Journal of Current Research in Oral Surgery
2022, Volume 2, Page No: 27-33

Available online at: www.tsdp.net

ISSN: 3062-3480

Original Article

A Systematic Review on the Use of Lasers for Removing All-Ceramic Restorations

Peter Rechmann[1*], Natalie C.H. Buu[1], Beate M.T. Rechmann[1], Frederick C. Finzen[1]

[1] School of Dentistry, Department of Preventive and Restorative Dental Sciences, University of California at San Francisco, 707 Parnassus Avenue, San Francisco, California 94143, USA.

***E-mail** ✉ peter.rechmann@ucsf.edu

Received: 26 May 2022; **Revised:** 10 August 2022; **Accepted:** 11 August 2022

ABSTRACT

All-ceramic restorations are widely favored due to their numerous advantages. However, their limited durability often requires removal or replacement when they lose functionality. Traditional removal methods rely on rotary instruments to grind away the veneer, a process that is both labor-intensive and inconvenient. In contrast, laser-assisted techniques have emerged as a promising alternative for the removal of all-ceramic restorations. This approach offers several advantages that contribute to its growing adoption among dental professionals and increased research interest. This systematic review aims to provide a detailed analysis demonstrating the effectiveness of laser-assisted removal of all-ceramic restorations. The findings indicate that laser-based technology significantly outperforms conventional grinding methods. This technique increases efficiency by minimizing discomfort, preserving the integrity of the underlying tooth structure, and simplifying the procedure. Additionally, laser-assisted removal significantly reduces the time required to complete the process compared to traditional methods.

Keywords: Sexual satisfaction, Pregnant mothers, Healthy mothers, Candidate vaginitis

How to Cite This Article: Rechmann P, Buu NCH, Rechmann BMT, Finzen FC. A Systematic Review on the Use of Lasers for Removing All-Ceramic Restorations. J Curr Res Oral Surg. 2022;2:27-33. https://doi.org/10.51847/XopIjIJbGh

Introduction

Many individuals experience dental issues such as tooth decay, fractures, or alterations due to prior tooth filing [1, 2]. In such cases, ceramic restoration is often necessary to restore the tooth's function and appearance. All-ceramic restoration is a technique that involves the use of crowns or veneers to address these dental concerns. The crown, also known as dental porcelain, is a popular choice due to its advantages, including its suitability for both anterior and posterior restorations. Additionally, its aesthetic appeal allows for customization based on patient preferences, with options such as discoloration, flourishment, and hypo-calcification. Despite these benefits, the longevity of all-ceramic restorations is limited, making their removal inevitable over time.

Conventional methods for removing ceramic crowns are inefficient and problematic, as they often compromise the structural integrity of the restoration. The process is further complicated by the color similarity between the bonding cement and the underlying dentin, making it difficult for the dentist to differentiate between the two. Moreover, traditional removal techniques are time-consuming and can result in damage to the restoration material.

A more advanced alternative is the laser-assisted procedure, which has been introduced as an effective method for removing all-ceramic restorations. This

technique works by reducing the shear strength that binds the ceramic crown to the tooth surface, allowing for easier detachment. Additionally, laser technology significantly shortens the duration of the procedure. However, several factors influence its effectiveness, including the crown's thickness, ceramic composition, laser frequency, and radiation levels. Depending on the specific laser parameters used, the time required for removal may vary. Despite these considerations, laser-assisted removal of all-ceramic restorations is widely regarded as a superior approach compared to conventional methods.

This systematic review aims to provide a detailed analysis demonstrating the effectiveness of laser-assisted removal of all-ceramic restorations.

Materials and Methods

The researcher utilized multiple databases as sources for the research articles included in the systematic review. These databases comprised Google Scholar, PubMed, Z-Library, and PMC. A variety of keywords were applied to refine the search process, including "all-ceramic restorations," "laser-assisted," "crown removal," "laser-aided," and "ceramic rebounding." To ensure that only relevant studies were selected, specific criteria were established for the inclusion and exclusion process after retrieving results from these databases.

1. A study was eligible for inclusion if it was either a scholarly article or a report within the healthcare domain.
2. Only studies published between 2011 and 2021 were considered.
3. Articles had to be available in full text to prevent conclusions based on incomplete information.

