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*Review*

# The Longevity and Clinical Performance of Direct and Indirect Restorations, Including Amalgam, Composite, Ceramic, and Metal Restorations

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**Abstract**

The longevity of dental restorations depends on patient-related, dentist-related, and material-related factors. Patient-related factors include restoration size, chewing habits, oral hygiene, and systemic conditions. Strength, wear resistance, water tolerance, dimensional stability, and colour stability are all material-related variables. When deciding on a course of treatment, dentists must take these things into account. Since the 19th century, dental amalgam, which is composed of mercury, silver, tin, copper, and other metals, has been used effectively. Although it has limits in terms of tooth colour matching, it is appropriate for Class I and II restorations. Amalgam offers good load-bearing qualities, wear resistance, and tolerance for various clinical conditions. Safety concerns include the release of mercury vapor and the possibility of localized allergic reactions. Resin-based composites are esthetic and safe materials used for anterior and small to moderate-sized posterior fillings. Postoperative tooth sensitivity and shrinkage-related issues can occur, but improvements have minimized these problems. Adequate field control is essential for successful placement. Indirect restorative materials include all-ceramic and base metal casting alloys. All-ceramic restorations provide excellent aesthetics, high strength, and biocompatibility. However, they rely on resin-based cements and adhesives for retention, and allergies can occur. Base metal alloys offer an economical alternative and are effective for crown-and-bridge restorations. The choice of restorative materials depends on various factors, and dentists must consider the specific needs of each patient to achieve successful outcomes.

**Keywords:** *longevity, dental amalgam, resin-based composites, safety concerns and indirect restorative materials*

## Introduction

For the treatment of carious lesions or missing teeth, patients and clinicians have a number of alternatives when it comes to materials and treatments (1). Dentists employ a wide range of materials for restoring teeth. When selecting the best restorative material for each condition, the dentist and the patient must take into account a variety of aspects, with some of the most crucial being clinical performance and longevity (2, 3). In contrast to how long a restoration lives (survival rate), which is frequently employed as a measure of clinical performance, restoration success is the documented capacity of restoration to operating as planned (4). Once a tooth is restored, a restorative cycle begins, during which the restoration is likely to be changed repeatedly throughout the course of the patient's lifetime. Restorations have a limited lifespan (5). Dentists are required to tell their patients how long certain materials and restoration techniques last. As a result, the patients will be able to choose their treatments with knowledge (4). Dentists must provide this information in a straightforward, concise way that is based on the most recent scientific research. The United States Public Health Service (USPHS) standards have been the most often employed to assess the clinical efficacy of restorations (2). It employs a grading system based on many observations (such as retention, colour match, secondary caries, etc.) and calls for two independent examiners. There is a letter grade for each observation, ranging from Alpha (excellent) Bravo (less perfect) to Charlie (total failure). Practitioners may want to describe how the two groups vary as follows: In a single session, direct materials are those that may be inserted right into the tooth cavity. Restorations are created in the dental laboratory using indirect materials, which are subsequently positioned in or on the teeth. The insertion of indirect materials often takes two or more sessions to complete placement of the restoration. Direct restoration as amalgam, glass ionomer, resin- modified glass ionomer and resin-based composite (1). Indirect restoration as ceramic and metal-ceramic, gold and metal restorations.

This review will focus on the longevity and clinical performance of direct and indirect restorations, including amalgam, composite, ceramic and metal restoration.

## Discussion

Dental restorative material is processed under ideal circumstances to produce a restoration that can last for a very long time. However, a variety of patient, dental, and material-related factors affect how long the restoration will last (6). Size and placement of the restoration, chewing patterns and loads, quality of oral cleanliness and maintenance, and systemic diseases that might alter salivary production and chemistry are all patient-related variables (1). Strength, wear resistance, water tolerance, dimensional stability, and colour stability are material-related aspects.

