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# Criteria for decision-making between direct and indirect composite resin restorations in posterior teeth: a literature review

*Critérios para a tomada de decisão entre restaurações diretas e indiretas em resina composta em dentes posteriores: uma revisão de literatura*

*Criterios para la toma de decisiones entre restauraciones directas e indirectas de resina compuesta en dientes posteriores: una revisión de la literatura*

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**Abstract:**
**Background:** The choice between direct and indirect composite resin restorations for posterior teeth depends on multiple clinical and biomechanical factors. **Aim:** This study aimed to identify and analyze the criteria guiding the indication of each approach. **Methods:** A literature review was conducted through a structured PubMed search guided by the PICO framework, including human clinical studies published within the previous ten years and supplemented by three classic studies. Of the 15 records initially identified, seven recent studies met the selection criteria, totaling ten publications for narrative synthesis. **Results:** The findings indicated that cavity extension alone does not determine the restorative technique. The number and thickness of remaining walls, cusp involvement, endodontic status, margin location, occlusal load, and feasibility of clinical control should be assessed together. Direct restorations showed satisfactory performance in small or moderate cavities with favorable remaining tooth structure, whereas onlays and overlays were more strongly indicated in cases of extensive structural loss and need for cuspal coverage. **Conclusions:** The decision should be individualized, prioritizing preservation of dental tissue without compromising biomechanical protection and restorative longevity.

**Keywords:**
composite resin. cuspal coverage. dental restoration. posterior teeth. restorative dentistry.

**Resumo:**
**Contexto:** A escolha entre restaurações diretas e indiretas em resina composta para dentes posteriores permanece dependente de múltiplos fatores clínicos e biomecânicos. **Objetivo:** Identificar e analisar os critérios que orientam a indicação de cada abordagem. **Métodos:** Realizou-se revisão de literatura com busca estruturada na PubMed, guiada pelo modelo PICO, incluindo estudos clínicos em humanos publicados nos últimos dez anos e complementados por três estudos clássicos. Dos 15 registros inicialmente identificados, sete estudos recentes atenderam aos critérios de seleção, totalizando dez publicações para síntese narrativa. **Resultados:** Os achados indicaram que a extensão cavitária, isoladamente, não determina a técnica. A quantidade e a espessura das paredes remanescentes, o comprometimento cuspídeo, a condição endodôntica, a localização das margens, a carga oclusal e a possibilidade de controle clínico devem ser avaliados conjuntamente. Restaurações diretas apresentaram desempenho satisfatório em cavidades pequenas ou moderadas com remanescente favorável, enquanto onlays e overlays mostraram maior indicação diante de perda estrutural extensa e necessidade de cobertura cuspídea. **Conclusões:** A decisão deve ser individualizada, priorizando a preservação de tecido dental sem comprometer a proteção biomecânica e a longevidade restauradora.

**Palavras-chave:**
cobertura cuspídea. dentes posteriores. odontologia restauradora. resina composta. restauração dentária.

**Resumen:**
**Contexto:** La elección entre restauraciones directas e indirectas de resina compuesta para dientes posteriores depende de múltiples factores clínicos y biomecánicos. **Objetivo:** Identificar y analizar los criterios que orientan la indicación de cada enfoque. **Métodos:** Se realizó una revisión de la literatura mediante una búsqueda estructurada en PubMed, guiada por el modelo PICO, que incluyó estudios clínicos en humanos publicados en los últimos diez años y se complementó con tres estudios clásicos. De los 15 registros identificados inicialmente, siete estudios recientes cumplieron los criterios de selección, con un total de diez publicaciones para la síntesis narrativa. **Resultados:** Los hallazgos indicaron que la extensión de la cavidad, de forma aislada, no determina la técnica. La cantidad y el espesor de las paredes remanentes, la afectación cuspídea, la condición endodóntica, la ubicación de los márgenes, la carga oclusal y la posibilidad de control clínico deben evaluarse conjuntamente. Las restauraciones directas presentaron un desempeño satisfactorio en cavidades pequeñas o moderadas con estructura remanente favorable, mientras que los onlays y overlays mostraron una mayor indicación ante una pérdida estructural extensa y la necesidad de cobertura cuspídea. **Conclusiones:** La decisión debe individualizarse, priorizando la preservación del tejido dental sin comprometer la protección biomecánica ni la longevidad restauradora.

**Palabras clave:**
cobertura cuspídea. dientes posteriores. odontología restauradora. resina compuesta. restauración dental.

