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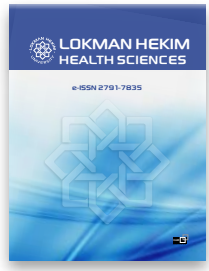

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REVIEW

Injection Molding Approach in Minimal Invasive Restorations: A Review Based on Current Literature and Clinical Application

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Abstract

This narrative review aims to summarize and critically discuss the current level of knowledge regarding the injection molding technique, an approach increasingly utilized in minimally invasive restorative dentistry. In addition to synthesizing existing evidence, a clinical case is presented to illustrate its application in daily clinical practice and to highlight potential implications for future research. A narrative review was conducted using a focused search of the PubMed (MEDLINE) and Scopus databases for English-language articles published between 2015 and 2025, applying predefined keywords and, where applicable, Medical Subject Headings terms related to flowable composite resins and injection molding techniques. Relevant clinical and experimental studies were included, while non-relevant publications were excluded. The literature was narratively synthesized, and clinical relevance was illustrated through a representative anterior case. The search was last updated in January 2026. The available literature suggests that the injection molding technique may be associated with favorable esthetic and functional outcomes while potentially supporting a conservative restorative approach. The presented clinical case illustrates how this technique can be applied in anterior restorations and may contribute to acceptable functional integration and esthetic outcomes in a clinical setting. From a clinical perspective, the injection molding technique, when used with contemporary high-filler-content flowable composite resins, may represent a viable option within minimally invasive restorative dentistry. However, considering the current level of evidence, further well-designed clinical and laboratory studies are needed to clarify its long-term performance and to guide future research and clinical protocols.

Keywords: Direct composite veneer; Esthetic restoration; Flowable composite; Injection molding; Minimally invasive dentistry

Dental esthetics is widely regarded as an important factor influencing social interactions and self-perception.[1] The increasing demand for esthetic dental procedures appears to have contributed to a growing number of patients seeking esthetic treatments in daily clinical practice.[2] Given the prominent role of anterior teeth in overall facial appearance, preserving or restoring their natural and harmonious morphology may be considered a key objective in contemporary restorative dentistry. Within this context, direct composite resin restorations have become one of the commonly preferred treatment options for esthetic rehabilitation of anterior teeth.[3]

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Composite resin materials are extensively utilized in esthetic dentistry due to their ability to reproduce the optical characteristics of natural tooth structures.[4] However, the handling challenges and limited adaptability associated with conventional packable composites have prompted clinicians to explore alternative restorative materials that may offer improved clinical manageability. As a result, flowable composite resins have been used in clinical practice for many years.[5]

Early-generation flowable composite resins were associated with relatively low filler content and, consequently, reduced mechanical strength, which restricted their indications mainly to low-stress restorative situations.[6] Advances in material science, however, have led to notable improvements in the physical and mechanical properties of these materials.[7] Contemporary high-filler-content flowable composite resins have been reported to demonstrate mechanical properties that may approach those of conventional packable composites in various clinical applications.[8]

These material advancements have facilitated the development of novel direct restorative techniques based on flowable composite resins. One such approach is the injection molding technique, which involves the controlled application of highly filled flowable composite resins onto tooth surfaces using pre-fabricated transparent silicone indices. The use of high-filler-content flowable composites in this technique may allow clinicians to obtain favorable esthetic outcomes while potentially maintaining adequate mechanical performance.[9] In addition, the relatively high elastic modulus of transparent index materials can enable the fabrication of thinner yet sufficiently rigid matrices, which may facilitate effective light transmission during polymerization while reducing excess material extrusion at the restoration margins.[10]

Search Strategy

This narrative review was based on a focused and structured literature search conducted in the PubMed (MEDLINE) and Scopus databases. The literature search was conducted in December 2025 and updated in January 2026, and included articles published between January 2015 and December 2025.

