

Review Article

The impact of occlusal forces on the longevity of restorations

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Received: 05 September 2023

Accepted: 20 September 2023

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ABSTRACT

The longevity of dental restorations like fillings, crowns, and bridges is critically influenced by occlusal forces exerted during biting and chewing. These forces vary among individuals based on diet, masticatory habits, and the structural soundness of the dental arch and can range from 11 to over 450 Newtons, depending on circumstances. The choice of restorative material is important for withstanding these forces. While amalgam is durable, modern dentistry has shifted towards aesthetic restoratives such as composite resins and ceramics. However, these materials respond differently to occlusal forces. Ceramics might fracture under excess load, whereas composite resins resist wear but can degrade over time due to other factors. Precision in restoration is crucial to preventing undue occlusal forces that might lead to restoration failure. Tools like T-scan assist in this precision. The manner and distribution of occlusal forces, along with the health of the periodontal ligament, are critical for restoration durability. Bruxism, a parafunctional habit, can significantly impact restorations, necessitating protective measures like occlusal splints and patient education. The interplay of occlusal forces and the chosen restorative material greatly affects the success and lifespan of dental restorations.

Keywords: Longevity, Dental restorations, Occlusal forces, Biting, Masticatory habits

INTRODUCTION

The integrity and durability of dental restorations are of paramount importance to the oral health and overall well-being of patients. The longevity of restorations, such as fillings, crowns, and bridges, can be influenced by numerous factors. Among the primary considerations is

the effect of occlusal forces, which refers to the forces exerted during biting and chewing. Understanding the interplay between occlusal forces and the durability of restorations aids dental professionals in delivering lasting dental solutions. Occlusal forces vary significantly among individuals. Factors such as the type of food consumed, masticatory habits, and the structural integrity of the

dental arch can impact the magnitude of these forces. Studies suggest that occlusal forces during normal chewing can range from 11 to 150 Newton, while forces during parafunctional habits like bruxism can exceed 450 Newton.¹ The choice of restorative material plays an important role in how restorations withstand occlusal loads. For instance, amalgam, which was traditionally used for decades, offers durability and resistance against wear. However, with the rise of esthetic dentistry, tooth-coloured restoratives like composite resins and ceramics have become popular. While they cater to esthetic demands, their responses to occlusal forces differ. Ceramics, although esthetically pleasing, can be brittle and might fracture under excessive loads.² Composite resins, on the other hand, have shown good resistance to occlusal wear but can be susceptible to degradation over time due to other factors like material shrinkage and secondary caries. Inaccurate occlusion can contribute to the premature failure of restorations. Uneven or high spots in restoration can lead to increased occlusal forces on a specific area, leading to cracks, wear, or even a complete fracture. Therefore, it's crucial to ensure a balanced occlusion during the restoration process. Dynamic occlusal analysis tools, like T-scan, have become valuable in achieving precise occlusal adjustments, helping extend the lifespan of restorations. The direction and distribution of occlusal forces also matter. Horizontal forces, especially in patients with bruxism, can have deleterious effects on restorations, leading to abfractions, wear, and possible debonding of restorations.³ The periodontal ligament, which preserves the tooth in its socket, also plays a role in dissipating occlusal forces. However, in cases of periodontal disease, where the ligament's health is compromised, teeth can become more susceptible to occlusal trauma, which might also jeopardize the longevity of restorations on such teeth.⁴ For patients with parafunctional habits, occlusal splints or nightguards are recommended. These devices distribute occlusal forces more uniformly and protect restorations from undue stress. Patient education is also crucial. Informing patients about the signs and consequences of bruxism and guiding them toward interventions can play a preventive role in ensuring the longevity of restoration.

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on July 8, 2023, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the impact of occlusal forces on the longevity of restorations. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Occlusal forces play an important role in the success, failure, and overall longevity of dental restorations. Burke and colleagues found that normal occlusal function is associated with increased restoration's age at replacement; and that excessive and high occlusal function is associated with reduced restoration's age at failure.⁵ Amalgam seems to have a greater wear resistance than composite^{6,7} and, for patients with heavy occlusion, bruxism, or restorations with all occlusal contacts in the restorative material, amalgam, rather than composite, is usually the material of choice. Nevertheless, for most cases with normal occlusal loading and at least some occlusal contacts in tooth structure, resin-composite restorations perform well.⁸⁻¹⁰

The dynamics of occlusal forces

The human masticatory system is a complex entity, capable of generating a wide range of forces.¹¹ It's well understood that posterior teeth, due to their anatomical and functional roles, typically endure higher occlusal loads than anterior teeth. However, the distribution and magnitude of these forces are not only influenced by the tooth's position but also by individual factors such as the muscular activity, temporomandibular joint health, and even parafunctional habits like bruxism. A comprehensive understanding of these dynamics is imperative when considering the longevity of dental restorations.

