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CAD/CAM Restorations in General Dentistry: Materials, Clinical Applications, and Current Evidence-A Narrative Review

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Abstract Computer-aided design and computer-aided manufacturing (CAD/CAM) have transformed restorative dentistry by integrating digital impressions, computer-assisted design, and automated manufacturing into clinical workflows. This narrative review summarizes the major CAD/CAM materials currently used in general dentistry, including glass ceramics, zirconia, resin-based materials, and hybrid materials, and examines their clinical applications in crowns, inlays, onlays, veneers, fixed dental prostheses, implant-supported restorations, and provisional restorations. Emerging developments, including artificial intelligence-assisted design, improved intraoral scanning, 3D printing, and novel restorative materials, are also considered. CAD/CAM technology provides increasingly versatile options for contemporary restorative care, although material selection, clinical indication, digital workflow, and long-term evidence remain important considerations for predictable outcomes.

Keywords: *CAD/CAM, Digital dentistry, 3D Printing, Restorative Dentistry*

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1. Introduction

Computer-aided design and computer-aided manufacturing (CAD/CAM) have become an integral part of modern restorative dentistry, transforming conventional laboratory and clinical procedures into increasingly digital workflows. The integration of intraoral scanning, computer-assisted design, and computer-controlled manufacturing has enabled dental restorations to be planned and fabricated with greater digital precision and workflow efficiency. [1,2] (Figure 1)

The development of CAD/CAM technology has been accompanied by substantial advances in restorative materials. Glass ceramics, lithium disilicate, zirconia, resin-based composite blocks, and hybrid materials are now available for a wide range of clinical applications. These materials differ considerably in mechanical properties, optical characteristics, fabrication methods, and cementation requirements, making appropriate material selection an important component of successful treatment. [3,4]

In general dental practice, CAD/CAM technology is used for the fabrication of crowns, inlays, onlays, veneers, fixed dental prostheses, implant-supported restorations, and provisional restorations. Chairside systems have further expanded its clinical application by allowing digital impressions, restoration design, and manufacturing to be completed within a single clinical workflow. [5] In addition to potentially reducing treatment time, digital workflows may improve communication between clinicians and dental laboratories and facilitate standardized digital records.

Despite these advantages, CAD/CAM dentistry has limitations. Outcomes can be influenced by scanning accuracy, preparation design, software and manufacturing techniques, material selection, restoration thickness,

surface treatment, and cementation procedures. Furthermore, the rapid introduction of new materials and technologies means that clinical evidence is continually evolving, and long-term data are not equally available for all CAD/CAM systems and materials. [6,7]

This narrative review discusses the evolution and clinical workflow of CAD/CAM restorative dentistry, currently available materials, their applications in general dental practice, and evidence regarding clinical performance and outcomes. The review also highlights practical considerations, current limitations, and emerging developments that may influence the future of digital restorative dentistry.

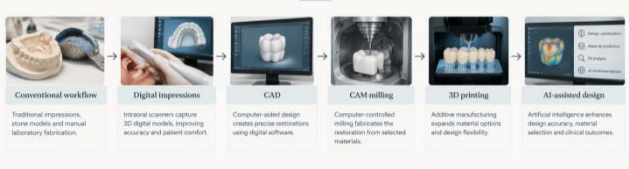

Figure 1. Evolution of CAD/CAM in restorative dentistry

2. CAD/CAM Workflow in General Dentistry

The CAD/CAM workflow integrates digital data acquisition, computer-assisted restoration design, and computer-controlled manufacturing into a sequential restorative process. In general dentistry, this workflow can be completed entirely in the dental office or can involve a dental laboratory, depending on the clinical indication, equipment, and complexity of the restoration. The basic sequence consists of patient assessment, tooth preparation, digital impression, restoration design, material selection, fabrication, try-in, surface treatment, cementation, and follow-up (Figure 2). [8]