## 1. Introduction

Adhesive composite resin restorations have become one of the main alternatives for the rehabilitation of posterior teeth, driven by the evolution of adhesive systems, improvements in the mechanical properties of composites, and the growing emphasis on minimally invasive dentistry. Unlike conventional indirect restorations and full crowns, adhesive restorations allow a greater amount of sound tooth structure to be preserved, reducing tissue removal and favoring more conservative interventions without compromising the restoration of function and esthetics. Consequently, the use of direct composite resin restorations has expanded significantly in recent decades, becoming the first therapeutic option for a large proportion of cavities in posterior teeth (Ferracane, 2011; Opdam et al., 2014; Demarco et al., 2012).

Despite the advances achieved, direct restorations still have important limitations when used in extensive cavities or teeth with major structural loss. Polymerization shrinkage remains one of the main challenges inherent to composite resins and may generate stresses at the adhesive interface that can compromise marginal adaptation, promote microgap formation, increase the risk of marginal leakage, and contribute to degradation of the restorative interface

over time. In addition, reconstruction of large cavities with loss of marginal ridges or cusp involvement creates greater difficulty in obtaining adequate proximal contacts, correct occlusal anatomy, and sufficient mechanical strength to withstand masticatory loads, especially in endodontically treated teeth (Braga; Ballester; Ferracane, 2005; Ferracane, 2011; Dietschi et al., 2011).

In this context, indirect composite resin restorations emerged as an alternative for increasing clinical predictability in more complex restorative situations. Extraoral polymerization reduces the effects of polymerization shrinkage on the adhesive interface, while laboratory composites and, more recently, industrially manufactured blocks for CAD/CAM systems provide a higher degree of conversion, better mechanical properties, and greater control of occlusal anatomy and proximal contacts. In parallel, the development of digital technologies, including intraoral scanning, computer-aided manufacturing, and three-dimensional printing, has expanded the possibilities for fabricating indirect restorations, allowing greater precision and standardization of restorative procedures (Magne; Knezevic, 2009; Ferracane, 2011; Dietschi et al., 2011).

Although extensive literature evaluates the clinical performance, mechanical strength, and longevity of direct and indirect composite resin restorations, it remains unclear which factors should effectively guide the clinical choice between these approaches. Most studies focus on comparing materials, restorative techniques, or specific cavity designs, whereas few studies provide an integrated synthesis of the clinical, biomechanical, and operational criteria involved in restorative decision-making (ANGELETAKI et al., 2016; OPDAM; FRANKENBERGER; MAGNE, 2016). Considering that an inappropriate technique can compromise treatment longevity and result in unnecessary removal of tooth structure, it is important to gather and critically analyze the available evidence to support this clinical decision (LYNCH et al., 2014; OPDAM; FRANKENBERGER; MAGNE, 2016).

Therefore, this literature review aimed to identify and analyze the clinical, biomechanical, and operational factors that influence the indication of direct or indirect composite resin restorations in posterior teeth.

## 2. Methodology

This study is a literature review conducted through a structured search and critical selection of the available scientific evidence. The methodological strategy was planned

according to the principles of transparency and reproducibility recommended by the PRISMA guidelines for literature reviews, adapted to the narrative design of the present study.

Initially, the guiding question of the review was defined: which clinical, biomechanical, and operational factors influence the indication of direct or indirect composite resin restorations in posterior teeth? Based on this question, the PICO framework was developed, in which the population (P) comprised permanent posterior teeth requiring adhesive composite resin restoration; the intervention (I) corresponded to direct and/or indirect composite resin restorations; the comparison (C) included different restorative approaches, when present; and the outcomes (O) involved clinical, biomechanical, and operational criteria related to indication, clinical performance, and restorative decision-making.

An electronic search was then conducted in the PubMed database (National Library of Medicine), using the following descriptors and Boolean operators: ("Composite Resins") AND ("Dental Restoration, Permanent") AND (inlay OR onlay OR overlay OR "direct restoration").

The following filters were applied: studies published within the previous ten years, conducted in humans, available in full text, written in English, and classified as clinical studies (Clinical Study) or clinical trials (Clinical Trial). Systematic reviews and literature reviews were initially included in the search strategy; however, these designs were subsequently excluded in order to prioritize primary clinical evidence.

After applying the search strategy and established filters, 15 potentially eligible studies were identified. The articles underwent title, abstract, and full-text screening and were subsequently assessed for relevance to the guiding question and the criteria established by the PICO framework.

Studies that did not directly address the objective of the review were excluded, including exclusively laboratory investigations (in vitro), finite element analyses, literature reviews, systematic reviews, studies involving only anterior teeth, studies primarily focused on the development or manufacturing of restorative materials, and investigations without clinical applicability to decision-making between direct and indirect composite resin restorations. One article whose full text was not freely available for reading and critical analysis was also excluded. After this stage, seven clinical studies directly related to the review objective remained and formed the main basis for the synthesis of results.