Material considerations and occlusal stress

Different restorative materials have varying thresholds of endurance under occlusal stresses. Amalgam, despite its debated use due to concerns about mercury, has been a stalwart in dentistry due to its notable durability.¹² However, larger amalgam restorations can be more prone to fracture under occlusal loads. Composite resins, on the other hand, offer aesthetic advantages but can wear down faster, especially in high-load bearing areas.¹³ Modern ceramics are becoming increasingly popular because of their aesthetic and functional attributes, but they aren't devoid of their own set of challenges.¹⁴

Restoration longevity and occlusal impacts

Wear and tear

Natural dentition wears over time, and restorative materials are no exception. The continuous interplay of occlusal forces can accelerate the wear of certain materials, leading to a reduced restoration lifespan.¹⁵

Fractures and failures

Off-axial forces, particularly in restorations without proper support or with inherent flaws, can predispose them to cracks or even catastrophic fractures.

Marginal degradation

Over time, occlusal forces can compromise the marginal integrity of restorations, facilitating bacterial invasion, recurrent caries, as well as the ultimately, restoration failure.¹⁶

Impacts of occlusal forces on various types of dental restorations

Amalgam restorations

Historically, dental amalgam, a blend of mercury with silver, tin, and copper, has been a popular choice for posterior restorations due to its durability and ease of use. Due to its metallic nature, it has inherent strength. However, when subjected to high occlusal forces, especially in patients with bruxism, wear, and fracture can occur.¹⁷ Moreover, under constant and excessive occlusal stress, amalgam restorations may exhibit marginal breakdown or fracture, especially in large restorations. Notably, around 90% of amalgam restorations function adequately for over a decade.¹⁸ The amalgam annual failure rates are relatively low, varying between 0% and 7.4%, based on the type of alloy used. Observations have been noted for periods extending to two decades.¹⁹ Several benefits of using amalgam have been noted. These include low technique sensitivity, exceptional wear resistance, high compressive strength, optimal radiopacity, and the unique ability to distinguish the appearance of the amalgam from the tooth structure. Moreover, amalgam can seal marginal spaces over time. The main drawbacks of amalgam restorations are their aesthetic quality and the requirement for more extensive tooth structure removal during the preparation process.²⁰ Some common problems that can impact the longevity of amalgam restorations are secondary caries, tooth fractures, cervical overhangs, and marginal ditching.²¹

Composite restorations

Composite resins, typically made of a resin matrix and filler particles, offer aesthetic advantages, making them suitable for both anterior and posterior restorations. Composites are more susceptible to wear than amalgam. Occlusal forces can lead to surface degradation, wear, and even fracture. Furthermore, forces can result in marginal discrepancies, leading to secondary caries.²² Additionally, improper occlusal contacts might accelerate wear. Direct composite restorations generally have a shorter lifespan than amalgam. For instance, while the median survival time for amalgam restorations is between 6.6-14 years, that for resin composites falls between 3.3-4.7 years.²³ Further evidence highlights that the risk of failure due to secondary caries in composite restorations is 3.5 times higher than in amalgam.²¹ In a span of 8 years, composite restorations were found to fail at rates two to three times that of amalgam restorations.²⁴ The primary advantage of resin composites over amalgam is their aesthetic appeal.

They closely mimic the appearance of natural teeth. Furthermore, they allow for the preservation of more tooth structure during the restoration process, and their low thermal conductivity is an added benefit.⁹ Despite their aesthetic advantage, resin composites' main drawback is their lower durability, especially in the posterior teeth.²¹ Furthermore, they demand a meticulous operative procedure to ensure long-term success. The primary causes of composite restoration failure are secondary caries and the fracture of the restoration itself. Observational studies for composite restorations in posterior teeth showcased survival rates fluctuating between 55% and 95% over a period of 5 years.²⁵

Glass ionomer cements

Glass ionomer cements (GIC) is a versatile material used in various dental applications, from fillings to luting agents. While GIC adheres well to tooth structure and releases fluoride, its resistance to occlusal forces is limited, making it less ideal for high load bearing areas. They can fracture or wear down under excessive occlusal stress.²⁶

Porcelain restorations

Although porcelain has an esthetic advantage, it can be brittle. High occlusal forces can lead to cracks, chipping, or even complete fractures. Occlusal adjustments and ensuring proper thickness can mitigate this risk.² Notably, prolonged occlusal forces can induce wear on both the porcelain and opposing natural teeth. These forces also jeopardize the marginal integrity of the restorations, hinting at potential issues like secondary caries. Furthermore, in the realm of implant-supported porcelain restorations, meticulous design is paramount to preventing prosthetic failures.