The search strategy combined free-text keywords and, where applicable, Medical Subject Headings. The following terms were used alone and in combination using Boolean operators (AND/OR): "injection molding technique," "injectable composite," "injection composite technique," "flowable composite," and "resin injection technique."

Inclusion criteria comprised English-language publications addressing the injection molding technique and injectable flowable composites in restorative dentistry, including clinical studies, randomized clinical trials, *in vitro* studies, technical reports, book chapters, and relevant narrative or systematic reviews with clear methodological or clinical relevance.

Exclusion criteria included studies unrelated to restorative dental applications, conference abstracts without full-text availability, opinion articles lacking clinical or experimental support, and publications with insufficient methodological detail.

Following title and abstract screening, 36 articles were assessed for full-text eligibility, and 29 publications were ultimately included in the narrative synthesis based on their relevance to clinical practice and contribution to the understanding of the injection molding technique. The study selection process is illustrated in Figure 1.

Indications, Advantages, and Disadvantages of Flowable Composites

Flowable composite resins have been reported to exhibit a broad range of clinical applications in restorative dentistry. Commonly cited indications may include:

- Preventive resin restorations in minimally invasive Class I cavities,[11]
- Pit and fissure sealants,[12]
- Use as cavity liner materials,[13]
- Minimally invasive Class III restorations,[14]
- Restoration of non-carious cervical lesions,[15]
- Repair of prosthetic restorations,[16]
- Cementation of indirect restorations,[17]
- Cementation of fiber posts in endodontics,[18]
- Bonding of orthodontic brackets,[19]
- Splinting of teeth following traumatic injuries.[20]

Compared with conventional packable composite resins, flowable composites may present certain advantages as well as limitations. Their lower viscosity can enhance adaptation to the cavity walls and tooth surfaces when compared to packable composites.[6] This property may facilitate easier handling with reduced need for instrument manipulation, potentially improving operator efficiency during clinical application.[21] In addition, the reduced viscosity has been associated with a lower risk of air bubble entrapment during placement.[6] Collectively, these characteristics have contributed to the development of restorative techniques such as the injection molding technique.[22]

