Review Article

LASER-ASSISTED REMOVAL OF ALL-CERAMIC RESTORATIONS: A SYSTEMATIC REVIEW

Khalid Mohammed AlShehri[1], Waleed Saeed Alqahtani[2], Ibrahim Shaya Alqahtani[3], Mohammed Ayed Albalawi[2], Naif Munawir Alotaibi[2], Kholoud Yahya Alahdal[4]*

[1] *Department of Dentistry, Special Emergency Forces, Riyadh, KSA. khaledalshehr1995@gmail.com*
[2] *General Dentist, Private Sector, Riyadh, KSA.*
[3] *Department of Dentistry, Ministry of Health, Riyadh, KSA.*
[4] *Department of Restorative Dental Sciences, Security Forces Hospital, Riyadh, KSA.*

https://doi.org/10.51847/cvBEagK4iN

ABSTRACT

All-ceramic restoration is popular due to the wide range of benefits associated with it. Nevertheless, all-ceramic restoration has a short life span, which necessitates replacement or removal when it is no longer effective. The traditional techniques used in removing the all-ceramic restoration involved utilizing rotary instruments to grind the veneer and this made the procedure time-consuming as well as inconvenient. However, the use of a laser-assisted approach is a promising treatment protocol in removing the all-ceramic restoration. The procedure is characterized by a wide range of advantages that lead to a surge in its popularity among dentists and also emaciates interest among researchers. The systematic review intends to provide a comprehensive systematic review that will demonstrate laser-assisted removal of all-ceramic restoration as an effective approach. The systematic review reveals that using laser-aided technology to remove all-ceramic restorations is a much more effective process compared to the conventional grinding mechanisms. Firstly, the procedure is efficient because it is easy to procure, associated with minimum pain, and does not result in damages to the patient's tooth surface. Secondly, the time taken to complete the procedure is less when using laser-aided technology.

Key words: Laser-assisted, Laser-aided, Crown removal, All-ceramic restorations, Ceramic rebounding.

Introduction

Often, people struggle with dental health issues such as tooth decay, breakages, or individuals that have previously filed their teeth [1, 2]. Such instances require ceramic restoration of the tooth. All-ceramic restoration refers to an approach used to repair various dental health issues such as the ones outlined above using a crown or veneer. The crown is also commonly referred to as dental porcelain. An all-ceramic restoration is a preferred approach because it is characterized by several benefits such as its effectiveness when used for both anterior and posterior restorations. Furthermore, since the crowns are aesthetic, multiple strategies can be used in improving their appearance to fit the specific preferences of the customer. For instance, the crown can be discolored, flourished, and hypo-calcified. Nevertheless, the benefits associated with this process have a limitation due to the life span constraint associated with it. Consequently, it becomes inevitable to remove the all-ceramic restorations from the patient's teeth after a given period. The traditional methods used to remove the crown from the tooth's surface are inefficient and inconvenient because they destroy the ceramic, which damages the integrity of the material. Moreover, the procedure is time-consuming because underlying dentin and bonding cement share the same color, thus making it is extremely difficult for the dentist to distinguish between the two.

The laser-assisted procedure is the new invention utilized in the removal of all-ceramic restorations. The procedure is considered to be efficient because it reduces the shear strength that the ceramic crown uses to hold onto the tooth's surface. Moreover, the time is taken to complete the process significantly reduces. However, it is essential to note that even though laser-aided rebounding of all-ceramic restorations is popular, multiple factors influence its effectiveness such as the thickness of the crown, chemical composition in the ceramic, laser frequency, and radiation. Hence, depending on the type of laser used, the time taken could differ. However, despite the existing shortcomings, laser-assisted rebounding of all-ceramic restoration is considered a more effective process compared to the conventional methods used in the past.

Materials and Methods

The researcher considered different databases as the source of the research articles included in the systematic review. These databases include PubMed, Google Scholar, Z-Library, and PMC. Different terms were used as the keywords that guided the search for the resources considered in this study including "laser-assisted," "laser-aided," "crown removal," "all-ceramic restorations," and "ceramic rebounding." Below are some factors considered for the inclusion or exclusion procedure after the search in various databases to ensure that only relevant articles are featured.