2.1. Intraoral Scanning

Following clinical examination and tooth preparation, an intraoral scanner (IOS) can be used to capture the prepared tooth and surrounding structures as a digital impression. The scanner acquires multiple optical images that are computationally combined to generate a three-dimensional representation of the dentition. Compared with conventional impression techniques, digital impressions can improve patient comfort, facilitate immediate visualization of the preparation, and allow digital storage and transfer of records. [9] However, scanning accuracy may be influenced by factors such as saliva, blood, limited access, reflective surfaces, preparation geometry, and the extent of the scanned area. Appropriate scanning technique and soft-tissue control therefore remain important for obtaining reliable digital data. [10]

2.2. Computer-Aided Design

The digital impression is imported into CAD software, where the restoration is designed according to the preparation geometry and clinical requirements. The software can assist with margin identification, proximal contacts, occlusal morphology, emergence profile, and restoration thickness. Depending on the system, libraries of anatomical tooth forms can be used and modified to achieve an appropriate functional and esthetic result. Digital articulation and occlusal analysis may also be incorporated into the design process. Although automated design functions can improve efficiency, clinician oversight remains essential because the final restoration must be compatible with the patient's occlusion, preparation, periodontal environment, and clinical needs. [11]

2.3. Material Selection and CAM Fabrication

Material selection represents an important transition between digital design and manufacturing. The choice depends on restoration type, location, functional loading, esthetic requirements, available space, bonding strategy, and material properties. Common CAD/CAM materials include glass ceramics, lithium disilicate, zirconia, resin-based materials, and hybrid materials. [12]

The completed digital design is transferred to a CAM system for fabrication. Subtractive manufacturing, particularly milling from prefabricated blocks or discs, remains widely used for definitive restorations. Additive manufacturing, including dental 3D printing, has also expanded, particularly for provisional restorations, models, surgical guides, and selected definitive applications. Milling and 3D printing should not be considered interchangeable for every indication because their materials, manufacturing processes, accuracy, post-processing requirements, and clinical evidence differ. [13]

2.4. Chairside and Laboratory Workflows

In a chairside workflow, scanning, design, and fabrication are performed within the dental office, potentially allowing restoration delivery during a single appointment. In a laboratory-assisted workflow, digital files are transferred to a dental laboratory for design, fabrication, or both. Laboratory workflows may provide access to a broader range of equipment, materials, and specialized expertise, particularly for complex or extensive restorations. Thus, the appropriate workflow depends on the clinical situation rather than simply on the availability of digital technology. [14]

2.5. Try-In, Surface Treatment, and Cementation

After fabrication, the restoration is evaluated intraorally for marginal adaptation, proximal contacts, occlusion, contour, and esthetics. Appropriate surface treatment is then performed according to the restorative material and cementation protocol. Depending on the material, this may involve etching, priming, air abrasion, or application of a ceramic-specific coupling agent. Adhesive or conventional cementation is selected according to the material, preparation characteristics, and clinical indication. Strict adherence to manufacturer recommendations and established bonding protocols is important for predictable outcomes. [15]

Following cementation, occlusion and restoration margins are reassessed, and the restoration is documented within the patient's digital record. Periodic follow-up allows evaluation of function, periodontal health, marginal integrity, and restoration performance. Overall, the CAD/CAM workflow can streamline restorative treatment while maintaining the fundamental principles of tooth preparation, material selection, isolation, and adhesive or cementation technique. [15]