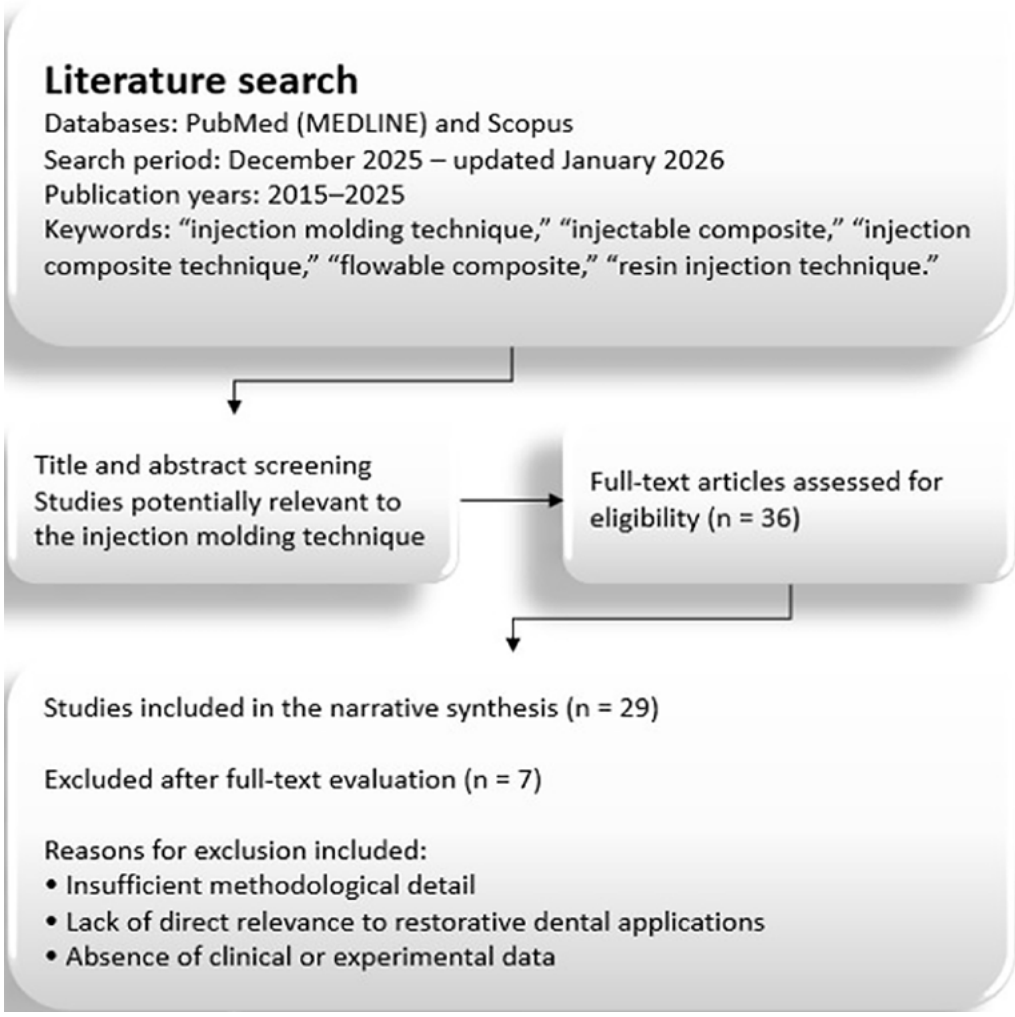

Figure 1. Flow diagram illustrating the study selection process used for the narrative review.

Despite these advantages, flowable composite resins have traditionally been associated with higher polymerization shrinkage and lower filler content, which may result in inferior mechanical properties when compared to packable composites.[6] However, recent advancements in material formulation have been reported to improve the physical and mechanical properties of flowable composites, enabling certain high-filler-content materials to achieve mechanical performance that may be comparable to that of conventional packable composites in selected clinical applications.[8]

Advantages and Limitations of the Injection Molding Technique

The injection molding technique has been described as a relatively predictable and controllable restorative approach that may allow clinicians to better anticipate esthetic and functional outcomes.[23] The technique can be considered minimally invasive and may offer several clinical advantages, including cost-effectiveness and the potential to fabricate both provisional and definitive restorations using the same workflow.[24] In addition, it may contribute to reduced chair time and can facilitate restorations that are amenable to repair, thereby potentially enhancing overall clinical efficiency.[25]

Nevertheless, despite its reported clinical benefits, several limitations of the injection molding technique have been highlighted in the literature. The technique may not be recommended for stress-bearing areas[26] or for the closure of wide diastemas,[27] and its application can be considered contraindicated under conditions of inadequate isolation.[3] Furthermore, the composite materials used in this technique may exhibit color instability over time, as suggested by limited clinical and laboratory evidence, which could potentially compromise long-term esthetic outcomes.[28]

Another reported limitation of the injection molding technique is the inability to apply multiple composite