Gold restorations

Gold restorations stand out in dentistry for their historical use and inherent strengths, including exceptional durability and biocompatibility. Their ability to resist wear, especially when compared to materials like amalgam or composite resins, makes them a resilient choice under the stress of occlusal forces. Gold's unique properties of ductility and malleability facilitate tight fits in dental cavities, reducing the risks associated with marginal leakage or decay. Unlike some dental materials, gold does not expedite the wear of opposing teeth, indicating a harmonious interaction under occlusal pressures. Although gold's thermal conductivity can cause sensitivity to temperature changes and its proximity to other metals might induce a galvanic response, these are not due to occlusal forces. With careful preparation and cementation, gold restorations prove to remain stable and well-retained, underscoring their longstanding preference in the realm of dentistry. Its wear is compatible with natural enamel, making it an ideal material for inlays, Onlays, and crowns.²⁷

Implant restorations

Dental implants replace tooth roots, and prostheses (crowns or bridges) are then placed on them. Longevity of implant restorations can be compromised by excessive occlusal forces, leading to mechanical complications such as screw loosening, screw fractures, and even implant fractures. Occlusal overload can also lead to bone loss around implant, known as peri-implantitis.²⁸

Toward a better clinical outcome

Clinicians must integrate knowledge of occlusal forces and material properties into their daily practice. Material selection is crucial, especially in patients with a history of bruxism or in those with other predisposing factors.²⁹ Regular monitoring and timely interventions can prevent minor wear from escalating into significant failures.

The future of dentistry holds promise for effectively addressing the challenges posed by occlusal forces on dental restorations. Key advancements will emerge from technological innovations such as improved materials designed for enhanced resilience and better force distribution. The digitization of dentistry will allow for precise occlusal analyses, improving diagnoses and management strategies. Bioengineering will offer insights into the natural resilience of teeth, potentially guiding the design of more durable restorations. The era of personalized medicine heralds treatments tailored to individual occlusal dynamics, aiming to extend the life of restorations. With AI and machine learning, predictive models could forecast restoration longevity based on multifaceted criteria. Enhanced awareness and education will empower both dental professionals and patients to prioritize occlusal balance, while a holistic perspective will integrate broader health considerations into dental care strategies. Collectively, these advancements suggest a future where dental restorations are not only more durable but also more attuned to each patient's unique needs and overall well-being.

CONCLUSION

Longevity and success of dental restorations, including fillings, crowns, and bridges, hinge on their interaction with occlusal forces experienced during biting and chewing. Magnitude of these forces varies considerably among individuals due to factors like diet, masticatory habits, and dental arch integrity. While materials like amalgam have historically demonstrated durability against these forces, modern dentistry is tilting towards aesthetic materials like composite resins and ceramics. However, these materials react distinctly to occlusal stresses. For instance, ceramics may fracture under excessive loads, while composite resins might degrade over time. Thus, material choice, precise restoration, and the distribution of occlusal forces are all essential factors. Health of periodontal ligament and conditions such as bruxism also significantly influence restoration longevity.

Integrating knowledge of these forces and the properties of restorative materials can guide clinicians towards optimal and lasting dental solutions.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

