



Clinical Success of Direct V/S Indirect Composite Restorations: a Systematic Review

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Abstract

The present systematic review aims to compare the clinical effectiveness of direct and indirect composite restorations in the posterior teeth by taking into consideration several clinical factors including the marginal status, surface finish, color change and the overall patient opinion. This paper, based on the randomized controlled trials and clinical studies, was designed to introduce a comparison between the two techniques, shed light on the strength and weakness of the two, and contribute to dental practice. The risk of bias for the randomized controlled trials was evaluated by the Cochrane Risk of Bias tool and the quality of the observational studies by Newcastle–Ottawa Scale. These tools assess different parameters of study quality such as participant selection, reporting, performance, detection and attrition biases. The studies show that though, both techniques have their advantage and disadvantages, overall, indirect composite restorations provide better results in some or many ways, where marginal adaption, surface finish is considered but they take more time and cost.

Keywords: Direct restorations, indirect restorations, case-control study, restorative dentistry.

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Introduction

The desire for more esthetic dental materials has caused a propensity for tooth-colored, non-metallic restorative materials like composites. Composite restorations can be classified into two main categories: These are; direct and indirect. Several types of direct composites; they are done in a single sitting and involve placing the composite material directly on the prepared tooth in layers and then curing under light. Direct composite restorations, on the other hand, are those that are applied and adapted to the cavity in the mouth, chair side while indirect composite restorations require the restoration to be made in a dental laboratory and then cemented at a later date.

Ceramic restorations have been particularly favored because of their aesthetic properties but this has been encountered with such

disadvantages as expensive, fragile, and has the potential of causing wear on the contacting surface of the opposing arch. Resin composites on the other hand have received much preference especially in the posterior teeth to show properties such as esthetics, economical and reduced abrasiveness. Of the various reinforced composites, hybrid, microfilled and Nano filled composites are widely used and out of these, Nano filled composites are much prized for both their translucency and physical properties. The decision on which of them to use is a crucial one in restorative dentistry as it depends on the degree of the crown loss, the load applied on the teeth, aesthetic consideration and the patient's preference (Karaarslan et al. 2020). Direct restorations are developments which are aesthetically more conservative and less destructive to the



remaining tooth structure than indirect restorations; however, they have the disadvantages of being the least enduring and more susceptible to wear and marginal failure than indirect restorations. Although more technique sensitive, time consuming and expensive, indirect restorations provide better control over the final contour, occlusal relationship and marginal fit of the restoration. This systematic review aims to compare the clinical performance of direct and indirect composite restorations in posterior teeth, addressing the question: Is the clinical efficiency of direct composite restoration more efficient than indirect composite restoration in the posterior teeth.

Traditional Approaches and Limitations

In restorative dentistry, composite materials have been employed, from time immemorial, for the treatment and restoration of posterior teeth. Conventional abutment restorations have been done using direct and indirect composites, the choice between which depends on certain merits and demerits. These classification encompasses restoration in which the composite resin is placed directly on the prepared tooth surface during one seating appointment. It is built up layer by layer and can be modeled to the shape of the cavity and the anatomy of the tooth before it is subjected to a curing light. Eugenol cementation has been found greatly preferred because it leaves much of the tooth surface intact while it is less expensive and takes less time to fabricate than indirect restorations. However, direct restorations are operator sensitive and required a great deal of finesse to accomplish. The technique is sensitive one and proper isolation, careful layering and adequate curing to avoid problems such as incompletely polymerized composite, marginal gaps and secondary caries. Further, direct restorations are generally more susceptible to wear, marginal stain, and fracture as they are indicated for post clinical service which in most cases is the high stress areas the posterior teeth. Although their application is esthetic in nature, direct composites are capable of undergoing changes

in appearance as a result of rough surfaces and staining. The direct composite restorations are placed inside the patients mouth while the indirect composite restorations are prepared in a dental laboratory. It involves making an impression of the prepared tooth, making a model and making the restoration out of composite resin under conditions. They are then cemented onto the tooth during a second visit since it is not practicable to complete all the restorations in one sitting (Manhart et al. 2019). Microfilled indirect restorations have the pros over the direct techniques which include a better fit, long service, and a better appearance. The controlled laboratory environment can provide higher degrees of polymerization, a better mechanical characteristic and accurate product. However, these benefits are not without preconditions as well as severe drawbacks. In indirect restorations, the tooth preparations necessary are deeper; this weakens the rest of the tooth structure and the health of the tooth in general. The process is also lengthy and costly due to the several appointments for making an impression, providing a temporary restoration, and cementing the final restoration. Moreover, with daily application of the restoration, the fabrication becomes intricate and may have large or small flaws, for instance, inaccuracy in the impression, during laboratory treatments, affecting both the suitability and durability of the appliance. In general, direct and indirect traditional methods of composites over the years have been quite reliable for various types of dental restorations; however, they also come with some limitations. Direct restorations are less invasive than indirect restorations and comparatively cheaper but they are technique sensitive and they may not be as long-lasting as indirect restorations (Pallesen and Qvist 2019).