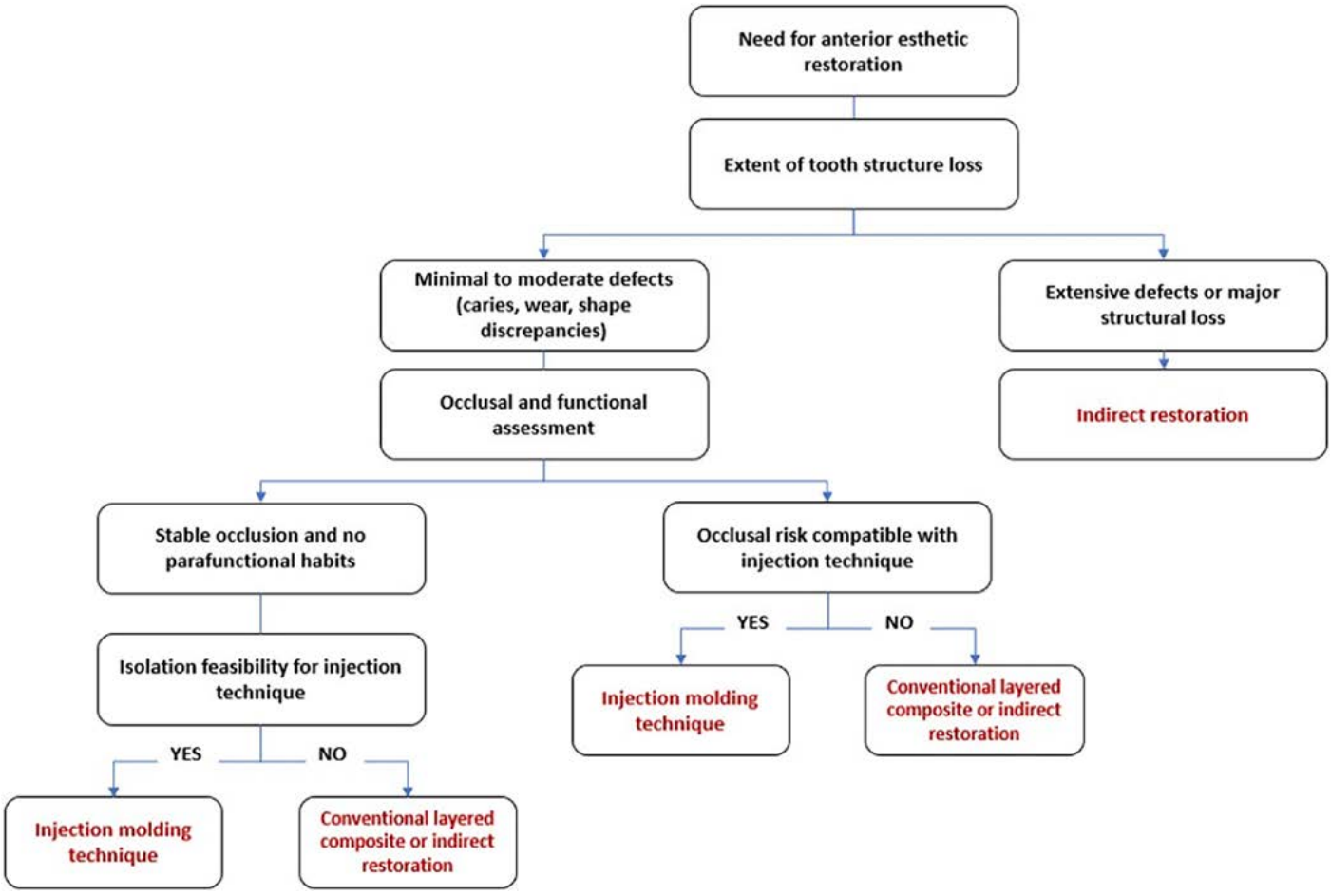

Figure 2. Simplified clinical decision-making flowchart for the injection molding technique in anterior esthetic restorations.

shades simultaneously during a single injection procedure. In clinical situations requiring complex layering or shade stratification, the injection process may need to be repeated, potentially increasing procedural complexity and chair time.[29] Moreover, despite the growing clinical interest in the injection molding technique, it should be emphasized that the current body of evidence is predominantly composed of case reports, technique descriptions, and short- to medium-term observational studies. High-level comparative clinical trials directly evaluating long-term outcomes such as wear resistance, color stability, and marginal integrity remain limited. Therefore, while reported outcomes appear promising, the available evidence should be interpreted with caution, and definitive conclusions regarding long-term clinical performance cannot yet be drawn.

Based on the aforementioned indications and limitations, a simplified clinical decision-making flowchart is presented in Figure 2 to support clinical case selection and treatment planning.