The search process was designed to ensure that the selected articles provided relevant insights for concluding the systematic review. Specifically, each study had to address key questions related to the topic. One primary criterion was that the article or report should evaluate the efficiency of laser-aided removal of all-ceramic restorations from a patient's teeth. Additionally, the study needed to determine whether laser-assisted rebounding of all-ceramic restorations offered greater efficiency compared to conventional methods. Another important aspect was assessing whether laser-assisted procedures minimized the rebounding process more effectively than traditional techniques. Lastly, the selected resources were expected to highlight the specific attributes that contributed to the effectiveness of laser-assisted rebounding compared to conventional approaches.

It is important to note that an individual resource was not required to address all these questions to be included in the review. Instead, a study qualified for inclusion if it provided an answer to at least one of the outlined questions. The selected articles were then categorized based on the specific aspect they addressed—efficiency, the time required for rebounding or defining characteristics. This classification facilitated the process of concluding why laser-aided rebounding of all-ceramic restorations is a more effective approach.

The PRISMA chart below will illustrate the methodology used to refine the initial 124 search results from various databases down to the final 15 studies included in the review. In addition, this section will incorporate a Cochrane risk of bias assessment to evaluate the factors influencing the inclusion of studies in the systematic review.

Study Selection

The PRISMA chart and the Cochrane risk of bias assessment outline the process followed in selecting the studies included in the systematic review, as well as the factors that influenced the inclusion of specific articles or reports.

PRISMA Chart

The PRISMA chart below provides a visual representation of the methodology used to gather and refine the information utilized in this research (**Figure 1**). The diagram will detail the identification phase, where articles retrieved from various databases are documented. It will also illustrate the number of studies that remained after the screening process and highlight the final selection of articles used to derive conclusions. Furthermore, each section of the PRISMA chart will specify the reasons for excluding certain resources from the review.

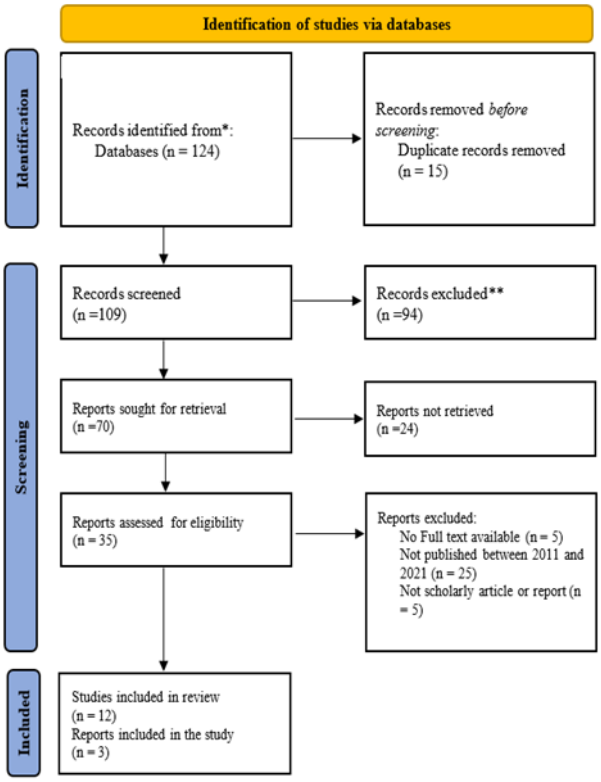

Figure 1. PRISMA chart illustrating the article screening process for inclusion in the systematic review

Cochrane Risk of Bias Assessment

The selected studies will be classified into three bias categories: low risk, some concerns, and high risk. Studies categorized as low-risk bias do not exhibit factors that could introduce bias, while those classified as high-risk bias contain elements that significantly affect the reliability of the findings. **Table 1** presents the bias assessment for the studies included in the systematic review.

Table 1. Cochrane risk of bias assessment

Author	Cochrane risk of bias assessment
Kellesarian *et al.*	Low
Ghazanfari *et al.*	Low
Bernal *et al.*	Some concerns
Deeb *et al.*	High
Grzech-Leśniak *et al.*	Some concerns
Morshedi *et al.*	Some concerns
Assat	Low
Walid	Low
Culhaoglu *et al.*	Low
Van As	Some concerns
Yilmaz *et al.*	Low
Pradhan and Gupta	Some concerns
Sari *et al.*	Low
McCall	High
Kunt and Duran	Low

Study characteristics

The studies included in this systematic review were published between 2011 and 2021. Both research studies and reports about the topic within this timeframe were considered for inclusion. As a result, the participant profiles varied, as each research or report focused on a distinct research population. To ensure comprehensive analysis, only studies with full-text availability were selected for inclusion in the review.