### *Direct restorative materials*

### *Dental amalgam*

Mercury, silver, tin, copper, and other metallic ingredients are used to make amalgam filling material in order to improve its mechanical and physical properties. The amalgam restoration is unique in that it starts off as a paste-like mixture of metals and, after being placed in the mouth for a short period of time, solidifies as a consequence of a series of chemical reactions to produce a sturdy metallic alloy. Mercury is changed from its metallic liquid condition into an intermetallic compound that is solid and stable (1). For Class I and II restorations on teeth that experience significant chewing pressure, amalgam is particularly suited. Frequently, Class II restorations have large tooth-material contact areas. These increase the risk of recurrent caries by creating a possibility for oral fluid leaks along the edges of the tooth-filling contact. However, it has been claimed that amalgam has the ability to seal the margins of tooth restorations with corrosion products that build up over time. Amalgam cannot completely mimic the colour or transparency of real teeth because of its metallic makeup, and its usage on anterior teeth is limited by its silver-grey hue.


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Amalgam restorations provide several benefits over alternative direct-placement materials, including good load-bearing qualities, resistance to wear, and tolerance for a variety of clinical placement circumstances, including moist settings (7-9). The capacity of amalgam to adjust via deformation under stress is primarily responsible for this. Despite having a lengthy history of effectiveness, this material's safety has occasionally come under question since it contains mercury. Chewing on amalgam restorations can cause very minute amounts of elemental mercury vapour to escape less than half of the estimated normal daily exposure (10). Higher survival time and a lower annual failure rate for amalgam restorations in Class I defects compared with Class II cavities (6). Cavity size influenced the longevity of amalgam restorations. Large amalgam restorations exhibit more deterioration than moderate- and small-sized restorations.

In contrast to the adhesive capabilities with modern composite systems, the lack of adhesive stabilization of hard tooth tissues, in combination with amalgam, frequently results in infraction or fracture of restored teeth. Since it affects the amalgam's ability to resist corrosion, it has been discovered that the alloy's zinc and copper composition has a significant influence on the survival rates of amalgam restorations. Compared to standard amalgams, high-copper amalgams have greater survival rates (11).

***Resin-based composites***

Complex mixtures of polymerizable resins and glass powder fillers are used to create composite restorative materials. In composite compositions, additional chemicals are also used to improve viscosity for easier handling, speed up curing, and increase radiographic opacity for improved diagnostic identification. The most visually acceptable direct filling material available is dental composite, which has had its colour and translucency modified to mimic those of teeth. Comparable to other restorative materials that are already approved for use in dentistry, resin-based composites are believed to be secure. In a very small percentage of people, allergic reactions to resin-based composites have been reported (12, 13). It is not unusual for postoperative tooth sensitivity to occur following the use of composite materials, although it is often temporary and associated with leaking adjacent to the filling's edges or, rarely, mechanical stress put on the tooth while the filling material cures (14). Composite fillings adhere to the tooth using highly efficient bonding resins. The shrinkage of the composite after it has dried can put stress on the restoration's link with the tooth, causing strain, bending, or, in rare cases, fracture. Early postoperative sensitivity can also be caused by a failure of the tooth or composite bond. Recent developments in composites and the adhesives used to install composites have reduced the incidence of these undesirable events. Composite restorative materials are seldom used without an adhesive. Cleaning, etching the dentin and enamel using phosphoric acid or a similar etching agent, and then impregnating the cavity preparation with a bonding glue to mechanically adhere to the microporosities created by this process. Low-molecular-weight resin monomers are a common component of bonding resins, and some of them have been linked to allergy responses. Hypersensitivity to substances like hydroxyethyl methacrylate has been recorded; however, dentists tend to experience the issue more frequently than patients do (13). Clinicians who frequently come into contact with these unreacted monomers directly have reported developing allergic dermatitis on their fingertips as a result of exposure to these resins (15). The original design of these aesthetic materials called for the use of exclusively anterior restorations. As their use increased and the materials kept getting better, they were used for almost all classes and varieties of dental restorations. Today, composites are often used for anterior restorations as well as small- to medium-sized posterior fillings in teeth with modest chewing pressures. Resin-based composites have shown promise of improvement in durability and duration of service in clinical trials examining their performance in Class I and Class II restorations, despite the fact that they are frequently not as tough or durable as metals. When installing resin-based composites, adequate field control is essential. Composite restorations cannot be successfully


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placed in a cavity that has been contaminated by blood or saliva. Cavity contamination interferes with the filling's ability to attach to the tooth, leading to interface leakage.