General Clinical Steps in the Application of the Injection Molding Technique

The clinical workflow of the injection molding technique may be summarized through a series of sequential steps. It should be noted that minor modifications can be required depending on the clinical scenario and the restorative objectives.

1. Taking intraoral impressions: Impressions are obtained either by conventional methods or using digital scanners
2. Smile design: Based on the obtained impressions, the smile design is created. In conventional workflows, wax-up models are prepared, whereas in digital workflows, computer-aided design software is used for design and the models are produced using computer-aided manufacturing systems
3. Fabrication of the transparent matrix: A transparent polyvinyl siloxane (PVS) matrix is fabricated on the designed model. Small injection holes are then created

in the incisal areas of the matrix to allow the application of the flowable composite resin

4. Tooth preparation: In some cases, minimal tooth preparation may be required to ensure proper adaptation of the silicone matrix to the teeth. This step may also assist in minor repositioning of the teeth when necessary
5. Isolation: The teeth that will not be restored are isolated with Teflon tape. Typically, adjacent teeth are isolated (for example, when restoring teeth 13–11–22, the adjacent teeth 12–21–23 are isolated)
6. Etching: The tooth surfaces to be restored are etched with 37% phosphoric acid for 30 s and then thoroughly rinsed with water
7. Adhesive application: A bonding agent is applied to the etched surfaces, air-thinned, and light-cured
8. Placement of the transparent matrix: The previously fabricated transparent matrix is carefully seated on the teeth. It is crucial to ensure complete seating of the matrix, as improper adaptation may lead to an inaccurate final form
9. Composite injection: The flowable composite resin is injected through the pre-made holes in the matrix, filling the cavity space
10. Polymerization: The injected composite is light-cured from multiple directions for adequate polymerization
11. Matrix removal and finishing: The transparent matrix is carefully removed, and any excess composite material is trimmed and finished
12. Restoration of remaining teeth: The same procedure is repeated for the remaining teeth that were not initially restored
13. Polishing: After completing all restorations, the surfaces are polished with appropriate polishing systems to achieve optimal smoothness and gloss.

Clinical Steps of the Technique: A Case with Complicated Carious Lesions

A 40-year-old female patient presented to our clinic for esthetic treatment due to wear on the incisal edges and multiple carious lesions in the anterior region (Fig. 3a). The patient requested esthetic treatment for the anterior teeth only and declined treatment of the posterior dentition. Because the patient also desired reshaping of the anterior tooth forms, it was decided to restore the six maxillary anterior teeth (FDI 13–23) using the injection molding technique to meet her esthetic expectations.

Clinical examination revealed no signs of parafunctional habits, and occlusal evaluation indicated no excessive anterior guidance or abnormal occlusal loading. The patient reported high satisfaction with the immediate esthetic outcome at the follow-up visit.

The anterior carious lesions were excavated under rubber-dam isolation. Enamel surfaces were etched with 37% phosphoric acid for 30 s and dentin surfaces for 15 s (Panora 200, Imicryl Dental, Konya, Turkey), then thoroughly rinsed with water. A universal adhesive (Nova Compo B Plus, Imicryl Dental, Konya, Turkey) was applied, air-thinned, and light-cured for 20 s using an LED curing unit (Valo Cordless, Ultradent, South Jordan, UT). The teeth were then restored with a composite resin (Essentia, MD shade, GC Corporation, Tokyo, Japan) (Fig. 3b).

Following the restorations, conventional impressions were taken using a C-type silicone impression material, and a dental cast was fabricated. Wax-up modeling was performed on this model for smile design purposes (Fig. 3c). This step may alternatively be performed using a fully digital workflow. Once the design was finalized, a transparent silicone matrix was fabricated from the model using an elastomeric PVS material (Exaclear, GC Corporation, Tokyo, Japan).

Minimally invasive veneer (laminate) preparations were then performed (Fig. 3d).

