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Pioneering Chairside Digital Crowns in Qatar's Primary Health Care Settings: A Single-Visit Monolithic Zirconia Restoration Case Report

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Abstract

Nowadays, advances in chairside digital workflows have transformed restorative dentistry by enabling the delivery of indirect restorations in a single visit. Monolithic zirconia crowns fabricated with computer-aided design/computer-aided manufacturing (CAD/CAM) systems demonstrate excellent survival rates and are increasingly used for posterior and premolar teeth following endodontic treatment. However, their implementation in public primary care settings remains underreported. This report describes the case of a 44-year-old male patient with controlled hypothyroidism requiring restoration of a root canal-treated maxillary first premolar. Using a fully digital workflow with CEREC Prime scan, Prime Mill, and Speed Fire furnace, a monolithic zirconia crown was designed, fabricated, and cemented in one visit. At one-, three- and six-month follow-up, the restoration exhibited excellent marginal adaptation, occlusion, and esthetics, with no reported complications. The patient expressed high satisfaction with the convenience of single-visit treatment. This case highlights the efficiency and predictability of chairside zirconia restorations for endodontically treated teeth and supports existing evidence that such digital workflows provide reliable and clinically successful outcomes. To the best of our knowledge, this represents one of the first documented chairside digital crown restoration in Primary health care settings in Qatar. The case demonstrates the feasibility of CAD/CAM adoption in government primary care and underscores its potential role in driving digital innovations within public oral health services in Qatar.

Keywords

CAD/CAM Dentistry, Chairside Crown, Zirconia Restoration, Prime Scan, Prime Mill, Speed Fire, Single-Visit Workflow, Digital Innovation

1. Introduction

Digital dentistry has transformed restorative workflows, with chairside CAD/CAM systems enabling the fabrication and delivery of indirect restorations in a single visit. The ability to scan, design, mill, and cement a crown during one appointment eliminates provisional restorations and multiple visits, offering significant advantages in efficiency and patient convenience [1] [2].

Zirconia has become a preferred restorative material because of its high flexural strength, biocompatibility, and resistance to chipping when used in monolithic form [3] [4]. Advances in translucency have extended its use beyond posterior load-bearing teeth into esthetically demanding regions, further broadening its clinical applications [5]. Together with innovations in milling and high-speed sintering, these developments have positioned monolithic zirconia crowns as a reliable option for same-day workflows [6] [7].

Although the clinical performance of chairside zirconia crowns has been well documented in private practice and academic settings, their adoption within government primary healthcare services remains limited. Most published reports focus on survival rates, marginal adaptation, and complication profiles in conventional or tertiary care environments [8] [9]. Evidence from high-volume public systems where workflow efficiency and resource allocation are critical is still scarce [10].

Qatar's Primary Health Care Corporation (PHCC) is currently exploring the integration of digital dentistry technologies to enhance service delivery and reduce reliance on secondary care referrals. Documenting early planning and feasibility studies within this context is essential for evaluating outcomes, and future directions for large-scale adoption.

This report describes a case of a monolithic zirconia crown fabricated and delivered using a complete chairside CAD/CAM workflow in a primary health care dental clinic. The objective is to illustrate the clinical steps, short-term outcomes, and broader relevance of such an approach in a government primary healthcare setting.

2. Case Presentation

A 44-year-old male patient presented to dental department in primary Health Center seeking a definitive restoration for the maxillary left first premolar (tooth #14). His medical history revealed well-controlled hypothyroidism, and no systemic contraindications to dental treatment were identified. The tooth had previously undergone root canal therapy and exhibited significant coronal structure loss, although the patient reported no symptoms at presentation. Clinical examination demonstrated healthy periodontal tissues, stable occlusion, and adequate restorative space. A periapical radiograph confirmed the quality of obturation and absence of periapical pathology (**Figure 1**: Preoperative periapical radiograph of root canal-treated maxillary left first premolar).

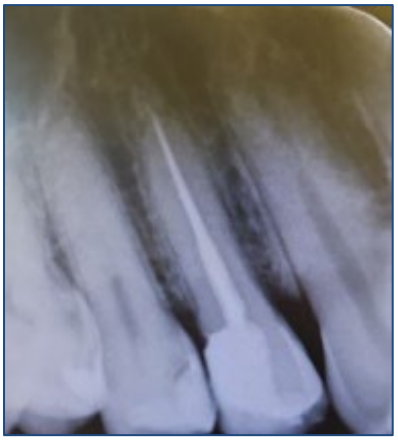

Figure 1. Preoperative periapical radiograph of maxillary left first premolar (14) following root canal treatment.