Figure 2. CAD/CAM clinical workflow

Table 1. CAD/CAM Materials: Properties, Clinical Applications, and Limitations

Material category	Representative materials	Key characteristics	Common clinical applications	Advantages	Important limitations
Glass ceramics [18]	Feldspathic ceramic, leucite-reinforced ceramic, lithium disilicate	High esthetic potential; variable strength depending on composition; generally etchable	Veneers, inlays, onlays, anterior/posterior crowns	Excellent optical properties; adhesive bonding possible; good esthetics	Lower fracture resistance for some formulations; technique-sensitive bonding
Zirconia [19]	3Y, 4Y, 5Y zirconia	High strength; fracture-resistant; translucency varies with formulation	Crowns, posterior restorations, fixed dental prostheses, implant-supported restorations	High mechanical strength; suitable for high-load areas; metal-free	Limited conventional etching; surface treatment and cementation require material-specific protocols; translucency-strength trade-off
Resin-based CAD/CAM materials [20]	CAD/CAM composite resin, PMMA, polymer blocks	Good machinability; relatively resilient; easy to adjust and polish	Provisional restorations, selected definitive restorations, long-term temporization	Efficient milling; repairable; favorable shock absorption	Lower stiffness and wear resistance than many ceramics; indications vary by material
Hybrid materials [20]	Resin nanoceramics, polymer-infiltrated ceramic networks [PICNs]	Combination of ceramic and polymer characteristics; favorable machinability	Inlays, onlays, veneers, selected crowns	Good balance of esthetics, strength, and adjustability; reduced brittleness	Material-specific bonding protocols; long-term evidence varies among products
Emerging materials [21]	High-translucency zirconia, advanced ceramic-polymer systems, reinforced ceramics, printable restorative materials	Designed to improve optical properties, mechanical performance, manufacturing efficiency, or digital compatibility	Expanding applications in crowns, fixed restorations, provisional and digitally manufactured restorations	Expanding material selection; potential for improved digital workflows	Limited long-term clinical evidence for some newer materials; indications and protocols continue to evolve

3. CAD/CAM Materials

The development of CAD/CAM technology has been accompanied by a broad range of machinable restorative materials with different mechanical, optical, and bonding characteristics. The principal material categories used in general dentistry include glass ceramics, zirconia, resin-based CAD/CAM materials, and hybrid materials. More recently, newer ceramic-polymer systems and additively manufactured materials have expanded the range of digital restorative options. Material selection should be based on the clinical indication, functional loading, esthetic requirements, available restorative space, preparation design, and cementation strategy. The major characteristics, indications, and limitations of commonly used CAD/CAM materials are summarized in Table 1. [16,17]

4. Clinical Applications in General Dentistry

CAD/CAM technology is now used across a broad range of restorative and prosthodontic procedures, from conservative partial-coverage restorations to single crowns, fixed partial dentures, implant-supported prostheses, and provisional restorations. The clinical application of a CAD/CAM material depends on the restoration type, tooth position, functional loading, remaining tooth structure, esthetic requirements, and cementation strategy. Overall, clinical evidence supports the use of CAD/CAM restorations for several routine indications, although the strength and duration of evidence vary considerably among restoration types and materials.

4.1. Crowns

Single crowns represent one of the most established applications of CAD/CAM technology. Lithium disilicate and zirconia are commonly used for both anterior and posterior crowns, while resin-based and hybrid materials may be selected for specific clinical situations. Systematic reviews have reported clinically acceptable marginal adaptation for CAD/CAM lithium disilicate and zirconia crowns, with reported marginal gaps generally within clinically acceptable ranges. [22]

Long-term clinical evidence also supports the use of CAD/CAM ceramic single-tooth restorations. A systematic review involving 2,916 CAD/CAM single-tooth ceramic restorations reported an estimated 5-year survival of approximately 89.7%, with overall survival comparable to conventionally fabricated ceramic restorations. [23] Monolithic zirconia has additionally demonstrated favorable short- to intermediate-term clinical performance, particularly in posterior applications. [24] Thus, CAD/CAM crowns can provide predictable outcomes when preparation design, material selection, occlusal considerations, and cementation protocols are appropriately controlled.

4.2. Inlays and Onlays

CAD/CAM inlays and onlays provide conservative alternatives to complete-coverage restorations when sufficient tooth structure remains. These restorations are particularly useful for posterior teeth with moderate structural loss where preservation of sound enamel and dentin is desirable. CAD/CAM systems can provide clinically acceptable marginal adaptation for intracoronal and partial-coverage restorations, although adaptation is influenced by the restorative material, preparation design, software parameters, milling system, and cementation procedure. [25]

Clinical evidence indicates generally favorable survival of indirect inlays and onlays, although direct comparisons between materials and restoration designs remain limited by heterogeneity among studies. [26] The adhesive nature of many ceramic and hybrid CAD/CAM materials also allows minimally invasive preparations with relatively limited removal of sound tooth structure.