Materials and Methods

Search Strategy

The present systematic review followed the PRISMA guidelines for efficient and bias free data extraction. An extensive systematic approach regarding the research guidelines was



used in the current review in order to provide the comparison of clinical outcomes of direct and indirect composite restorations in posterior teeth. The search was performed across three major databases: Some of the databases included in the search were PubMed, Medline, and the Cochrane Database of Systematic Reviews. These databases were selected due to the coverage of the highest quality peer-reviewed articles and clinical researches in the field of dentistry and the related disciplines. The search involved the use of keyword and Boolean operators so as to make more refined search that would enable the inclusion of studies that were core to the research question.

Data Collection and Extraction

The preliminary identification involved 117 papers; title and abstracts were compared to exclude irrelevant papers. From the 175 identified papers, 88 papers were only excluded following an initial data review because they were not related to the inclusion criteria or were just duplicates. The titles and abstracts of the remaining 29 papers were reviewed and 27 of these corresponded with the inclusion criteria of this systematic review, therefore, full-text articles were retrieved. It was in this process that we rejected 18 papers, mainly because they did not address the question of direct and indirect composite resin restorations comparing the results of at least one clinical outcome measure, or had serious methodological shortcomings. As a result, 11 of the initial number of studies complied with all criteria of the method and were included in the analysis. However, further two similar kind of research articles were retrieved by manually

going through the references and some selected journals making the total of foregoing research articles to thirteen. Information regarding each of the studies was obtained by using a form of data extraction that was developed for the purpose of the review. The study aimed to provide information on overall study characteristics, such as the study design, sample size, demographic data of patients, direct or indirect restorations utilised, clinical measures evaluated, follow-up time and main results. The data extraction process was done in duplicate at individual level to reduce potential of bias in the study. Inter-reviewer differences were settled through a mutual consensus through possibly a third reviewer in case of inconsistency.

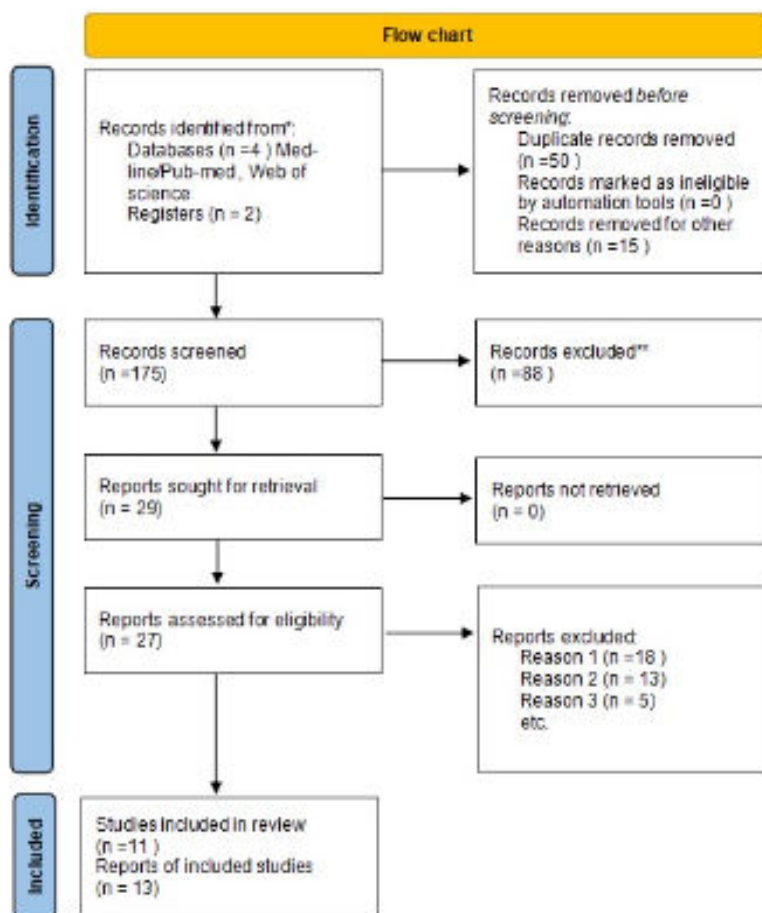
Quality Assessment

The risk of bias for the randomized controlled trials was evaluated by the Cochrane Risk of Bias tool and the quality of the observational studies by Newcastle–Ottawa Scale. These tools assess different parameters of study quality such as participant selection, reporting, performance, detection and attrition biases. Every piece of study was assessed in terms of the risk of bias as defined by the aforementioned tools: low, moderate, or high. The quality assessment proved useful in fixing the meaning of the results obtained as well as in identifying the confirmation that the studies offered.