Results and Discussion

Table 2 provides a summary that was used to generate the results presented in the systematic review.

Table 2. Summary of studies included in the systematic review

Author	Category	Title	Year of publication	Type	Findings
Kellesarian *et al.*	Efficiency	Laser-assisted removal of all-ceramic fixed dental prostheses: A comprehensive review	2017	Scholarly article	The study concludes that laser-assisted technology shows great potential, as it enables crown removal without harming the surface of the tooth.
Ghazanfari *et al.*	Time-taken	Laser-aided ceramic restoration removal: A comprehensive review	2019	Scholarly article	The study concludes that laser-assisted technology for removing all-ceramic restorations is more time-efficient and preserves the integrity of the tooth's surface.
Bernal *et al.*	Features	Retreatment of 6 ceramic restorations in a single session-the application of Er: YAG laser and CAD/CAM technology: An 1 year follow up clinical evaluation	2021	Report	The study highlights the technological aspects that enhance the effectiveness of removing all-ceramic restorations by simplifying the procedure and minimizing bleeding.
Deeb *et al.*	Efficiency	Using Er: YAG laser to remove lithium disilicate crowns from zirconia implant abutments: An in vitro study	2019	Scholarly article	The study shows that laser-assisted technology allows for the removal of all ceramic restorations without inflicting any damage.
Grzech-Leśniak *et al.*	Efficiency	Utilization of Er: YAG laser in retrieving and reusing of lithium disilicate and zirconia monolithic crowns in natural teeth: An in vitro study	2020	Scholarly article	The article illustrates that laser-assisted technology is effective for removing all-ceramic restorations, as it preserves the appearance of the teeth.
Morshedi *et al.*	Time taken	Effect of Er: YAG laser irradiation on shear bond strength of two porcelain laminate veneers bonded to the tooth surface	2020	Scholarly article	The article shows that laser-assisted removal of all-ceramic restorations is effective as it reduces the bond strength between the tooth's surface and the crown.
Assat	Features	A novel approach to veneer removal: a clinical case report using Er, Cr: YSGG laser	2018	Report	The characteristics of veneers and ceramic crowns enable dentists to enhance patient satisfaction.
Walid	Features	Application of laser technology in fixed prosthodontics —A review of the literature	2020	Scholarly article	The article suggests that laser-assisted technology improves patient satisfaction by removing all-ceramic restorations without causing pain or noise.
Culhaoglu *et al.*	Efficiency	The efficiency of laser application for debonding laminate restorations manufactured of current CAD-CAM materials with different thicknesses	2021	Scholarly article	The article's findings suggest that laser-assisted technology is an effective method for removing ceramic restorations, as it does not result in any damage.
Van As	Time taken	Using the erbium laser to remove porcelain veneers in 60 seconds	2013	Scholarly article	The article concludes that the removal of all-ceramic restorations using laser assistance is more time-efficient than traditional methods.
Yilmaz *et al.*	Features	The contribution of ceramic thickness and adhesive type on the de-bonding strength of dental ceramic veneers using Er, Cr: YSGG laser.	2019	Scholarly article	The article describes how the laser effectively weakens the bond of all-ceramic restorations.
Pradhan and Gupta	Efficiency	Laser-assisted smile designing	2011	Report	The report claims that laser-assisted removal of all-ceramic restorations is painless and promotes rapid healing.
Sari *et al.*	Features	Transmission of Er: YAG laser through different dental ceramics	2014	Scholarly article	The article highlights the factors that should be taken into account when selecting a laser for the rebounding process.
McCall	Time taken	Non- invasive retrieval of prefabricated zirconia crowns with non-invasive retrieval of prefabricated zirconia crowns with Er, Cr: YSGG laser from primary and permanent teeth Er, Cr: YSGG	2020	Scholarly article	The article details the characteristics that contribute to reducing the time required to weaken the bond between the crown and the tooth.

		laser from primary and permanent teeth			
Kunt and Duran	Efficiency	Effects of laser treatments on surface roughness of zirconium oxide ceramics	2018	Scholarly article	The article sought to assess the effects of laser-assisted technology in the removal of all-ceramic restorations.