4.3. Veneers

CAD/CAM technology can be used to fabricate ceramic veneers when digital scanning and computer-assisted design are integrated with appropriate adhesive protocols. Feldspathic and glass-ceramic materials remain widely used because of their optical properties, while lithium disilicate and other CAD/CAM ceramics may be selected according to the required thickness, strength, and esthetic demands.

Clinical evidence indicates favorable survival of ceramic veneers, although the specific evidence base for CAD/CAM-fabricated veneers is smaller than that for conventional laboratory-fabricated veneers. A recent systematic review identified only four eligible clinical studies involving 1,037 milled ceramic anterior veneers, with two reported failures, both associated with veneer fracture; the authors emphasized the limited long-term evidence specifically for CAD/CAM veneers. [27] Importantly, substrate influences clinical performance. A recent systematic review and meta-analysis found higher survival and success for ceramic veneers bonded predominantly to enamel compared with veneers involving greater dentin exposure. [28]

4.4. Fixed Partial Dentures

CAD/CAM technology is increasingly used for the fabrication of tooth-supported fixed partial dentures (FPDs), particularly zirconia-based and other high-strength ceramic frameworks. Digital workflows can facilitate standardized framework design, connector dimensions, occlusal morphology, and laboratory communication. However, multi-unit restorations are subjected to greater biomechanical demands than single crowns, and complications such as framework fracture, veneering-ceramic fracture or chipping, loss of retention, and biological complications remain relevant. [29]

A systematic review of CAD/CAM tooth-supported zirconia and lithium disilicate fixed dental prostheses estimated pooled 1-, 5-, and 10-year survival rates of approximately 94%, 90%, and 79-82%, respectively, although outcomes varied according to material and restoration characteristics. [29] A broader systematic review and meta-analysis similarly found that CAD/CAM single crowns and FPDs demonstrate generally comparable biological and technical outcomes to conventionally fabricated restorations, while FPDs showed greater complication-related challenges than single crowns. [30]

4.5. Implant-Supported Restorations

CAD/CAM workflows have become an important component of implant prosthodontics, particularly for customized abutments, single implant crowns, screw-retained restorations, and full-arch prostheses. Digital implant workflows can integrate intraoral scanning, implant-position data, virtual design, and computer-controlled fabrication to improve standardization and facilitate the production of individualized prosthetic components.

Available clinical evidence suggests favorable outcomes for CAD/CAM implant-supported restorations, although the evidence is stronger for some applications than others. An earlier systematic review of CAD/CAM-fabricated implant-supported restorations reported survival rates ranging from 92% to 100% over 1-10 years, while also emphasizing the limited number of high-quality long-term studies, particularly for single crowns and partial fixed prostheses. [31] For single implant-supported crowns, randomized clinical trial evidence has not demonstrated significant differences between ceramic and metal-ceramic restorations in prosthesis failure, mechanical or biological complications, marginal bone loss, or patient satisfaction. [32] These findings support CAD/CAM as an important manufacturing approach while highlighting the need for material- and indication-specific clinical selection.

4.6. Provisional Restorations

CAD/CAM technology has expanded the fabrication of provisional crowns and fixed dental prostheses through both subtractive milling and additive manufacturing. Milled PMMA and related polymer-based materials have traditionally been used for digitally fabricated provisionals, while 3D-printed provisional resins have become increasingly available. Digital fabrication allows rapid reproduction of tooth morphology, standardized thickness, and easy duplication of provisional designs.