Inclusion and Exclusion Criteria

The following are the characteristics of eligibility for both inclusion and exclusion of theoretical constructs in the systematic review:





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Inclusion Criteria:

Criteria Type	Description
Inclusion Criteria	<ul style="list-style-type: none"> Select 18–55-year-old adults with significant posterior teeth. Direct composite restorations were evaluated for marginal adaptability, surface polish and stability, esthetics, patient satisfaction, retention, and secondary caries. Used composite materials to compare direct and indirect avoidance restorations in posterior teeth. Clinical performance, marginal adaptability, wears characteristics, patient perception, or secondary caries. . Those with English or translated results.

Exclusion Criteria:

Criteria Type	Description
Exclusion Criteria	<ul style="list-style-type: none"> Case reports, case series, animal studies, in vitro studies, and research lacking direct and indirect composite restoration comparisons were excluded.



- Pediatric, geriatric, and non-vital tooth studies were excluded.
- Excluded studies that merely examined mechanical parameters without clinical connection.

Results:

The Role of Direct and Indirect Composite Restorations in Clinical Success

Several predictors are used to measure the clinical effectiveness of direct and indirect composite restorations which can include the ability of the restoration to maintain the marginal seal, wear resistance, aesthetics to the surrounding dentition and patient satisfaction over time.

Direct Composite Restorations:

Direct composite restorations have been performed frequently because of its conservative approach, comparatively inexpensive and short treatment time needed for the procedure. These restorations are particularly useful in cases of minimal tooth structure loss or where by one wants to be as conservative as possible. From the literature, it can be concluded that based on caries increment, complication, retention and esthetic outcome, color stability and patient satisfaction, Direct restorations are rather satisfactory as short to medium term restorative material (Scheibenbogen et al. 2021). Nonetheless, short-term outcome and conservative direct restorations are threatened by marginal degradation, surface roughness and secondary caries in high-stress areas of the oral cavity.

Indirect Composite Restorations:

There is therefore a significantly greater benefit for indirect composite restorations especially with regard to the Marginal adaptation and wear factor. The other techniques employed in

making indirect restorations are characterized by other curing processes which lead to a higher degree of polymerization thus increase the physical properties of the restorations while minimizing on polymerization shrinkage (Wassell et al. 2021). These restorations also favorably compare in anatomic form, occlusion, and esthetics, thereby making them ideal for extensive cores or esthetically sensitive restorations. Research papers included in this review have in overall identified indirect restorations as superior to direct restorations, chiefly in regard to marginal adaptation, surface finish and resistance to wear. But all these advantages should be viewed in conjunction with such disadvantages as the higher price, longer time to complete treatment, and increased limitations of the tooth structure during the fabrication process.

In the current review, 15 articles were included, which involved a total of 1466 teeth. Among all the restored teeth, 741 teeth were restored directly with composite restorations and 725 were restored indirectly with composite restorations. The population of the patients in the studies ranged with less than 55 years. In the various studies, different follow-up periods were used ranging from one to eleven years and a number of clinical parameters were used such as surface texture, marginal integrity, color stability, retention, patient satisfaction and the rate of secondary caries.