This section of the systematic review will explore the results derived from the variables considered in the study. The discussion will be organized into three categories, each designed to address questions that align with the objectives of the paper, as outlined below:

Efficiency

The efficiency of the laser-assisted procedure in removing all-ceramic restorations is crucial in determining whether this new technology surpasses conventional methods. Numerous studies have provided valuable insights into the effectiveness of laser-aided technology for removing crowns and veneers. Kellesarian et al. conducted research to assess the effectiveness of laser-aided technology for removing all-ceramic restorations. Key benefits highlighted in the study include the prevention of tooth surface damage, ease of use, and reduced time compared to traditional methods [3]. Additionally, another study explored the effectiveness of the Er: YAG laser in removing all-ceramic restorations. The findings indicate that the laser-assisted method protects enamel from damage and avoids fractures in restorations [4]. The study also mentions ongoing advancements in the field aimed at improving the technology's efficiency for consumers.

Another consideration was whether the laser-aided procedure caused alterations during crown removal. Various studies showed that minimal changes occurred during this process [5, 6]. Furthermore, Gupta and Pradhan's research highlights how laser-aided technology has simplified the rehabilitation of teeth, creating a painless procedure that also offers quicker recovery times [7]. The advent of laser-aided technology in removing all-ceramic restorations offers significant promise for the dental field. However, it is also important to assess the potential drawbacks. Kunt and Duran noted that laser-aided technology could cause roughness on the ceramic surface, particularly when zirconium oxide is affected by elevated carbon dioxide levels [8].

Time

One of the disadvantages of traditional methods for removing all-ceramic restorations is the time required for the procedure. Therefore, evaluating the time efficiency of the laser-aided approach was crucial. Ghazanfari *et al.* [9] highlighted that the laser-aided procedure uses 3 mechanisms in the rebounding process: photo-ablation, thermal softening, and thermal ablation. Laser irradiation is directed through the veneers or crowns to interact with and weaken the bonding cement. The reduction in the strength of the bonding cement allows dentists to separate the tooth from the crown more easily [10].

However, it is important to consider factors that could affect the time needed to complete the rebounding process when removing all ceramic restorations. Morshedi et al. suggest that critical factors influencing the procedure's duration include the crown material, surface area, and the thickness of the veneering layer [10]. Although several studies have indicated that laser-aided technology reduces the time needed to remove all ceramic restorations, there is no clear consensus on the exact duration of the process. For example, McCall's study suggests that it takes approximately three minutes and 47 seconds to remove a crown from molars and two minutes and five seconds from premolars [11]. In contrast, Van As claims that removing porcelain veneers from a tooth takes only 60 seconds [12]. Therefore, further research is needed to establish a more accurate understanding of the time efficiency of laser-aided removal of all ceramic restorations.

Features

Identifying the key features that make laser-assisted removal of all-ceramic restorations a more efficient procedure is crucial. Bernal et al. carried out a study to explore the factors that contribute to the effectiveness of the laser-aided approach in removing all-ceramic restorations. The research found that using the Er: YAG laser in the procedure reduced working time by 75% [13]. Additionally, the study highlighted the integration of CAM/CAD technology in the process, which enables the procedure to be completed in one session without the need for follow-up appointments. Another significant finding is that water plays a crucial role in the energy absorption process during laser-aided removal of all-ceramic restorations using the Er: YAG laser [14]. The research emphasizes that water is the primary component involved in this energy absorption. The Er: YAG laser, known for its popularity in this field, operates at a speed of 0.5 mm/min during the removal process [15, 16]. In another study, Azzat found that erbium lasers utilize water to enhance the

weakening of the rebounding procedure [17]. Water absorbs the energy, which in turn weakens the bond between the veneers and the tooth surface. However, the research also indicated that the effectiveness of energy absorption depends on the thickness of the cement used to facilitate the removal of the restorations.

Conclusion

The systematic review indicates that the use of laser-assisted technology for the removal of all-ceramic restorations is significantly more effective than traditional grinding methods. This technique offers several advantages, including ease of access, minimal discomfort for patients, and preservation of the tooth surface. Additionally, procedures performed with laser technology are completed in a shorter timeframe. Nonetheless, further research is recommended to accurately assess the duration of the process. Ultimately, the effectiveness of laser-assisted removal depends on various factors, such as the crown material, surface area, and thickness, which influence its efficiency compared to conventional techniques.

Acknowledgments: The authors express their gratitude for the support and collaboration of the research center at Riyadh Elm University.

Conflict of Interest: None

Financial Support: None

Ethics Statement: Ethical approval was secured from the REU review board.