1. The search result would be considered for inclusion in the study if it is either a report within the healthcare field or a scholarly article.
2. The report or the scholarly article must be published in the period between 2011 and 2021.
3. The report or the article must be available in full to ensure that the conclusion made is not a judgment from partial details.

Moreover, the search process aimed at ensuring that the articles chosen to make conclusions in the current systematic review answered some questions that are relevant to the topic of study. For instance, either the report or scholarly article had to address the efficiency in using laser-aided removal of all-ceramic restorations from a patient's teeth. Furthermore, the article should help to answer whether laser-assisted rebounding of all-ceramic restorations was a more efficient strategy compared to other conventional processes. Another critical question that the resources considered should answer is whether a laser-assisted procedure is capable of minimizing the rebounding process compared to the conventional approaches. Finally, the resource should outline the features or qualities that made the laser-assisted rebounding method more effective compared to other conventional methods. It is essential to note that a single resource may not necessarily answer all the intended questions. Hence, a resource qualifies to be included in the study if it responded to only one of the above questions. Additionally, it is essential to note that the resources included in the study were classified depending on the question that was answered, namely efficiency, time-taken to rebound, and features. Accordingly, it would be possible to deduce conclusions for the present systematic review demonstrating aspects that make laser aided rebounding of all-ceramic restorations a more effective process.

The PRISMA Chart below will illustrate the process involved in narrowing down the research to 15 studies from a total of 124 results acquired in various databases. Additionally, this section will conduct a Cochrane risk of bias assessment aimed at illustrating the factors that would influence the inclusion of the study in the systematic review.

Study selection

The PRISMA chart and the Cochrane risk of bias assessment illustrate the procedure followed in selecting studies featured and factors that influence the inclusion of an article or a report in the systematic review.

PRISMA chart

The PRISMA chart below helps to demonstrate the methodology procedure used to correct information used to conclude the current study **(Figure 1)**. The diagram will feature the identification phase where all the articles from each of the databases will be noted. Additionally, it will show the number of articles that remained after the screening process and eventually accounting for the studies that will be considered to deduce the results as illustrated below. Importantly, in each section, the PRISMA chart will demonstrate the reason why the resource was excluded from the study.

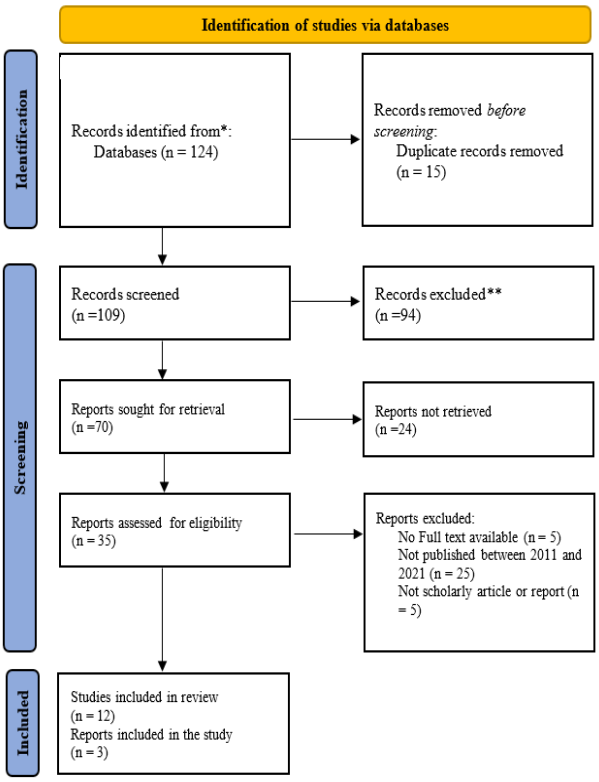

Figure 1. PRISMA Chart demonstrating the screening process for articles used in the systematic review

Cochrane risk of bias assessment

The studies will be categorized into three types of bias, namely low risk, some concerns, and high-risk bias. The low-risk bias is articles that lacked any factor that would trigger biases, while the high risk has factors that trigger a lot of bias. Below is **Table 1**, demonstrating the bias assessment for various studies used 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 featured in the systematic review were published in the period between 2011 and 2021. It is vital to note that both reports and research studies relevant to the topic of a study published within the period were considered for inclusion in the systematic review. Hence, the profile of the participants is diverse since each study or report had a unique research population. The studies and reports considered to compile the findings of the systematic review needed to have their full version accessible.