Evidence suggests that 3D-printed provisional materials can provide mechanical properties suitable for provisional crowns and fixed dental prostheses, although their physical properties may differ from those of milled and conventionally fabricated materials. A systematic review and meta-analysis found that 3D-printed provisional materials demonstrated favorable mechanical performance but differences in physical properties compared with milled and conventional materials. [33] Accordingly, provisional material selection should consider the expected duration of service, span length, occlusal loading, esthetic requirements, and post-processing protocol. (Table 2)

5. Advantages and Limitations of CAD/CAM Dentistry

CAD/CAM technology offers several advantages over conventional restorative workflows, including digital data acquisition, standardized restoration design, efficient manufacturing, and improved communication between the dental office and laboratory. Depending on the system, chairside workflows may also reduce the number of clinical appointments and facilitate same-day restorative treatment. Digital records can be stored, reproduced, and transferred easily, supporting continuity of care and laboratory collaboration. [34,35,36]

Despite these advantages, CAD/CAM dentistry remains dependent on the accuracy of scanning, software design, manufacturing, material selection, and clinical cementation. Initial equipment and software costs can be substantial, and clinicians require appropriate training to use digital systems effectively. In addition, the rapid development of new materials and technologies means that long-term clinical evidence is not equally established across all CAD/CAM applications. Therefore, CAD/CAM should be considered a tool that complements, rather than replaces, fundamental restorative principles. [37,38] (Table 3)

Table 2. Clinical Applications of CAD/CAM Restorations

Clinical application	Common CAD/CAM materials	Typical indications	Key clinical considerations	Current evidence
Crowns [22,23,24]	Lithium disilicate, zirconia, hybrid/resin-based materials	Anterior and posterior single crowns	Preparation design, occlusion, esthetics, cementation	Strongest evidence among CAD/CAM applications; favorable medium- to long-term survival reported
Inlays/onlays [25,26]	Lithium disilicate, glass ceramics, hybrid materials, resin-based materials	Moderate posterior defects; conservative indirect restorations	Preservation of tooth structure, adhesive bonding, marginal adaptation	Favorable clinical performance; evidence heterogeneous
Veneers [27,28]	Feldspathic ceramic, glass ceramics, lithium disilicate	Esthetic anterior rehabilitation	Enamel preservation, ceramic thickness, adhesive protocol	Favorable ceramic veneer survival, but CAD/CAM-specific long-term evidence is limited
Fixed partial dentures [29,30]	Zirconia, lithium disilicate in selected indications, resin-based/hybrid materials for selected applications	Short-span tooth-supported FPDs	Connector dimensions, framework design, occlusal loading, veneering complications	Good short-/medium-term evidence; more complications than single crowns
Implant-supported restorations [31,32]	Zirconia, lithium disilicate, titanium/ceramic CAD/CAM components, hybrid materials	Single crowns, screw-retained restorations, implant FPDs, full-arch prostheses	Implant position, emergence profile, screw access, passive fit, material selection	Favorable evidence, but long-term evidence varies substantially by application
Provisional restorations [33]	PMMA, CAD/CAM composite resin, 3D-printed provisional resin	Single crowns, FPDs, long-term provisionals	Duration of service, fracture resistance, wear, post-processing	Rapidly expanding evidence; 3D printing is promising but material-specific protocols remain important

Table 3. Advantages and Limitations of CAD/CAM Dentistry

Advantages	Limitations
Digital workflow: Integrates scanning, design, and manufacturing into a standardized process	High initial cost: Acquisition and maintenance of scanners, milling units, furnaces, and software can be substantial
Improved workflow efficiency: Can reduce laboratory and clinical processing time	Learning curve: Effective use requires training and familiarity with digital systems
Patient comfort: Intraoral scanning may be more comfortable than conventional impression procedures	Scanning limitations: Saliva, blood, reflective surfaces, deep margins, and limited access can affect scan quality
Chairside fabrication: Selected restorations can be designed and fabricated during a single appointment	Equipment dependence: Workflow can be interrupted by software, hardware, or technical failures
Digital communication: Files can be rapidly transferred between clinicians and laboratories	Material limitations: No single CAD/CAM material is ideal for all clinical indications
Reproducibility: Digital designs can be stored, modified, and reproduced when necessary	Manufacturing constraints: Milling limitations, tool diameter, material thickness, and restoration geometry can affect fabrication
Standardized design: CAD software facilitates controlled contacts, occlusion, morphology, and restoration thickness	Post-processing requirements: Some materials require sintering, crystallization, staining, glazing, polishing, or other processing