References

1. Hamed MT, Mously HA. Investigating Economic and Clinical Implications of Tooth Implant Supported Prosthesis among Patients and Practitioners. Int J Pharm Res Allied Sci. 2019;8(4):116-21.
2. Asgari I, Soltani S, Sadeghi SM. Effects of Iron Products on Decay, Tooth Microhardness, and Dental Discoloration: A Systematic Review. Arch Pharm Pract. 2020;11(1):60-82.
3. Kellesarian SV, Ros Malignaggi V, Aldosary KM, Javed F. Laser-assisted removal of all-ceramic fixed dental prostheses: a comprehensive review. J Esthet Restor Dent. 2017;30(3):216-22.
4. Culhaoglu AK, Kilicarslan MA, Gokdeniz B, Gur G. The efficiency of laser application for debonding laminate restorations manufactured of current CAD-CAM materials with different thicknesses. Niger J Clin Pract. 2021;24(5):705-11. Available from: https://pubmed.ncbi.nlm.nih.gov/34018980/
5. Deeb JG, Bencharit S, Dalal N, Abdulmajeed A, Grzech-Leśniak K. Using Er: YAG laser to remove lithium disilicate crowns from zirconia implant abutments: An in vitro study. Plos One 2019;14(11):e0223924.
6. Grzech-Leśniak K, Bencharit S, Skrjanc L, Kanduti D, Matys J, Deeb JG. Utilization of Er: YAG laser in retrieving and reusing of lithium desilicated and zirconia monolithic crowns in natural teeth: an in vitro study. Appl Sci. 2020; 10(12):4357.
7. Pradhan S, Gupta M. Laser-assisted smile designing. Int J Laser Dent. 2011;1(1):45-7.
8. Kunt GE, Duran I. Effects of laser treatments on surface roughness of zirconium oxide ceramics. BMC Oral Health. 2018;18(1):1-7.
9. Ghazanfari R, Azimi N, Nokhbatolfoghahaei H, Alikhasi M. Laser aided ceramic restoration removal: a comprehensive review. J Lasers Med Sci. 2019;10(2):86-91. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6499569/
10. Morshedi E, Zavaree M, Mohammad S, Hakimaneh R, Shayegh S, Pirmoradian M, et al. Effect of Er: YAG laser irradiation on shear bond strength of two porcelain laminate veneers bonded to tooth surface. J Iran Dent Assoc. 2020;32(1):21-9. Available from: http://jidai.ir/article-1-2100-en.pdf
11. Mccall C. Non-invasive retrieval of prefabricated zirconia crowns with non-invasive retrieval of prefabricated zirconia crowns with Er, Cr: YSGG laser from primary and permanent teeth Er, Cr: YSGG laser from primary and permanent teeth; 2020. Available from: https://scholarscompass.vcu.edu/cgi/viewcontent.cgi?article=7252&context=etd
12. Van As G. Using the erbium laser to remove porcelain veneers in 60 seconds minimally invasive, efficient, and safe. J Cosmet Dent 2013;28(4):21-34. Available from: https://aacd.com/proxy.php?filename=files/Dental%20Professionals/jCD/Vol.28/Issue%204/28-4_vanas.pdf
13. Bernal CG, Lee EMR, Eduardo CDP, Souza AMA, Azevedo LH. Retreatment of 6 ceramic restorations in a single session - the application of er: YAG laser and CAD/CAM technology: a 1-

year follow-up clinical evaluation. Braz Dent Sci. 2021;24(2).
14. Walid AJ. Application of laser technology in fixed prosthodontics —a review of the literature. Open J Stomatol. 2020;10(10):271-80.
15. Yilmaz BD, Polat ZS, Izgi AD, Gunduz DT, Dirihan RS. The contribution of ceramic thickness and adhesive type on the de-bonding strength of dental ceramic veneers using Er, Cr: YSGG laser. J Oral Res. 2020;8(2):131-9.
16. Sari T, Tuncel I, Usumez A, Gutknecht N. Transmission of Er: YAG laser through different dental ceramics. Photomed Laser Surg. 2014;32(1):37-41.
17. Azzat A. A Novel Approach to Veneer Removal: A clinical case report using er,cr: YSGG laser. Oral Health Group 2018 [cited 2021 Jun 27]; Available from: https://www.oralhealthgroup.com/features/a-novel-approach-to-veneer-removal-a-clinical-case-report-using-ercrysgg-laser/