To complement the scientific foundation and broaden the discussion of the findings, three classic clinical studies were also included. They were intentionally selected because of their recognized scientific relevance and their contribution to consolidating concepts related to

the indications, limitations, clinical performance, and longevity of direct and indirect composite resin restorations in posterior teeth.

At the end of the selection process, the review comprised ten scientific articles: seven recent clinical studies obtained through the structured search strategy and three classic publications included to provide a conceptual basis and support discussion of the results. Data extraction covered study design, sample characteristics, objective, clinical factors evaluated, main results, conclusions, and clinical implications related to the indication criteria for direct and indirect composite resin restorations. The results were synthesized narratively, prioritizing critical comparison of the available evidence and its clinical applicability to restorative decision-making.

## 3. Results

### 3.1 Extent of structural loss

The extent of structural loss is one of the main criteria used in decision-making between direct and indirect composite resin restorations for posterior teeth. However, the literature shows that the indication should not be based exclusively on cavity size, but on the association among isthmus width, marginal ridge involvement, cusp loss, and the amount of remaining tooth structure (Angeletaki et al., 2016; Incekara; Karadas, 2025).

Among the objective parameters described in the literature, isthmus width was one of the criteria most frequently used to indicate indirect restorations. Class II cavities whose isthmus exceeded approximately two-thirds of the intercuspal distance or that involved the loss of at least one cusp were restored using indirect composite resin restorations, whereas smaller cavities remained indicated for direct restorations. Although used for more extensive structural defects, indirect restorations showed clinical performance similar to that of direct restorations after 12 months of follow-up, suggesting that this approach is a predictable alternative when structural involvement is greater (Incekara; Karadas, 2025).

The presence of mesio-occlusodistal (MOD) cavities, especially when associated with a reduced number of remaining walls, was also related to a preference for indirect restorations. In endodontically treated molars with MOD cavities and only two remaining coronal walls, overlay restorations characterized by cuspal coverage showed better marginal adaptation and fewer occurrences of marginal discoloration and fractures than inlays, in which the cusps were

preserved. These results suggest that as structural loss increases, preserving all cusps becomes less predictable than incorporating them into the restorative design (Fouda et al., 2024).

However, classifying a cavity as MOD does not, by itself, constitute an absolute criterion for indicating an indirect restoration. Clinical studies have shown that endodontically treated posterior teeth with at least three remaining coronal walls more than 2 mm thick can be restored directly, with clinical performance similar to that observed for full crowns over three years of follow-up. These findings indicate that the quantity and quality of remaining tooth structure exert a more relevant influence than cavity extent alone (Abu-Awwad et al., 2025).

Conversely, when structural loss involved extensive defects associated with the loss of at least one cusp and deep cervical margins, the literature showed favorable results for partial indirect composite resin restorations. In these cases, combining the proximal box elevation technique with the restoration produced high clinical survival rates, indicating that this approach may increase restorative predictability in extensive cavities where a direct restoration becomes more complex to perform (Gözetici-Çil et al., 2024).

Taken together, the studies analyzed indicate that progression of structural loss gradually increases the indication for indirect restorations. Nevertheless, the clinical decision should not be based exclusively on cavity extent, but on the integration of isthmus width, cusp involvement, number and thickness of remaining walls, depth of cervical margins, and the ability to maintain the biomechanical integrity of the remaining tooth structure. This combination of factors proved more consistent for guiding the selection between direct and indirect composite resin restorations than any isolated parameter (INCEKARA; KARADAŞ, 2025; FOUDA et al., 2024; ABU-AWWAD et al., 2025; GÖZETICI-ÇIL et al., 2025; ANGELETAKI et al., 2016).

### 3.2 Amount of remaining tooth structure and cuspal coverage

The quantity and quality of remaining tooth structure proved decisive in determining the need for cuspal coverage. In general, the greater the number and thickness of preserved coronal walls, the greater the possibility of maintaining a direct and conservative approach. Conversely, loss of axial walls, marginal ridges, and cusps reduced the support provided by the remaining structure and increased the indication for indirect restorations with partial or complete cuspal coverage (Abu-Awwad et al., 2025; Fouda et al., 2024; Incekara; Karadas, 2025).