Table 1: Main Studies Incorporated

Author (Year)	Comparison	Patient Satisfaction	Clinical Outcomes	Methodologies	Main Results
Karaarslan et al. (2020)	Direct vs. Indirect Composite Restorations	Higher with direct restorations	Effective for posterior teeth	Clinical study	Direct restorations were more favored for their aesthetic appeal and comfort, but both were effective.
Fennis et al. (2021)	Direct vs. Indirect Composite Restorations	Similar in both	Good retention and survival rates	Randomized clinical trial	Both restoration types showed similar patient satisfaction; indirect had slightly better retention.
Ozakar-Ilday et al. (2019)	Direct vs. Indirect Composite Restorations	Higher with indirect restorations	Good performance over 5 years	Clinical performance study	Indirect composites performed well over 5 years, with patients preferring them for durability.
Cetin and Unlu (2022)	Direct vs. Indirect Composite Restorations	Higher with direct restorations	Effective in function and aesthetics	Comparative study	Direct composites were preferred for immediate results, while both showed good functional outcomes.
Mendonça and Santos (2021)	Direct vs. Indirect Composite Restorations	Higher with indirect restorations	Better marginal integrity with indirect	Clinical comparison	Indirect composites showed better marginal integrity and were preferred for long-term satisfaction.
Bartlett and Sundaram (2020)	Direct vs. Indirect Composite Restorations	Similar satisfaction in both	Effective in treating tooth wear	Clinical efficacy study	Both methods were effective in managing tooth wear, with no significant difference in patient satisfaction.
Pallesen and Qvist (2019)	Direct vs. Indirect Composite Inlays	Higher with indirect inlays	Long-term durability	Randomized clinical trial	Indirect composite inlays showed greater durability and patient satisfaction in the long-term study.
Manhart et al. (2019)	Direct vs. Indirect Composite Restorations	Higher with indirect restorations	Excellent long-term performance	Long-term study	Indirect composites had better long-term survival and clinical performance compared to direct composites.
Wassell et al. (2021)	Direct vs. Indirect Composite Inlays	Higher with indirect inlays	Good clinical performance over 5 years	5-year clinical results	Indirect inlays showed better clinical outcomes and patient satisfaction over 5 years.
Scheibenbogen-	Direct vs. Indirect	Similar in both	Better anatomic	Clinical study	Both types showed similar satisfaction; indirect



Fuchsbrunne r et al. (2020)	Composite Restorations		form with indirect		restorations had better anatomical accuracy.
Scheibenbogen et al. (2021)	Direct vs. Indirect Composite Restorations	Similar in both	Better surface texture with indirect	Randomized clinical trial	Indirect composites showed superior surface texture and marginal integrity.
Wassell et al. (2021)	Direct vs. Indirect Composite Restorations	Similar satisfaction in both	Effective clinical performance	5-year clinical study	Both direct and indirect composites showed effective clinical performance with similar patient satisfaction.
Ferrari and Cagidiaco (2019)	Direct vs. Indirect Composite Restorations	Not specified	Better longevity with indirect	Clinical review	Indirect composites were associated with better long-term durability due to superior adhesive systems.
Kubo and Kawasaki (2020)	CAD/CAM-fabricated Composite Inlays	Higher with CAD/CAM inlays	Effective for posterior teeth	Clinical evaluation	CAD/CAM-fabricated inlays offered high patient satisfaction and effective clinical outcomes in posterior teeth.
Shiratsuchi et al. (2021)	Direct vs. Indirect Composite Restorations	Higher with direct restorations	Effective over 6 years	Randomized controlled trial	Direct restorations provided high satisfaction and were effective over a 6-year period.

Integration with 3D Printing

In addition to the use of composite materials, the technology of indirect composite restoration has been also developed with highly improved fabrication techniques including 3D printing. Some of the research synthesized in this review developed highly accurate models and restorations through the use of 3D printing technology which in turn led to enhanced marginal adaptation as well as fit. This integration of technology is a major upgrade towards the advancement of restorative dentistry the future may reveal much more clinical possibility. (Shiratsuchi et al. 2021).

Clinical Applications and Case Studies

That is, direct and indirect composite restorations, their clinical outcomes are systematically differing by the study type, materials, and follow-up time. In total, there were appreciable differences in favor of indirect restorations in connection with marginal

adaptation and wear resistance. For instance, Karaarslan et al. (2020) compared the surface roughness, postoperative sensitivity, and soft tissue irritation between indirect restoration and direct restoration with C&B and get the following results. In the same way, Ozakar-Ilday et al. (2019) found that indirect restorations had reportedly improve clinical outcomes in terms of retention and marginal integrity. In contrast, Fennis et al. (2021) and Cetin et al. (2022)'s studies have shown that direct to indirect restoration had no statistically significant clinical performance difference. These investigations imply that though there may be some merits of indirect restorations, direct restorations can give acceptable results, if properly applied in practice.

Recent Advancements

There has been typical development in direct as well as in indirect composites in the recent past, which has improved their efficiency



considerably in restorative dentistry. There is a new future found in the application of nanotechnology in the reinforcement of composite material. Composites that are filled with nanoparticles have garnered much attention from users because of improved mechanical characteristics of the material and enhanced esthetics. These materials contain nanoparticles and have a higher level of filler content and thus enhance the composite's strength, its wear resistance, and shade. Other advantages of Nano filled composites raised by the authors are better physical properties of the material and, therefore, their unsuitability for posteriors fillings, where the work load demand is high (Kubo and Kawasaki (2020).