1. Manfredini D, Lobbezoo F. Relationship between bruxism and temporomandibular disorders: a systematic review of literature from 1998 to 2008. *Oral Surg Oral Med Oral Pathol Oral Radiol Endodontology*. 2010;109(6):e26-50.
2. Kelly JR. Ceramics in restorative and prosthetic dentistry. *Ann Rev Materials Sci*. 1997;27(1):443-68.
3. Pintado MR, Anderson GC, DeLong R, Douglas WH. Variation in tooth wear in young adults over a two-year period. *J Prosthetic Dentistry*. 1997;77(3):313-20.
4. Gross MD, Ormianer Z. A preliminary study on the effect of occlusal vertical dimension increase on mandibular postural rest position. *Int J Prosthodontics*. 1994;7(3).
5. Kolker JL, Damiano PC, Caplan DJ, Armstrong SR, Dawson DV, Jones MP et al. Teeth with large amalgam restorations and crowns: factors affecting the receipt of subsequent treatment after 10 years. *J Am Dental Asso*. 2005;136(6):738-48.
6. Gil F, Espias A, Sánchez L, Planell J. Comparison of the abrasive wear resistance between amalgams, hybrid composite material and different dental cements. *Int Dent J*. 1999;49(6):337-42.
7. Lutz F, Phillips R, Roulet J, Setcos J. *In vivo* and *in vitro* wear of potential posterior composites. *J Dental Res*. 1984;63(6):914-20.
8. Bjertness E, Sønju T. Survival analysis of amalgam restorations in long-term recall patients. *Acta odontologica Scandinavica*. 1990;48(2):93-7.
9. Rawls H, Esquivel-Upshaw J. Resinas restauradoras. Phillips materiais dentários, 3rd ed Elsevier, Rio de Janeiro. 2005:375-418.
10. Roberson T, Heymann H, Ritter A, Pereira P. Classes I, II, and VI direct composite and other tooth-colored restorations. *Art and science of operative dentistry* Philadelphia, Mosby. 2006:576-7.
11. Gibbs CH, Mahan PE, Lundeen HC, Brehnan K, Walsh EK, Sinkewicz SL et al. Occlusal forces during chewing-influences of biting strength and food consistency. *J Prosthet Dent*. 1981;46(5):561-7.
12. Bernardo M, Luis H, Martin MD, Leroux BG, Rue T, Leitão J et al. Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial. *The Journal of the American Dental Association*. 2007;138(6):775-783.
13. Ferracane JL. Current Trends in Dental Composites. *Critical Reviews in Oral Biology & Medicine*. 1995;6(4):302-18.

14. Pjetursson BE, Brägger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). *Clin Oral Implants Res*. 2007;18(s3):97-113.
15. Heintze S, Cavalleri A, Forjanic M, Zellweger G, Rousson V. Wear of ceramic and antagonist—A systematic evaluation of influencing factors *in vitro*. *Dental Materials*. 2008;24(4):433-49.
16. Kidd EA, Toffenetti F, Mjör IA. Secondary caries. *Int Dent J*. 1992;42(3):127-38.
17. Smales RJ, Berekally TL. Long-term survival of direct and indirect restorations placed for the treatment of advanced tooth wear. *Eur J Prosthodontics Restorative Dentistry*. 2007;15(1):2-6.
18. Marshall S, Marshall G, Anusavice K. *Amalgamas Dentárias*. Anusavice KJ Phillips, *Materiais Dentários 11ª ed* Rio de Janeiro: Elsevier. 2005:469-514.
19. 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.
20. Wilder A, Roberson T, Pereira P, Ritter A, May K. Classes I, II and VI amalgam restorations. Roberson T, Heymann H, Swift E *Sturdevant's Art and Science of Operative Dentistry 4ª ed* Missouri: Mosby. 2002:671-739.
21. Soares AC, Cavalheiro A. A Review of Amalgam and Composite Longevity of Posterior Restorations. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*. 2010;51(3):155-164.
22. Ferracane JL. Resin composite-state of the art. *Dental materials*. 2011;27(1):29-38.
23. Opdam NJ, Bronkhorst EM, Roeters JM, Loomans BA. A retrospective clinical study on longevity of posterior composite and amalgam restorations. *Dental materials*. 2007;23(1):2-8.
24. Collins C, Bryant R, Hodge K-L. A clinical evaluation of posterior composite resin restorations: 8-year findings. *Journal of dentistry*. 1998;26(4):311-7.
25. Hickel R, Manhart J. Longevity of restorations in posterior teeth and reasons for failure. *J Adhesive Dentistry*. 2001;3(1).
26. Sidhu SK, Nicholson JW. A Review of Glass-Ionomer Cements for Clinical Dentistry. *J Fncional Biomaterials*. 2016;7(3).
27. Jagger D, Harrison A, Jandt K. The reinforcement of dentures. *J Oral Rehabilitation*. 1999;26(3):185-194.
28. Goodacre CJ, Kan JY, Rungcharassaeng K. Clinical complications of osseointegrated implants. *J Prosthetic Dentistry*. 1999;81(5):537-52.
29. Van Dijken J. Direct resin composite inlays/onlays: an 11 year follow-up. *J Dentistry*. 2000;28(5):299-306.

Cite this article as: Asaad YM, Alhudaithi MK, Alazraqi MS, Almugren SS, Alhumizi NA, Albeshir FA et al. The impact of occlusal forces on the longevity of restorations. *Int J Community Med Public Health* 2023;10:3899-903.