An onlay was more appropriately indicated when structural loss or weakening was limited to one or more specific cusps, while other cusps remained sufficiently thick and supported. An onlay allows selective coverage of the compromised cusps while preserving those that still have adequate structure. In the study by Gözetici-Çil et al., partial indirect composite resin restorations were used in molars with large defects, loss of at least one cusp, and deep cervical margins. After up to three years, these restorations had a survival rate of 93.8%, and the risk of failure was lower for onlays with partial cuspal coverage than for overlays covering all cusps (Gözetici-Çil et al., 2024).

An overlay, in turn, was used when all cusps were compromised or when the tooth presented extensive coronal loss, making selective coverage insufficient. By definition, an overlay covers the entire occlusal surface and all cusps and is indicated for large cavities requiring overall protection of the remaining structure. The included literature associated this design with extensive Class II cavities, large occlusal surfaces compromised by wear or biocorrosion, and teeth in which all cusps showed reduced thickness or insufficient structural support (Gözetici-Çil et al., 2024).

In endodontically treated molars with MOD cavities and only two remaining coronal walls, Fouda et al. compared inlays without cusp reduction with full-coverage overlays. The overlays showed better marginal adaptation and lower frequencies of discoloration, tooth or restoration fracture, and caries over two years. These results indicated that, in the presence of extensive loss of remaining structure and generalized cusp involvement, full coverage may offer greater predictability than preserving all cusps in an inlay design (Fouda et al., 2024).

However, the findings of Fouda et al. and Gözetici-Çil et al. should not be interpreted as contradictory. In the first study, overlays were superior to inlays in endodontically treated teeth with extensive MOD cavities and only two remaining walls, a situation in which all cusps were at greater biomechanical risk. In the second study, onlays had a lower risk of failure than overlays in a sample of large cavities with different patterns of cusp loss. Taken together, the results indicate that overlays should be reserved for teeth in which all or nearly all cusps are compromised, whereas onlays are preferable when structural loss is localized and part of the remaining tooth structure can still be preserved (Fouda et al., 2024; Gözetici-Çil et al., 2024).

In summary, a direct restoration remains indicated when the cusps are intact, the marginal ridges retain adequate support, sufficient coronal walls remain, and there is no major weakening of the residual structure (ABU-AWWAD et al., 2025; LEYTON et al., 2025; TEKCE et al., 2025). An onlay is indicated when one or more specific cusps are missing, cracked, thinned, or unsupported, while other cusps remain preservable (GÖZETICI-ÇIL et al.,

2024; GALIATSATOS et al., 2022). An overlay should be considered when involvement affects all or nearly all cusps, especially in extensive MOD cavities, endodontically treated teeth with few remaining walls, or major occlusal loss (FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024). The available evidence therefore favors selective cuspal coverage proportional to structural damage, avoiding both the absence of protection for weakened cusps and the unnecessary removal of cusps that remain sound (ANGELETAKI et al., 2016; FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024; INCEKARA; KARADAŞ, 2025).

### 3.3 Endodontically treated teeth

Endodontic status modifies restorative decision-making but does not, by itself, determine the need for an indirect restoration. The included studies indicated that the prognosis of endodontically treated teeth is more directly related to the amount of coronal structure lost, the number and thickness of remaining walls, marginal ridge involvement, cusp condition, and the intensity of occlusal loads than to the absence of pulp vitality alone (Abu-Awwad et al., 2025; Fouda et al., 2024; Leyton et al., 2025).

Despite the absence of a statistical difference in overall survival and success rates, direct restorations showed greater deterioration during follow-up with respect to caries, discoloration, marginal integrity, and fracture. Bruxism was identified as a significant predictor of failure, with an approximately 12.8-fold higher risk. Thus, even with favorable remaining structure, the direct technique proved less predictable in patients exposed to high or parafunctional occlusal loads, and the indication should consider not only tooth anatomy but also the patient's functional conditions (Abu-Awwad et al., 2025).

Conversely, the indication for indirect restorations becomes more consistent when endodontic treatment is associated with extensive MOD cavities, loss of both marginal ridges, a reduced number of coronal walls, and weakening of one or more cusps. Fouda et al. evaluated endodontically treated molars with MOD cavities and only two remaining coronal walls, comparing inlays without cuspal coverage with CAD/CAM composite resin overlays covering all cusps. After two years, the overlays showed better marginal adaptation, less discoloration, fewer fractures of the tooth or restoration, and a lower incidence of caries than the inlays (Fouda et al., 2024).

Indirect restorations also showed favorable clinical results in teeth with large defects, cusp loss, and deep cervical margins. Gözetici-Çil et al. included vital and endodontically treated molars with loss of at least one cusp, restored with composite resin onlays or overlays

combined with proximal margin elevation. Overall, the restorations achieved a 93.8% survival rate over up to three years, indicating that the indirect technique can be used predictably in cases of marked structural loss and proximal margins that are difficult to access clinically (Gözetici-Çil et al., 2024).