The adjacent teeth of those to be restored were isolated with PTFE (Teflon) tape (Fig. 3e). The surfaces were etched with 37% phosphoric acid for 30 s (Panora 200, Imicryl Dental, Konya, Turkey) and rinsed with water. A universal adhesive (Nova Compo B Plus, Imicryl Dental, Konya, Turkey) was applied, air-thinned, and light-cured from both buccal and lingual aspects for 10 s each using an LED curing unit (Valo Cordless, Ultradent, South Jordan, UT).

The transparent silicone matrix was then seated intraorally (Fig. 3e), and a highly filled flowable composite (G-ænial Universal Injectable, A2 shade, GC Corporation, Tokyo, Japan) was injected through the preformed access holes. The material was light-cured from buccal and lingual directions for 20 s each (Valo Cordless, Ultradent, South Jordan, UT). The same procedure was repeated for the remaining teeth that were not restored in the first sequence.

After removal of the silicone matrix, minor composite excesses around the restorations were removed with finishing/polishing discs (Sof-Lex, 3M ESPE, St. Paul, MN). The patient was scheduled for a follow-up appointment 1 week later. Intraoral images taken at the control visit are shown in Figure 3f.

Figure 3. Clinical workflow of the injection molding technique in the presented case. **(a)** Preoperative intraoral photographs of the patient. **(b)** Caries excavation under isolation and restoration with composite resin. **(c)** Wax-up models prepared on the cast. **(d)** Intraoral view after veneer preparations. **(e)** Tooth isolation and intraoral placement of the transparent silicone matrix. **(f)** Intraoral images at the 1-week follow-up.

The short-term clinical outcome was considered satisfactory. At the control visit, marginal adaptation and surface integrity of the restorations were judged to be acceptable. The patient was informed of the need for treatment of the posterior carious lesions and was given appropriate recommendations and referrals.

It should be noted that the 1-week follow-up period limits interpretation to short-term clinical observations, and no conclusions regarding long-term performance, color stability, or wear can be drawn from this illustrative case.

Clinical and Research Consequences

The injection molding technique may provide clinicians with a structured and minimally invasive approach for achieving esthetic and functional anterior restorations. When applied in carefully selected cases, this method may facilitate enhanced control over restoration morphology and surface adaptation, potentially minimizing extensive intraoral adjustments and chair time. The integration of both conventional and digital planning workflows, including wax-up and silicone index fabrication, can contribute to improved predictability of clinical outcomes and patient communication.

Clinically, this technique may be particularly relevant for practitioners seeking conservative alternatives to indirect restorations, especially in situations where preservation of sound tooth structure is prioritized. However, the successful clinical implementation of the injection molding technique appears to be linked to factors such as meticulous isolation, accurate matrix fabrication, and

appropriate material selection. Operator experience and case complexity may also influence outcomes, suggesting that clinicians should consider these factors when determining the suitability of the technique.

From a research perspective, the current evidence base is largely composed of short- and medium-term observations with limited high-level comparative data. Available data regarding mechanisms of long-term failure, including discoloration, wear, and marginal degradation, remain heterogeneous and are largely derived from indirect evidence extrapolated from studies on flowable composite materials rather than the injection molding technique itself. Future studies may benefit from standardized clinical protocols, randomized controlled trials, and long-term follow-up evaluations to assess outcomes such as color stability, wear resistance, marginal integrity, and patient-reported esthetic satisfaction. Comparative research examining different injectable materials and workflow variants could further clarify optimal clinical indications and limitations, ultimately supporting evidence-based decision-making in restorative dentistry.

Therefore, when interpreting the available literature, it should be considered that findings obtained under controlled laboratory conditions may not always directly correspond to clinical performance in the complex intraoral environment. While *in vitro* investigations provide valuable insights into material properties, degradation mechanisms, and potential failure patterns, the translation of these observations to long-term clinical outcomes may be limited. Accordingly, interpretations regarding the durability, esthetic stability, and long-term behavior of restorations performed using the injection molding technique should therefore be made with appropriate consideration of these contextual differences until supported by further clinical evidence.