Advantages	Limitations
Conservative treatment: Digital design and adhesive materials can facilitate minimally invasive restorative approaches in appropriate cases	Cementation sensitivity: Surface treatment and bonding protocols vary considerably among materials
Digital records: Scans and restoration designs can be archived for future treatment and comparison	Long-term evidence: Clinical evidence is less established for some newer materials and digital workflows
Laboratory integration: Digital workflows facilitate communication and collaboration with dental laboratories	Workflow variability: Outcomes depend on scanner, software, manufacturing system, operator technique, and clinical conditions
Easy modification: Digital restorations can often be adjusted before manufacturing	Technology obsolescence: Rapid technological development may require periodic software, hardware, or equipment upgrades
Potential reduction in remakes: Digital standardization and immediate visualization may help identify errors earlier in the workflow	Not a substitute for clinical judgment: Digital accuracy does not eliminate the need for sound preparation, occlusal, periodontal, and cementation principles

6. Emerging Technologies and Future Directions

The continued development of digital dentistry is expanding CAD/CAM beyond conventional scanning, computer-assisted design, and subtractive milling. Artificial intelligence (AI), automated CAD systems, additive manufacturing, and novel restorative materials are increasingly being integrated into digital workflows. These developments have the potential to improve automation, personalization, manufacturing efficiency, and clinical decision-making. However, their widespread clinical adoption will depend on validation of accuracy, reproducibility, safety, cost-effectiveness, and long-term clinical performance. [39]

6.1. Artificial Intelligence

AI is increasingly being incorporated into digital restorative workflows for image analysis, tooth and margin identification, segmentation, treatment planning, and restoration design. Machine-learning and deep-learning algorithms can analyze intraoral scans, photographs, radiographs, and other digital records to identify anatomical structures and assist with restoration planning. In CAD/CAM dentistry, AI-assisted systems may facilitate automated tooth segmentation, margin detection, occlusal analysis, and generation of preliminary restoration designs. Future systems may integrate multiple sources of patient data, including intraoral scans, facial photographs, radiographs, and clinical information, to generate more individualized restorative designs. Nevertheless, clinical validation, standardized datasets, explainability, and appropriate clinician oversight remain important considerations. [40]

6.2. Automated CAD

Automated and AI-assisted CAD systems are moving restoration design from predominantly manual digital modeling toward increasingly automated workflows. Algorithms can assist with tooth morphology, proximal contacts, occlusal anatomy, emergence profiles, and restoration thickness based on adjacent and contralateral teeth. Such automation may reduce design time and improve workflow consistency, particularly for routine single-tooth restorations. However, automated designs should remain subject to clinician review because anatomical variation, occlusal relationships, periodontal conditions, and patient-specific requirements cannot always be adequately represented by standardized algorithms. [41]

6.3. 3D Printing

Additive manufacturing is becoming an important component of digital dentistry and provides an alternative to conventional subtractive milling. Three-dimensional printing can fabricate models, surgical guides, provisional restorations, dentures, orthodontic appliances, and, increasingly, selected definitive restorations. Compared with milling, additive manufacturing may reduce material waste and permit fabrication of complex geometries that are difficult to produce through subtractive methods. Improvements in printable ceramic, polymer, and composite materials are expected to broaden its clinical applications. Important challenges include dimensional accuracy, polymerization shrinkage, surface quality, post-processing, material aging, and the need for standardized long-term clinical evidence. [42]

