used along with the composite that directly bonds the material to the tooth structure.

Mercury Controversy

In the 1990's concerns began to grow among dental professionals and patients about the safety of dental amalgam. As research began to reveal major systemic complications following exposure to mercury, many made a connection to the mercury found in amalgam fillings. Claims began to circulate throughout the dental community and the public media that amalgam fillings could be linked to many health risks including neurological symptoms, brain tumors and cancer. These reports had dentists and patients alike apprehensive about the continued use of amalgam for dental restorations. Amalgam became almost entirely unseen in dental practices across the world. Since this time many studies have been conducted to determine the amount of mercury released into the body by amalgam fillings. These studies have indicated that the

amount of mercury released by even a mouth full of amalgam fillings is less than the amount of mercury that we absorb from food, water and air. One study stated that the amount of mercury release from five amalgam fillings is about the same as the mercury that we ingest when eating a tuna fish sandwich. What early skeptics had failed to realize is that when the mercury used in amalgam is mixed with the solid silver alloy it completely changes the chemical nature of the mercury. After these two components have mixed the mercury is no longer harmful. In 1997 the FDI World Dental Federation and the World Health Organization released a statement announcing that there was significant research to support the safety of continued use of dental amalgam.

Tooth Fracture

Another misconception that many have about amalgam fillings is that they cause the tooth to crack and fracture more than composite. While it is true that large amalgam fillings may cause the tooth to fracture after many years, it is not true that this will happen with every amalgam filling or that composite is less likely to cause fractures. Both amalgam and composite undergo what is known as thermal expansion. This is when the filling material expands or contracts due to temperature change. For example, when you eat or drink something cold the material will shrink and contract, and when you eat or drink something hot the material will expand. After many years of this expanding and contracting the tooth structure begins to weaken, and as the filling expands it can cause fracture lines that run vertically from the top of the tooth to the root. When these fracture lines reach the root, the filling can no longer be replaced and a crown is the only possible treatment option.

Many dentists and patients see this occur and associate this process with amalgam fillings. This is because amalgam is often the material of choice for large, deep, posterior fillings. What they fail to realize is that with these large fillings it wouldn't matter if the material was amalgam or composite, the filling will only last for so long before it fails. In fact, composite actually has a higher coefficient of thermal expansion than amalgam. I believe that another reason dentists have not made the connection between fracturing and composite is because composite is still a fairly new material. It is very uncommon to see a twenty year old composite filling because composite has barely been used in dentistry for twenty years. Also, most composites begin to leak after five to ten years and must be replaced either by another filling or a root canal if the decay is extensive enough, so they typically don't last long enough to cause fractures. However, it is very common to see twenty year old amalgams, and of course if a large filling has been untouched for twenty years or longer the integrity of the tooth will be compromised.

Strength and Durability

When restoring a tooth that has significant caries decay, it is essential to choose a material that will provide the strength necessary to maintain full function of the tooth. If the filling material is too weak and chips or fractures the filling must be repaired which requires that some of the surrounding healthy tooth structure will have to be removed in order to restore the filling. Strength is especially important in restorations involving the posterior teeth. The posterior molars and premolars must be able to bare extreme amounts of pressure that are produced when we chew food, grind our teeth or clench our jaws. Amalgam has been tried and tested under the pressure placed on posterior

teeth and typically outperforms composite. It has also been observed that amalgam is the better choice when a cusp must be replaced. The cusps are the ridges or projections on the grinding surface to the tooth that endure a great deal of pressure so it is important that the material used in these restorations is strong enough to take the pressure. Although advances are being made in the development of stronger composite, amalgam is still the stronger material.

Durability is also a factor that should be considered by both dentists and patients when choosing a filling material. Because valuable tooth structure is lost each time a filling must be replaced it is important to choose the filling material that will last the longest without being constantly replaced. Amalgam has proven to be the longer lasting material by far. Composite fillings typically last for five to seven years before they need replaced. Some composites can last up to ten to twelve years but this is fairly uncommon. Amalgam fillings have an average longevity closer to fifteen years, and many have been noted to last for over twenty years. One reason that composite fillings do not have the longevity of amalgam is that composite undergoes a process called dissolution. Dissolution is the process by which a composite filling slowly dissolves and breaks down over time. Another common reason that composites must be replaced after only a few years is that they are prone to recurrent decay.

Preventing Recurrent Decay

Preventing recurrent decay is a very important factor to consider when choosing a filling material. If caries bacteria penetrate the margins and gain access to the tooth structure beneath an existing filling it can cause severe decay. It is very hard to detect

decay that has started under an existing filling. X-rays could detect the decay; however, dental x-rays are only administered once a year. In one year, decay that has started beneath a filling could have easily reached the nerve and this will result in a root canal. Composite fillings start off strong in preventing secondary decay. A bonding agent is used that bonds the composite directly to the tooth creating very tight margins which prevent bacterial penetration. However, as mentioned previously, composite has a high coefficient of thermal expansion so it expands and contracts significantly with changes in temperature. When exposed to cold temperatures the composite will contract and pull away from the tooth structure. Over time this will break the tight bond of the margins and cause leakage which will allow the bacteria access to the underlying tooth.