Conclusion

Within the limitations of this narrative review and the illustrative clinical case, the injection molding technique may be considered a contemporary restorative approach for managing esthetic concerns in anterior dentition within a minimally invasive framework. When applied in appropriate clinical situations, this technique may facilitate the delivery of esthetic and functional restorations while potentially supporting the preservation of healthy tooth structure.

The clinical case presented in this review illustrates that with careful case selection and meticulous execution, the injection molding technique can be effectively applied in the treatment of complex anterior carious lesions. However, the current body of evidence remains limited, particularly with respect to long-term outcomes and comparative performance against alternative restorative approaches.

Consequently, further well-designed clinical and laboratory studies with extended follow-up periods are needed to better elucidate the clinical durability, esthetic stability, and material performance associated with this technique across diverse patient populations and clinical scenarios.

Ethics Committee Approval: Ethical committee approval was not required for this narrative review and illustrative clinical case in accordance with institutional guidelines.

Conflict of Interest: None declared.

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References

1. Campos LA, Costa MA, Bonafé FSS, Marôco J, Campos JADB. Psychosocial impact of dental aesthetics on dental patients. Int Dent J 2020;70(5):321-7. [CrossRef]
2. Abbasi MS, Lal A, Das G, Salman F, Akram A, Ahmed AR, et al. Impact of social media on aesthetic dentistry: general practitioners' perspectives. Healthcare (Basel) 2022;10(10):2055. [CrossRef]
3. Torres CRG, Zanatta RF. Composite restoration on anterior teeth. In: Modern Operative Dentistry: Principles for Clinical Practice. Cham: Springer; 2019. p. 465-575. [CrossRef]
4. de Azevedo Miranda D, Marçal YLV, Proba FP, Moreira TKP, Ferraz LN, Aguiar FHB. Color correspondence of different brands and composite resin systems in relation to the Vita Classical scale through spectrophotometry. Dent Oral Craniofac Res 2018;5(1):1-4. [CrossRef]
5. Vouvoudi EC. Overviews on the progress of flowable dental polymeric composites: their composition, polymerization process, flowability and radiopacity aspects. Polymers (Basel) 2022;14(19):4182. [CrossRef]
6. Baroudi K, Rodrigues JC. Flowable resin composites: a systematic review and clinical considerations. J Clin Diagn Res 2015;9:ZE18-24. [CrossRef]
7. Imai A, Takamizawa T, Sugimura R, Tsujimoto A, Ishii R, Kawazu M, et al. Interrelation among the handling, mechanical, and wear properties of the newly developed flowable resin composites. J Mech Behav Biomed Mater 2019;89:72-80. [CrossRef]
8. Harish L. An analysis of clinical effectiveness of different types of direct restorative materials in permanent posterior teeth. Arch Orofac Data Sci 2024;1:1-7.
9. Shinkai K, Taira Y, Suzuki S, Kawashima S, Suzuki M. Effect of filler size and filler loading on wear of experimental flowable resin composites. J Appl Oral Sci 2018;26:e20160652. [CrossRef]