***Direct versus indirect composites***

By constructing and curing the majority of the repair outside the mouth, shrinkage during the curing process can be partially avoided. Pressure and heat can also enhance the restoration's degree of cure. These factors led to the development of indirect composite restorations generated in a dental lab in an effort to improve the filling's overall durability. Indirect composites, however, could need a second appointment to be placed. One study shows that direct composite restorations meticulously manufactured from high-quality materials are likely as serviceable as their indirect laboratory-produced equivalents, even though some improvements in characteristics could be made (16).

***Indirect restorative materials***

Every indirect restoration needs cement to hold the prepared teeth in place. The performance and biocompatibility of the entire repair might be greatly impacted by the cement. Water-based cements and resin-based cements are two major groups of cements that are readily accessible.

***All-ceramic restorations***

The creation of realistic indirect restorations involves the use of dental ceramic materials (1). Both teeth with vital pulp and those with root fillings are routinely used due to the advancement of all ceramic materials for indirect restorations. These materials offer high cosmetic benefits without significantly compromising restorative strength or lifespan (17). Restorations made of ceramic are very aesthetically pleasing because of their translucency and toothlike colour. Ceramic is an extremely tough and durable material that can withstand biting pressures, but because it is fragile and glass-like, it can break when subjected to powerful forces or a direct blow (1). These restorations are extremely durable because of the natural hardness of ceramic. If they are not smooth and well-polished, they may quickly wear down neighbouring restorations or natural teeth. All-ceramic restorations created in a lab have gained a lot of popularity over time thanks to their exceptional aesthetic qualities, high strength, and excellent biocompatibility. ceramic materials' safety. Natural oxides that have been fused make up the majority of these materials. They are relatively inert due to their glass-like characteristics, and they frequently exhibit great biocompatibility and good tolerability (18). However, to stay in position and prevent leaking from the tooth, all-ceramic restorations rely on technique-sensitive resin-based cements and adhesives. Rarely, reactions to the resin components of cements and adhesives may cause allergies or sensitivities. For crowns, inlays, onlays, and veneers where the highest level of aesthetics is required, dental ceramics are recommended. The success rate of ceramic crowns on posterior teeth is lower than that of metallic restorations, despite the fact that ceramic is a naturally durable material because of its brittleness (19). To enhance the look or colour of teeth, ceramic veneer restorations replace a very thin layer of enamel on the front of the teeth. These restorations are just around 0.5 millimetres thick, but because of the resin-based cements and adhesives used to connect them to the tooth beneath, they have proven to be highly strong. All-ceramic crowns, inlays, and onlays can be similarly bonded to teeth to reinforce and improve function. A well-built and bonded all-ceramic repair can last for many years with hardly any colour or aesthetic alterations. The most typical pattern of failure of a ceramic onlay was fracture, followed by debonding (20). The most observed form of degradation was linked with margin integrity and discoloration. Tooth preparation, tooth vitality, and occlusal force appear to influence ceramic onlay survival.

***Base metal casting alloys restorations***

Base metal alloys, also known as non-noble alloys, were created as a more affordable substitute for cast-gold alloys. Typically, nickel, chromium, and cobalt make up these alloys. For detachable partial dentures or for bigger frameworks in crowns and bridges, base metal alloys can be precisely cast. Allergy to nickel is a known contraindication for using nickel-based alloys. For crown-and-bridge


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restorations, the base metal alloys work well. These materials exhibit less flexure than gold alloys because of their increased rigidity. This is crucial when supporting teeth must be spaced far apart or when ceramic is bonded to the surface. Base metal alloys are also substantially lighter in terms of weight than equivalent gold alloys. For larger castings, like the frames for partial dentures, this is crucial. A wide range of cements can be used to cement base metal restorations as well (1).

## Conclusion

The choice of dental restorative materials depends on several criteria, including patient-related, dentist-related, and material-related considerations. Dental amalgam, which is made of mercury, silver, tin, copper, and other metals, has been used effectively for Class I and II restorations despite its shortcomings in tooth colour matching because of its high load-bearing capacity and wear resilience. Resin-based composites are frequently used for anterior and small- to moderate-sized posterior fillings, despite the possibility of postoperative tooth discomfort and shrinkage-related issues. All-ceramic restorations provide excellent aesthetics, great strength, and biocompatibility, but they must be retained with resin-based cements and adhesives. Base metal alloys provide an economical alternative and are effective for crown-and-bridge restorations. Dentists must consider the specific needs of each patient to achieve successful outcomes in restorative dentistry.