However, endodontic treatment was not identified as a factor that necessarily required complete coverage of all cusps. In the study by Gözetici-Çil et al., partial coverage with onlays showed fewer failures than complete coverage with overlays. This result reinforces that, even in nonvital teeth, cuspal coverage should be proportional to the pattern of structural loss: compromised cusps should be covered, whereas thick and adequately supported cusps can be preserved (Gözetici-Çil et al., 2024).

In summary, endodontic treatment modifies the indication by increasing the biomechanical vulnerability of the tooth, but it does not, by itself, constitute a mandatory indication for an indirect restoration (ABU-AWWAD et al., 2025; LEYTON et al., 2025; ANGELETAKI et al., 2016). The direct technique remains appropriate when at least three thick walls are present, the cusps are supported, structural loss is limited, and occlusal load is controlled (ABU-AWWAD et al., 2025; LEYTON et al., 2025). An indirect restoration becomes more strongly indicated in extensive MOD cavities, loss of marginal ridges, the presence of only two remaining walls, weakened cusps, deep cervical margins, or high functional demand (FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024; INCEKARA; KARADAŞ, 2025). In these cases, an onlay should be used when involvement is restricted to specific cusps, whereas an overlay is more justified when all or nearly all cusps are structurally at risk (FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024).

### 3.4 Clinical performance

The included studies demonstrated that both direct and indirect composite resin restorations show satisfactory clinical performance when correctly indicated. Overall survival rates were high for both techniques, ranging from approximately 76% to 100%, depending on follow-up duration, extent of structural loss, and case-selection criteria. However, indirect restorations tended to show greater clinical stability in extensive cavities and over longer follow-up periods (Tekce et al., 2025; Fouda et al., 2024; Gözetici-Çil et al., 2024).

As follow-up duration increases, however, a trend favoring indirect restorations is observed. At ten-year clinical follow-up, indirect restorations had a survival rate of 96.3%,

while direct restorations had a rate of 85.2%, indicating fewer cumulative failures over time and greater long-term clinical stability (TEKCE et al., 2025).

Taken together, the evidence indicates that clinical survival depends less on the isolated choice between a direct or indirect technique and more on appropriate case selection. Small or moderate cavities with sufficient remaining tooth structure and no significant cusp involvement performed excellently when restored directly (ABU-AWWAD et al., 2025; LEYTON et al., 2025; TEKCE et al., 2025). Conversely, extensive cavities, endodontically treated teeth with marked structural loss, and cases requiring cuspal coverage had more favorable outcomes when restored using indirect approaches, especially onlays and overlays (FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024; GALIATSATOS et al., 2022). Thus, the available literature suggests that correct indication of the restorative technique has a greater influence on clinical longevity than the technique used in isolation (ANGELETAKI et al., 2016; TEKCE et al., 2025).

### 3.5 Marginal adaptation and stability

Marginal adaptation is one of the main parameters used to assess the clinical performance of adhesive restorations because it is directly related to sealing of the tooth-restoration interface, prevention of marginal leakage, stability of proximal contacts, and longevity of restorative treatment. Although both direct and indirect composite resin restorations show satisfactory clinical results when correctly indicated, the studies analyzed demonstrated that the indirect technique tends to perform more favorably in extensive cavities, mainly because the effects of polymerization shrinkage are reduced (Angeletaki et al., 2016; Tekce et al., 2025; Fouda et al., 2024).

Polymerization shrinkage remains one of the main limitations of direct composite resin restorations. Because polymerization occurs entirely within the cavity, shrinkage stresses develop and may compromise marginal adaptation, promote microgap formation, and increase the risk of marginal leakage, postoperative sensitivity, and degradation of the adhesive interface over time. In indirect restorations, by contrast, most polymerization occurs extraorally, limiting shrinkage mainly to the thin layer of resin cement used to lute the restoration and thereby reducing the stresses developed at the adhesive interface (Angeletaki et al., 2016; Fouda et al., 2024).

Despite this theoretical advantage, clinical studies have shown that differences between the techniques do not always translate into significant differences in clinical performance. In

Class I and Class II cavities, direct and indirect restorations showed satisfactory marginal adaptation during follow-up, with no statistically significant differences in most of the clinical criteria evaluated (Tekce et al., 2025; Incekara; Karadas, 2025). These results suggest that when correctly performed and indicated, both techniques can provide adequate marginal sealing in the short and medium term.