Results and Discussion

Below is **Table 2**, outlining a summary considered to derive the results discussed 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 is a promising technology since it facilitates the removal of crowns without causing damages on the tooth's surface.
Ghazanfari *et al.*	Time-taken	Laser Aided Ceramic Restoration Removal: A Comprehensive Review	2019	Scholarly article	The study concludes that using laser-assisted technology to remove all-ceramic restorations takes less time and does not destroy 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 points to the technological features that make the removal of all-ceramic restorations effective by easing the process and preventing 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 demonstrates that the use of laser-assisted technology to remove all-ceramic restorations without causing any damages.
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 demonstrates that laser-assisted is an effective technology in removing all-ceramic restorations because it does not change 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 Tooth Surface	2020	Scholarly article	The article reveals that laser-assisted removal of all-ceramic restorations is effective because it weakens the bond 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	Veneers and ceramic crown features help dentists achieve customer satisfaction.
Walid	Features	Application of Laser Technology in Fixed Prosthodontics —A Review of the Literature	2020	Scholarly article	The article argues that laser-assisted technology enhances customer satisfaction because it eliminates pain and noise while removing all-ceramic restorations.
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 findings of the article argue that laser-assisted technology is an effective approach in removing ceramic restorations because it does not cause any damages.
Van As	Time taken	Using the Erbium Laser to Remove Porcelain Veneers in 60 Seconds	2013	Scholarly article	The article concludes that laser-aided removal of all-ceramic restorations takes less time compared to conventional 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 explains the effectiveness of the laser in weakening the all-ceramic bond.
Pradhan and Gupta	Efficiency	Laser-Assisted Smile Designing	2011	Report	The report argues that laser-assisted removal of all-ceramic restoration is not painful and heals quickly.
Sari *et al.*	Features	Transmission of Er: YAG Laser Through Different Dental Ceramics	2014	Scholarly article	The article emphasizes the considerations that ought to be made when choosing a laser to use in 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 Laser from Primary and Permanent Teeth	2020	Scholarly article	The article outlines the features that help to minimize the time taken to weaken the bond between the crown and tooth.
Kunt and Duran	Efficiency	Effects of laser treatments on surface roughness of zirconium oxide ceramics	2018	Scholarly article	The article aimed to evaluate the impact of laser-assisted technology when removing all-ceramic restoration.

In this section, the systematic review will discuss the findings made from the variables included in the systematic review. The discussion will be subdivided into three different categories aimed at answering questions aligned with the paper's objective as follows;

Efficiency

The efficiency of laser-aided procedure in removing all-ceramic restorations play a vital role in determining which between the new technology and the conventional approaches is better suited for use in this process. Several studies have highlighted different insights relating to the effectiveness of laser-aided technology in removing veneers and crowns. Kellesarian *et al.* conducted a study aimed at identifying the effectiveness of using laser-aided technology in the removal of all-ceramic restorations. Among the benefits identified in this study include lack of capability to damage the surface of the teeth, ease of use, and takes less time than the conventional approaches [3]. On the other hand, another study also reviewed the aspects that make Er: YAG laser an efficient method of removing all-ceramic restorations. The study reveals that the laser-aided procedure protects the enamel from experiencing any damages as well as avoids causing restoration fractures [4]. Moreover, the study notes that there are multiple developments in this field aimed at enhancing its effectiveness when used among consumers. Another factor under consideration was whether the laser-aided procedure made any alterations when removing the crowns, whereby different studies demonstrate that minimum changes were incurred [5, 6]. Finally, a study by Gupta and Pradhan illustrates the advancement among dentists as it simplifies the process of rehabilitating teeth. Moreover, the scholars argued in the report that using laser-aided procedures helped in inventing a painless procedure that is also associated with a quick recovery process [7]. As such, the invention of laser-aided technology in removing all-ceramic restorations brings a lot of hope in dentistry. Alternatively, it was also essential to consider the impact of using laser-aided technology in removing veneers and crowns. According to Kunt and Duran, the laser-aided technology leads to a rough surface on the ceramic surface, especially if compromising of zirconium oxide due to increased levels of carbon dioxide [8].