10. Machado N, Rocha MG, Oliveira D, Reardon KG, Martins E, Lawson NC. Compressive modulus, translucency, and irradiance transmittance of clear PVS materials used for resin injection molding technique. J Esthet Restor Dent 2025;37(2):412-22. [CrossRef]
11. Sabbagh J, Dagher S, El Osta N, Souhaid P. Randomized Clinical Trial of a Self-Adhering Flowable Composite for Class I Restorations: 2-Year Results. Int J Dent 2017;2017:5041529. [CrossRef]
12. Bagherian A, Shirazi AS. Flowable composite as fissure sealing material? A systematic review and meta-analysis. Br Dent J 2018;224(2):92-7. Erratum in: Br Dent J. 2018;224(4):254. [CrossRef]
13. Boruziniat A, Gharaee S, Sarraf Shirazi A, Majidinia S, Vatanpour M. Evaluation of the efficacy of flowable composite as lining material on microleakage of composite resin restorations: A systematic review and meta-analysis. Quintessence Int 2016;47(2):93-101.
14. Signore A, Solimei L, Arakelyan MG, Benedicenti S, Mollica C. A 24-month randomized clinical study of flowable bulk-fill resin composites in Class III restorations. J Clin Exp Dent. 2024;16(2):e111-e13. [CrossRef]
15. May S, Cieplik F, Hiller KA, Buchalla W, Federlin M, Schmalz G. Flowable composites for restoration of non-carious cervical lesions: Three-year results. Dent Mater 2017;33(3):e136-e45. [CrossRef]
16. Alshali RZ, Bukhary DM, AlQahtani MA, Alenazi NO, Alzahrani AH, Alobaid HA. Repair of temporary fixed dental prostheses using a flowable resin composite: Effect of material, bonding, and aging. Saudi Dent J 2021;33(7):495-502. [CrossRef]
17. Omidi BR, Heidari S, Izadpanah A. Bond strength of flowable dental composites in the cementation of indirect restorations: a systematic review and meta-analysis. Evid Based Dent 2025;26(4):178-9. [CrossRef]
18. Suni AO, Lassila LVJ, Tuokko JK, Garoushi S, Vallittu PK. Adhesion of individually formed fiber post adhesively luted with flowable short fiber composite. Biomater Investig Dent 2023;10(1):2209593. [CrossRef]
19. Nahidh M, Sofar MK, Venugopal A. Flowable composites in daily orthodontic practice-a review. Journal of Hunan University Natural Sciences 2022;49(2). [CrossRef]
20. Raza MA, Khan JA, Akhtar H, Farooqui WA, Faraz H, Hasan A. Comparison of two composite resin materials for splinting of dental luxation injuries: A double blind randomized controlled trial. Dent Traumatol 2024;40(1):44-53. [CrossRef]
21. Zhou X, Huang X, Li M, Peng X, Wang S, Zhou X, Cheng L. Development and status of resin composite as dental restorative materials. J Appl Polym Sci 2019;136(44):48180. [CrossRef]
22. Geštakovski D. The injectable composite resin technique: biocopy of a natural tooth-advantages of digital planning. Int J Esthet Dent 2021;16(3):280-99.
23. Peumans M, Gestakovski D, Mattiussi J, Karagiannopoulos K. Injection moulding technique with injectable composites: quick fix or long-lasting solution. Int Dent Afr Ed 2023;1:14-22.
24. Ammannato R, Rondoni D, Ferraris F. Update on the 'index technique' in worn dentition: a no-prep restorative approach with a digital workflow. Int J Esthet Dent 2018;13(4):516-37.
25. Kılıç V, Baktır S. A contemporary review of injection molding technique and materials used. In: Cangül S, Kılıç V, editors. Current Developments in Restorative Dentistry. Sheridan, WY: Zeus Publishing; 2024. p. 6-13.
26. Coachman C, de Arbeloa L, Mahn G, Sulaiman T, Mahn E. An improved direct injection technique with flowable composites: a digital workflow case report. Oper Dent 2020;45(3):235-42. [CrossRef]
27. Valente MSO, Neto CF, Obeid AT, Furuse AY, Ishikiriama BLC, Ishikiriama SK, et al. Direct vs indirect restorations for diastema closure: determining the suitable approach. Gen Dent 2023;71(5):53-57.
28. Tian Y, Chen C, Xu X, Wang J, Hou X, Li K, et al. A review of 3D printing in dentistry: technologies, affecting factors, and applications. Scanning 2021;2021:9950131. [CrossRef]
29. Liaropoulou YM, Jiménez AK, Chierico F, Blatz MB. The multilayer flowable injection technique for highly esthetic restorations. J Esthet Restor Dent 2025;37(10):2161-70. [CrossRef]