However, in situations of greater structural involvement, the literature showed a trend favoring indirect restorations. In endodontically treated molars with extensive MOD cavities and only two remaining coronal walls, overlays showed better marginal adaptation than inlays after two years of follow-up, as well as lower rates of marginal discoloration and fewer restoration fractures. These results indicate that cuspal coverage associated with the restorative design may contribute to greater stability of the adhesive interface when structural loss is significant (Fouda et al., 2024).

Similar results were observed for indirect restorations combined with the proximal box elevation technique. Even in deep cavities with subgingival cervical margins, the restorations showed high levels of marginal adaptation and clinical stability over up to three years of follow-up, demonstrating that the indirect technique may facilitate control of marginal quality in situations where operative isolation and clinical access are more challenging (Gözetici-Çil et al., 2024).

In addition to marginal adaptation, the stability of proximal contacts and occlusal anatomy is another potential advantage of indirect restorations. Extraoral fabrication allows better control of anatomical contouring, proximal contacts, and occlusal morphology before cementation, reducing the need for extensive clinical adjustments. Although the included studies did not objectively quantify this benefit, the preservation of anatomy and marginal integrity observed during follow-up suggests that this feature may contribute to the clinical predictability of indirect restorations, especially in large cavities (Galiatsatos et al., 2022; Fouda et al., 2024).

Finishing and polishing also directly influence the clinical stability of restorations. Smooth surfaces and well-adapted margins promote less biofilm accumulation, better color stability, and less surface wear. In posterior teeth with extensive coronal destruction, indirect restorations showed better surface smoothness and marginal adaptation than direct restorations, although the study used ceramic onlays as the indirect technique. Despite the difference in restorative material, these results reinforce the importance of anatomical control and surface quality for maintaining long-term clinical stability (Chen et al., 2019).

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Overall, the literature analyzed shows that both techniques provide satisfactory marginal adaptation when correctly indicated and performed (INCEKARA; KARADAŞ, 2025; TEKCE et al., 2025; ANGELETAKI et al., 2016). However, as cavity complexity increases, the indirect technique tends to offer greater predictability regarding control of polymerization shrinkage, marginal adaptation, stability of proximal contacts, and maintenance of restorative anatomy (FOUDA et al., 2024; GÖZETICI-ÇIL et al., 2024; GALIATSATOS et al., 2022). These factors do not make indirect restorations superior in every clinical situation, but they justify their indication in extensive cavities, cavities with difficult-to-access margins, or cases of major structural involvement in which clinical control of the direct technique becomes more complex (ANGELETAKI et al., 2016; FOUDA et al., 2024; TEKCE et al., 2025).

### 3.6 Advantages and limitations of each technique

Analysis of the included studies shows that both direct and indirect composite resin restorations have satisfactory clinical performance when correctly indicated. The choice of technique depends mainly on the extent of structural loss, the amount of remaining tooth structure, and the complexity of the clinical case, rather than on the absolute superiority of one approach over the other (Angeletaki et al., 2016; Tekce et al., 2025; Incekara; Karadas, 2025).

Direct restorations stand out for preserving more tooth structure, costing less, being completed in a single session, and allowing intraoral repair. These characteristics make them a conservative and predictable alternative for small and moderate cavities, provided that sufficient tooth structure remains to withstand functional loads. However, the technique remains more dependent on operator skill and more susceptible to the effects of polymerization shrinkage, making control of marginal adaptation, proximal contacts, and occlusal anatomy more challenging in extensive cavities (Leyton et al., 2025; Abu-Awwad et al., 2025; Tekce et al., 2025).

Indirect restorations, in turn, allow most polymerization to occur outside the oral cavity, reducing stresses generated by polymerization shrinkage and promoting greater dimensional stability of the restoration. In addition, extraoral fabrication provides better control of occlusal anatomy, proximal contacts, and marginal adaptation, aspects that are particularly important in large cavities, endodontically treated teeth, and situations requiring cuspal coverage. The studies analyzed also showed a trend toward greater clinical stability of indirect restorations during prolonged follow-up and in teeth with significant structural loss (Fouda et al., 2024; Gözetici-Çil et al., 2024; Galiatsatos et al., 2022).

On the other hand, the indirect technique has limitations related to higher treatment cost, the need for at least two clinical stages - or laboratory/CAD-CAM infrastructure - longer execution time, and dependence on the adhesive cementation procedure, which is considered a critical stage for clinical success. Furthermore, although it performs well in extensive cavities, its use for limited structural loss may result in unnecessary removal of tooth tissue, contrary to the principles of minimally invasive dentistry (Angeletaki et al., 2016; Incekara; Karadas, 2025; Fouda et al., 2024).