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There is no conflict of interest

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Non applicable

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Data that support the findings of this study are embedded within the manuscript.

### *Author contribution*

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

## References

1. Direct and indirect restorative materials. The Journal of the American Dental Association. 2003;134(4):463-72.

2. Kim KL, Namgung C, Cho BH. The effect of clinical performance on the survival estimates of direct restorations. Restorative dentistry & endodontics. 2013;38(1):11-20.

3. Schwass DR, Lyons KM, Purton DG. How long will it last? The expected longevity of prosthodontic and restorative treatment. The New Zealand dental journal. 2013;109(3):98-105.

4. Fernandes N, Vally Z, Sykes L. The longevity of restorations -A literature review. South African Dental Journal. 2015;70:410-3.

5. Chadwick B, Treasure E, Dummer P, Dunstan F, Gilmour A, Jones R, et al. Challenges with studies investigating longevity of dental restorations--a critique of a systematic review. Journal of dentistry. 2001;29(3):155-61.

6. Manhart J, Chen H, Hamm G, Hickel R. Review of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition. OPERATIVE DENTISTRY-UNIVERSITY OF WASHINGTON-. 2004;29:481-508.

7. Manhart J, García-Godoy F, Hickel R. Direct posterior restorations: clinical results and new developments. Dental Clinics. 2002;46(2):303-39.

8. Yap A, Teoh S, Chew C. Effects of cyclic loading on occlusal contact area wear of composite restoratives. Dental materials. 2002;18(2):149-58.

9. Leinfelder KF. Do restorations made of amalgam outlast those made of resin-based composite? The Journal of the American Dental Association. 2000;131(8):1186-7.

 http://dx.doi.org/10.52533/JOHS.2023.30706

10. Berglund A. Estimation by a 24-hour study of the daily dose of intra-oral mercury vapor inhaled after release from dental amalgam. Journal of dental research. 1990;69(10):1646-51.

11. Letzel H, Van't Hof M, Marshall G, Marshall S. The influence of the amalgam alloy on the survival of amalgam restorations: a secondary analysis of multiple controlled clinical trials. Journal of dental research. 1997;76(11):1787-98.

12. Lygre H, Høl PJ, Solheim E, Moe G. Organic leachables from polymer-based dental filling materials. European journal of oral sciences. 1999;107(5):378-83.

13. Hume W, Gerzina T. Bioavailability of components of resin-based materials which are applied to teeth. Critical Reviews in Oral Biology & Medicine. 1996;7(2):172-9.

14. Condon JR, Ferracane JL. Assessing the effect of composite formulation on polymerization stress. The Journal of the American Dental Association. 2000;131(4):497-503.

15. Geurtsen W. Biocompatibility of resin-modified filling materials. Critical Reviews in Oral Biology & Medicine. 2000;11(3):333-55.

16. Peutzfeldt A. Indirect resin and ceramic systems. Operative dentistry. 2001;26:153-76.

17. Mannocci F, Bitter K, Sauro S, Ferrari P, Austin R, Bhuva B. Present status and future directions: The restoration of root filled teeth. International endodontic journal. 2022;55 Suppl 4(Suppl 4):1059-84.

18. Sjögren G, Sletten G, Dahl JE. Cytotoxicity of dental alloys, metals, and ceramics assessed by millipore filter, agar overlay, and MTT tests. The Journal of prosthetic dentistry. 2000;84(2):229-36.

19. Rosenstiel SF, Land M, Fujimoto J, Cockerill J. Contemporary fixed prosthodontics. St. Louis. Mosby, Inc. 2001;2001:380-416.

20. Abduo J, Sambrook RJ. Longevity of ceramic onlays: A systematic review. Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry [et al]. 2018;30(3):193-215.


http://dx.doi.org/10.52533/JOHS.2023.30706