It is to be noted that together with material progress, great results have been achieved in the sphere of adhesion. Conventional bonding agents provided a multipurpose bonding medium and have enhanced the adhesive bond to enamel as well as dentin. The chemical composition of these agents makes them suitable for indirect restorations and can be used in the various adhesive techniques: total-etch, self-etch, and selective etch. These modern UAs have resulted in enhanced bonding and greater marginal seal, in addition to reducing the post-operative sensitivity in composite restorative procedures. In addition, the use of the digital technology especially computer aided design, and computer aided manufacturing has greatly enhanced the creation of indirect composite restorations. Computerized systems make it easier to scan, design, and mill restorations and due to the digital nature of the material; they fit well in the mouth and take less time to deliver. CAD/CAM technology has also helped in the integration of 3D printing to produce composite inlays and onlays as well (Ferrari and Cagidiaco(2019). It is an advantage for the fact that using 3D printing it is possible to create as accurate restorations with a complex geometrical shape as it is difficult to imagine achieving using traditional approaches. Last but not the least, there has been positive progression in the curing parameter enhancement for the polymerization

of composite materials. This is particularly so for the high intensity LED curing lights where the risk to incomplete polymerization is kept to a bare minimum hence technique such as marginal leakage is minimized which means the longevity of the restoration is improved (Fennis et al. 2021).

Challenges and Future Directions Challenges

Some issues related to both direct and indirect composites, however, are still the controversies and concerns arising from the latest composite restoration materials and techniques. The first of these is the conflict of interests where esthetic appeal is balanced with durability. Though in terms of esthetics direct composite restorations cannot be beat, they do not serve up the mechanical strength and wear inherent in indirect restorations, particularly in the stress-bearing areas such as the posteriors. This may cause problems like marginal rendering, surface finish, and secondary caries after sometime. One is technique sensitivity related to direct composite restorations, a drawback that has become apparent. These restorations are very technique sensitive especially in isolation, layering and curing of the material by the clinician. Smaller variations in the technique can lead to problems such as low polymerization shrinkage, interproximal gaps and post-operative sensitivity (Wassell et al. (2021). Thus, although IDC restorations owe their advantages to improved physical properties and marginal gap of the restorative material, they have their own set of problems. Most of these restorations demand more tooth tissue reduction that put the remaining dental structure at risk. Furthermore, the procedure which is required for the construction and placing of indirect restorative solutions is protracted and expensive and may require several appointments. The complexity of the procedure also brings the likelihood of some error; impression inaccuracies or even during the laboratory fabrication process.



Future Directions

That is why; the future research and development of the composite restorations should consider these challenges to get better clinical results. One potential avenue is the further refinement of new generation of direct and indirect composite which include both strength and esthetics attributes of the direct composites and strength attribute of the indirect restoration. Fiber reinforced composites also known as hybrid could fit into a wide clinical application need strength and esthetic work. Another location for future expansion is the utilization of information technology elements, including CAD/CAM systems and three-dimensional printing technologies. These technologies could prove to be indispensable in cutting down the time taken in the fabrication process and minimizing on the errors made while at the same time enhancing the accuracy of fit and morphology of both direct and indirect restorations. Further, improvements on the nature of adhesive systems that would increase bond strength, and at the same time, ease the method of application can minimize the technique sensitive characteristic inherent in straight restorations (Cetin and Unlu (2022). More clinical trials of longer durations are called for to obtain conclusive data on the superiority of direct and indirect modality of composite restorations. These research works should examine newer materials and methods and their survival and success rates especially in the degraded stress area such as posterior teeth. If these difficulties and many others are successfully managed and if the researchers and practitioners of restorative dentistry keep on trying to find ways on how to make composites better, the field of restorative dentistry will go further to achieve more dependable, long-lasting, and aesthetically more pleasing composite restorations (Fennis et al. 2021).

Conclusion

It is a systematic review where the outcomes of direct and indirect composite restorations have been compared in terms of clinical success in posteriors. The present work therefore

indicates that although both techniques are sufficient in maintaining satisfactory clinical performance, indirect restorations eclipse the outcomes based on MARDES, marginal adaptation, surface roughness and wear resistance. But, whether to use direct or indirect restoration; it must be dependent with the requirement of the individual patient and the clinical situation as well as the ability of the practitioner. The review also points to the necessity of additional studies, first and foremost, with concern to the fabrication of new materials and technology that would contribute to the improvement of the efficacy of composited restorations. By focusing on the current problems and developing on recent achievements, the field of restorative dentistry can further enhance the efficacy and durability of the composite restoration to the advantage of the patients and the clinicians.

Conflict

of interest: There is no conflict of interest among the authors.

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