Overall, the literature indicates that neither technique should be considered universally superior. Direct restorations offer greater advantages in conservative cavities, where a significant amount of tooth structure can be preserved, whereas indirect restorations become progressively more favorable as the extent of structural loss, the need for cuspal coverage, and the biomechanical complexity of the case increase. Therefore, selection of the restorative technique should balance preservation of dental tissue, clinical predictability, functional demands, and each patient's individual characteristics, always seeking the most conservative alternative capable of adequately restoring function and restoration longevity (Tekce et al., 2025; Angeletaki et al., 2016; Galiatsatos et al., 2022).

## 4. Discussion

The findings of this review demonstrate that the choice between direct and indirect composite resin restorations cannot be reduced to a rule based only on cavity size. Current literature points to a multifactorial decision in which the extent of structural loss must be interpreted together with cusp condition, the number and thickness of remaining walls, the presence of endodontic treatment, margin location, and the patient's functional demands. Although indirect restorations have potential advantages in extensive cavities, universal superiority over direct techniques has not been demonstrated, especially when the latter are used in teeth with favorable remaining structure and appropriate clinical selection (Angeletaki et al., 2016; Tekce et al., 2025; Incekara; Karadas, 2025).

This result is consistent with the evolution of minimally invasive and biomimetic concepts, which prioritize preservation of tooth structure and the use of adhesive procedures proportional to the magnitude of damage. Conservative approaches do not necessarily mean always choosing the direct technique, but rather avoiding both unnecessary removal of sound tissue and preservation of structurally compromised cusps. In this context, the ideal restoration should restore form, function, and stress distribution at the lowest possible biological cost, a

**Year VII, v.1 2026 | submitted: 04/08/2026 | accepted: 07/08/2026 | published: 10/08/2026**

principle compatible with the conservative approaches described by Dietschi and the biomimetic concept of reproducing the biomechanical behavior of the natural tooth (Dietschi et al., 2011; Magne et al., 2003).

Advances in restorative materials have also expanded the indications for direct restorations. Increased particle loading, reduced reinforcement size, improved mechanical properties, and enhanced light-curing systems have provided greater wear resistance and better performance in posterior teeth. Nevertheless, polymerization shrinkage and the stresses generated during monomer conversion remain inherent limitations of composite resins and may affect the adhesive interface, especially in large cavities with high geometric constraint. The evolution of composites has reduced, but not eliminated, this problem (Ferracane, 2011; Ferracane, 2024; Braga; Ballester; Ferracane, 2005).

At the same time, universal adhesive systems have simplified clinical protocols and increased versatility of application, while bulk-fill composites have reduced the number of increments required in deep restorations. However, technical simplification does not eliminate dependence on moisture control, correct light curing, and operator experience. The satisfactory performance observed for direct restorations using conventional or bulk-fill base techniques in endodontically treated teeth suggests that these materials may broaden conservative possibilities, but they do not replace assessment of cuspal support and the remaining coronal structure (Leyton et al., 2025).

In the field of indirect restorations, the development of laboratory composites and resin-composite blocks for CAD/CAM has allowed greater industrial control of polymerization, better material homogeneity, and more precise fabrication of occlusal anatomy and proximal contacts. These resources make the technique particularly useful in extensive cavities and in situations where contouring, finishing, or proximal control is difficult to perform directly. Clinical results for composite resin inlays, onlays, and overlays have shown satisfactory success and survival rates, including over extended follow-up, although predictability remains dependent on selection of the restorative design and the quality of adhesive cementation (Galiatsatos et al., 2022; Fouda et al., 2024; Gözetici-Çil et al., 2024).

Three-dimensional printing represents a more recent stage in this evolution and has the potential to reduce waste, manufacturing cost, and production time for indirect restorations (MENDES et al., 2024; ALQARNI et al., 2024). However, the evidence remains predominantly laboratory-based and focused on accuracy, marginal adaptation, and initial mechanical behavior, with a scarcity of long-term clinical studies (MENDES et al., 2024; RIBEIRO et al., 2025). Thus, 3D printing does not yet have sufficient clinical support to change the criteria for

choosing among direct, milled, or printed restorations, and longitudinal clinical studies are needed before it can be incorporated as a routine alternative (MENDES et al., 2024; RIBEIRO et al., 2025).

The findings also confirm that restorative longevity depends on factors beyond the material and technique used. Follow-up studies of posterior restorations demonstrate the influence of patient-, tooth-, and operator-related factors, including caries risk, tooth type and position, number of restored surfaces, parafunctional habits, and behavioral context. Relatively low annual failure rates can be achieved for posterior direct restorations, but risk is not uniformly distributed among patients, and isolated material properties appear to exert less influence than clinical and individual factors (Opdam et al., 2014; Demarco et al., 2012).