Amalgam differs from composite in this area because it is not directly bonded to the tooth. When a tooth is being prepared for an amalgam filling there is a very specific pattern that must be followed to create a secure hold. The dentist creates precise grooves and undercuts that form a socket to keep the amalgam filling in place. A unique property of amalgam that prevents bacteria from penetrating into the margins is its ability to change shape and form to the surrounding tooth. This is a property of the metals used in amalgam.

The metals used in amalgams have other beneficial properties that contributed to the prevention of secondary decay. It is often noted by dentists that secondary decay is less commonly seen with amalgam fillings. Some believe this is due to the superior sealing ability of the amalgam, but it has more recently been noted that the metals making up the amalgam alloy, specifically silver and mercury, have bacterial fighting properties. Silver is known for its bacteriocidal nature. Silver kills bacteria by binding the

thiol groups of the bacteria. This causes the cross-linking of amino acids which leads to a 3-D shape change. This inhibits or destroys the functions of the bacteria resulting in bacterial death. Mercury has also been noted for its bacteriostatic and bacteriocidal nature.

Cost-effectiveness

Although cost should not be the most important consideration when choosing a treatment plan, it will play a role for many patients. Amalgam is the most affordable option for some patients. Composite fillings can be quite expensive. The composite material itself is costly and there are also additional costs that come with composite fillings. The additional costs include an etching product, the bonding agent and typically some type of desensitizing agent. Amalgam is cheaper and does not require these additional products. Another reason that composites can end up costing more is because they are not fully covered by most dental insurance companies. Due to the decreased strength and durability of composite, insurance companies are hesitant to fully cover the treatment which will end up costing the patient more out of pocket. Amalgams will be covered under most patients' dental insurance plans.

The Dentist's Opinion

I surveyed several dentists about their opinions and experiences with amalgam and composite fillings. I knew going in to this research that amalgam is rarely used in most dental offices. I have shadowed various dentists and worked as an assistant to two dentists and have never seen any of them place an amalgam filling. I thought that amalgam was no longer used at all in dentistry until I went to shadow at the University

of Missouri Kansas City School of Dentistry where I saw several amalgam fillings placed. This sparked my interest and is the reason that I decided to choose this as a topic for my senior thesis.

After reviewing the surveys that I have received it is clear that there are very mixed and passionate opinions about the use of amalgam. Some dentists stand by amalgam as the superior material based on many of the previously mentioned benefits. However, many dentists have a very negative opinion of amalgam. The most common reason that dentists listed as to why they dislike amalgam is that it causes fracturing in the tooth. However, the research that I have done indicates that composite fillings can potentially create more severe fracturing due to the higher coefficient of thermal expansion. I believe that dentists related amalgam fillings to fracturing because they see so many old amalgam fillings on a daily basis. It is not uncommon to see amalgam fillings that are twenty or even thirty years old, and of course after this length of time there will be damage to the tooth. Composite is still a fairly new material, so it is much less common to see composite fillings that are even ten years old. No filling, composite or amalgam, will permanently repair a damaged tooth, and I believe that eventually dentists will realize that composite fillings produce the same degree, or worse, of fracturing.

The second reason that dentists listed as to why they don't use amalgam is that it is not aesthetically pleasing. This is a valid argument when you are dealing with anterior teeth that will be seen when the patient smiles or speaks, but I do not feel that this should be a problem when repairing posterior teeth that will not be visible. Furthermore, composites are not entirely without flaw in the area of appearance either. After several

years composites begin to accumulate tiny holes or pores in the surface or the filling. These pores take up stain from foods or drinks like coffee or red wine. After this staining has occurred there is no way to whiten the composite, so if a patient tries to whiten their teeth the tooth structure will become white and the composite will remain stained leaving dark spots on the teeth.

Conclusion

For the restoration of posterior teeth, amalgam is safe and superior to composite in many respects. Amalgam is safe for dental restorations and the amount of mercury released into the body is so minimal that it will not have negative effects on the health of the patient. Although any deep filling can cause fracturing of the tooth over time, amalgam has a lower coefficient of thermal expansion so it should ultimately cause less fracture damage than composite. Amalgam is also the stronger material and will not wear or break as easily as composite. This is important because every time a filling is replaced valuable tooth structure has to be removed. The superior ability of amalgam to prevent recurrent decay is also vital. Amalgam forms longer lasting margins and results in less leakage which prevents bacteria from gaining access to the underlying tooth structure. In addition to tighter margins, amalgam also prevents secondary decay due to the bacteriocidal action of the heavy metals found in the alloy. Because amalgam is a less expensive material and is covered by most dental insurances it is more affordable for patients who may have extensive treatment plans.

Most dentists that dislike amalgam list appearance as one of the main reasons that they have turned to composite. I agree that composite is a valuable asset for

patient treatment. Composite is most definitely the better choice when treating anterior teeth or small areas of decay because it is more aesthetically pleasing and the preparation requires less tooth structure be removed. However, when treating deep posterior decay I believe that amalgam is superior to composite in functionality in almost every way. Aesthetics is important but the overall functionality of the material and oral health of the patient should be the main priority when choosing a treatment plan. Every case is different, and not every filling can be approached the same way. Hopefully in the future research will provide an advanced composite with superior functionality for the treatment of posterior teeth, but at this time amalgam remains a safe, strong and reliable material for posterior restorations.

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