Time

Time consumption is among the characteristic that disadvantages the conventional procedures of removing all-ceramic restorations. Hence, it was of paramount importance to evaluate the time it took for the laser-aided approach to complete the process. According to Ghazanfari *et al.*, laser aided procedure uses three mechanisms in the rebounding process, namely photo-ablation, thermal softening, and thermal ablation [9]. Laser irradiation is usually transferred through the crowns or veneers aimed at reacting and weakening the bonding cement. The decreased strength of the bonding cement makes it easy for the dentists to separate the tooth from the crown with much ease [10]. However, it is essential to evaluate some factors that are likely to influence the time taken to complete the re-bounding process when removing all-ceramic restorations. Morshedi *et al.* argue that some critical factors to consider in this case include the material of the crown, surface area, and the thickness used on the veneering layer [10]. Even though different studies argued that the use of laser-aided technology minimized the time taken to remove all-ceramic restorations, there seems to lack a correlation on the actual time that the process takes to complete. In one of the studies, McCall argues that it would take at least 3 minutes and 47 seconds to remove a crown on molars and 2 minutes 5 seconds on premolars [11]. On the other hand, Van As argues that it would only take 60 seconds to remove porcelain veneers on an individual's teeth [12]. Hence, it is

recommendable that more research is conducted to determine the effectiveness of laser-aided removal of all-ceramic restorations through the reduction of time taken to complete the procedure.

Features

It is essential to identify the various features that make laser-assisted removal of all-ceramic restorations a more efficient procedure. Bernal *et al.* conducted a study aimed at identifying factors that make the laser-aided approach a more effective strategy in removing all-ceramic restorations. The study reveals that the procedure is capable of reducing the working time by 75% using the Er: YAG laser [13]. Moreover, the study also revealed that laser-aided procedure uses CAM/CAD technology, which makes it possible to complete the process once without the need for the patient to have subsequent appointments. It is further evident that laser-aided removal of all-ceramic restorations using Er: YAG laser has water playing a critical role in the absorption process [14]. Additionally, the study reveals that water is the main component in the energy absorption procedure. The Er: YAG laser is the most popular laser-assisted procedure in removing all-ceramic restorations and it uses a speed of 0.5mm/min [15, 16]. On the other hand, Azzat conducted a study that reveals that Erbium lasers utilize water to weaken the rebounding procedure [17]. The process uses water to absorb the energy that weakens the bond between the veneers and the tooth's surface. However, the study further reveals that energy absorption in the process depends on the thickness of cement used to weakening the restorations for easier removal.

Conclusion

The systematic review reveals that using laser-aided technology to remove all-ceramic restorations is a much more effective process compared to the conventional grinding mechanisms. Firstly, the procedure is efficient because it is easy to procure, associated with minimum pain, and does not result in damages to the patient's tooth surface. Secondly, the time taken to complete the procedure is less when using laser-aided technology. However, it is recommendable that more research is conducted in this area to determine the actual time it takes to complete the process. Finally, the laser-aided technology relies on numerous features that make the procedure effective compared to the conventional methods. Such factors include material of the crown, surface area, and thickness of the crown influences the effectiveness of laser-aided technology in removing all-ceramic restorations.

Acknowledgments: Authors of this study would like to acknowledge the support and cooperation of the research center of Riyadh Elm University.

Conflict of interest: None

Financial support: None

Ethics statement: An ethical approval was obtained from the REU review board.

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