Among these factors, occlusal load deserves special attention. Bruxism was identified as an important predictor of failure in endodontically treated molars, even when the remaining structure was considered favorable. This indicates that a cavity seemingly suitable for a direct restoration may require additional protection when subjected to functional overload. Similarly, age, caries risk, hygiene, the possibility of follow-up, and financial availability affect the decision because they determine both the probability of failure and the feasibility of maintaining and repairing the treatment (Abu-Awwad et al., 2025; Galiatsatos et al., 2022).

Margin location also changes predictability. Deep or subgingival margins make isolation, material placement, finishing, and cementation more difficult. In these cases, proximal margin elevation may make the adhesive procedure more accessible and allow the use of partial indirect restorations with satisfactory clinical rates. However, this technique should not be understood as an automatic solution for every deep margin because its success depends on adequate isolation, adhesion to the substrate, periodontal control, and precise execution of the definitive restoration (Gözetici-Çil et al., 2024).

From a clinical standpoint, the main implication of this review is that decision-making should begin with assessment of the remaining tooth structure rather than a prior choice of material. Small or moderate cavities with thick, supported cusps, accessible margins, and controlled occlusal load can be treated directly. When one or more cusps are weakened but part of the remaining structure is still reliable, selective coverage with an onlay is a conservative solution. An overlay should be reserved for situations in which involvement extends to all or nearly all cusps, especially extensive MOD cavities or endodontically treated teeth with few remaining walls. This approach avoids both undertreatment of weakened structures and excessive coverage of tissue that remains sound (Fouda et al., 2024; Gözetici-Çil et al., 2024; Abu-Awwad et al., 2025).

The direct technique retains important advantages because it requires less investment, can be completed in a single session, conserves dental tissue, and allows relatively simple repair. The indirect technique, on the other hand, tends to facilitate anatomical reproduction and control of polymerization in complex situations, but it entails higher cost, requires a fabrication stage, and depends more heavily on adhesive cementation. Therefore, the most conservative option is not necessarily the direct technique, but the one that preserves the greatest possible volume of sound structure without compromising the tooth's biomechanical protection (Angeletaki et al., 2016; Tekce et al., 2025).

This review has limitations that should be considered. Few clinical studies directly compared direct and indirect restorations, and some of the evidence derived from single-arm studies or comparisons involving different materials and restorative designs (ANGELETAKI et al., 2016). There was heterogeneity in the teeth evaluated, pulp vitality, cavity extent, materials, restorative techniques, follow-up time, and clinical assessment criteria, including the USPHS and FDI systems (ANGELETAKI et al., 2016; TEKCE et al., 2025; GALIATSATOS et al., 2022). In addition, few studies had follow-up longer than five years, and some had small samples or follow-up losses, which limits generalization of the results and prevents the establishment of universal indication criteria for direct and indirect restorations (ANGELETAKI et al., 2016; GALIATSATOS et al., 2022).

Future studies should prioritize multicenter randomized clinical trials directly comparing direct restorations, inlays, onlays, and overlays in groups defined by the amount of remaining tooth structure and the pattern of cusp involvement. Follow-up periods longer than ten years, standardization of clinical assessment criteria, inclusion of patient-centered outcomes, and economic analyses of the different restorative approaches are also needed (ANGELETAKI et al., 2016; OPDAM et al., 2014). Clinical investigation of new indirect composites and CAD/CAM systems may also help determine whether technological advances result in greater clinical longevity and a better cost-benefit ratio for indirect restorations (OPDAM; FRANKENBERGER; MAGNE, 2016).

## 5. Conclusion

This review aimed to analyze the clinical, biomechanical, and operational factors that influence the indication of direct and indirect composite resin restorations in posterior teeth. Analysis of the available clinical studies demonstrated that both techniques provide satisfactory

clinical performance when correctly indicated, reinforcing that restorative predictability depends more on appropriate case selection than on adoption of a specific technique.

The choice between direct and indirect restorations should not be based exclusively on cavity extent, but on the integration of factors related to the quantity and quality of remaining tooth structure, cusp involvement, margin location, endodontic status, biomechanical demands, and individual patient characteristics. In general, direct restorations remain a conservative and predictable alternative for small and moderate cavities with adequate structural support, whereas indirect restorations become more strongly indicated in cases of extensive structural loss, especially when cuspal coverage and greater control of marginal adaptation and biomechanical stability are required. Decision-making should therefore be individualized, always seeking the most conservative restorative alternative capable of restoring function and longevity while preserving dental tissue.

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