6.4. New Materials

Material development remains closely linked to advances in digital manufacturing. New generations of zirconia, glass ceramics, ceramic-polymer networks, resin-based materials, and printable restorative materials are being developed to improve the balance between strength, translucency, wear resistance, machinability, and bonding performance. Multilayer and gradient materials may further improve the reproduction of natural tooth optical characteristics while reducing the need for extensive manual characterization. In parallel, materials specifically engineered for additive manufacturing may expand the range of digitally fabricated definitive restorations. Future material development will increasingly require evaluation not only of mechanical and optical properties but also of long-term wear, aging, bonding stability, biological compatibility, and clinical survival. [43,44]

7. Discussion

CAD/CAM technology has become an established component of contemporary restorative dentistry, integrating digital impression acquisition, computer-assisted design, and computer-controlled manufacturing into a streamlined clinical workflow. Advances in

intraoral scanners, CAD software, and machinable restorative materials have expanded its applications from single crowns to inlays, onlays, veneers, fixed partial dentures, implant-supported restorations, and provisional prostheses. Current evidence generally supports CAD/CAM as a clinically viable approach, although outcomes depend on the restoration type, material, manufacturing method, and clinical protocol. [45]

A major advantage of CAD/CAM dentistry is improved workflow standardization. Digital impressions allow immediate visualization of preparations, while CAD software facilitates control of restoration morphology, proximal contacts, occlusion, and material thickness. Digital files can also be stored and transferred efficiently between clinicians and dental laboratories. However, digital workflows do not inherently guarantee accuracy. Scanner performance, scanning technique, preparation geometry, soft-tissue management, software, and operator experience can all influence the final restoration. [46]

Material selection remains an important determinant of clinical performance. Glass ceramics, particularly lithium disilicate, provide favorable esthetics and adhesive bonding potential, whereas zirconia offers high strength and is frequently selected for posterior and high-load applications. Resin-based and hybrid materials provide favorable machinability and may be useful for provisional and selected definitive restorations. Therefore, CAD/CAM material selection should be based on the clinical indication, functional demands, esthetic requirements, available restorative space, and cementation strategy rather than on material availability alone.

The strongest clinical evidence is currently available for CAD/CAM single-tooth restorations, particularly crowns, which have demonstrated favorable adaptation and medium- to long-term survival. Evidence for inlays, onlays, fixed partial dentures, and implant-supported restorations is also generally favorable, although outcomes vary according to material, restoration design, and follow-up period. Ceramic veneers demonstrate good overall clinical performance, but long-term evidence specifically evaluating CAD/CAM-fabricated veneers remains more limited. Similarly, newer CAD/CAM materials and additive manufacturing technologies have shorter clinical histories, making direct comparison with established materials difficult. [47]

The rapid development of artificial intelligence, automated CAD, and 3D printing is likely to further transform digital restorative workflows. AI-assisted systems may facilitate tooth segmentation, margin detection, occlusal analysis, and automated restoration design, while additive manufacturing provides new possibilities for provisional and selected definitive restorations. However, emerging technologies require appropriate validation because laboratory measures of accuracy or mechanical performance do not necessarily predict long-term clinical behavior. [48]

Despite its advantages, CAD/CAM dentistry involves significant equipment costs, maintenance requirements, software dependence, and a learning curve. Importantly, digital technology does not replace fundamental restorative principles. Adequate tooth preparation, isolation, material selection, surface treatment, occlusal management, and appropriate cementation remain essential for predictable outcomes. [49,50]

8. Conclusion

CAD/CAM technology has become an important component of contemporary restorative dentistry, integrating digital impressions, computer-aided design, and computer-controlled manufacturing into increasingly efficient clinical workflows. The expanding range of glass ceramics, zirconia, resin-based, hybrid, and emerging materials provides versatile options for different restorative indications. However, predictable clinical outcomes depend on appropriate material selection, scanning accuracy, preparation design, manufacturing technique, surface treatment, and cementation protocols. Continued advances in intraoral scanning, additive manufacturing, and artificial intelligence-assisted design are expected to further expand the capabilities of digital restorative dentistry. Nevertheless, continued evaluation of emerging materials and technologies, particularly through long-term clinical evidence, remains important for their reliable integration into routine practice.

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