Based on the compromised coronal structure, a full-coverage indirect restoration was deemed the most appropriate treatment option, and a chairside CAD/CAM zirconia crown was planned.

Tooth preparation was performed according to current recommendations for monolithic zirconia restorations. Occlusal reduction of approximately 1.5 - 2.0 mm and axial reduction of 1.2 mm were achieved, while a rounded chamfer finish line was prepared and placed supragingival to facilitate intraoral scanning and maintain periodontal health. All internal line angles were rounded to reduce stress concentration, and the preparation was carefully evaluated to ensure smooth taper and absence of undercuts. Shade selection (A2) was carried out using a conventional shade guide under natural daylight to maximize color accuracy.

Digital impressions were acquired with the CEREC Primescan intraoral scanner. The scanning sequence involved registration of the maxillary arch, the opposing arch, and a buccal bite in maximum intercuspation to ensure precise articulation. The virtual dataset was automatically processed by the software to produce a high-resolution three-dimensional model. The digital model was subsequently optimized by aligning the model axis, trimming extraneous data, and conducting a preparation analysis to confirm appropriate taper and evaluate potential undercuts. The restoration margins were carefully traced using the margin delineation tool (**Figure 2**: Digital intraoral scan of the preparation captured with Primescan; **Figure 3**: Virtual model optimization in CEREC software).

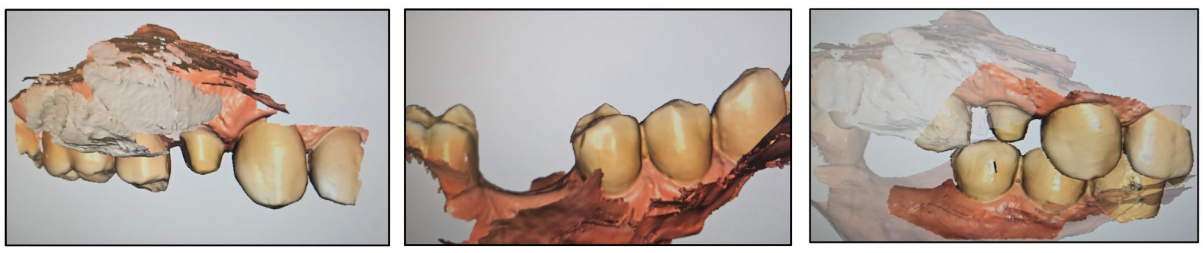

Figure 2. Digital intraoral scan of the preparation captured with Primescan.

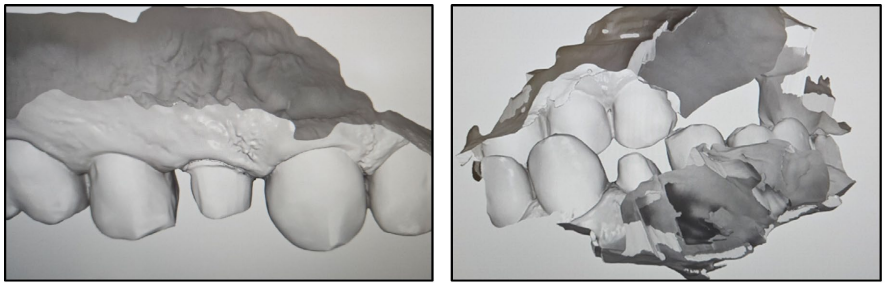

Figure 3. Virtual model.

Crown design was performed in the CEREC software using the biogeneric mode, which generated an occlusal morphology harmonized with the patient's existing dentition (Figure 4: Biogeneric crown design in CEREC software). The design parameters were adjusted to 25 μm for proximal contacts and 40 μm for cement space, while maintaining a minimum occlusal thickness of 1000 μm in accordance with manufacturer guidelines. Manual refinements were applied to optimize contour, occlusal contact distribution, and proximal relationships. The finalized design demonstrated anatomic accuracy (Figure 5: Finalized digital crown design).

Figure 4. Biogeneric crown design generated in CEREC software.

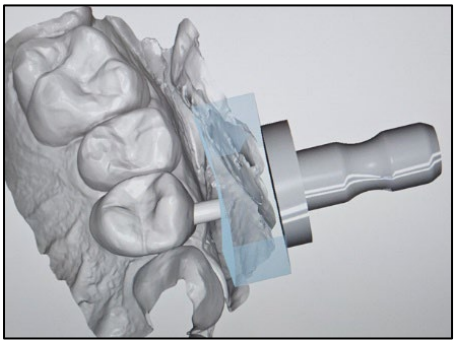

Figure 5. Finalized digital crown design.

The restoration was fabricated in the CEREC Prime Mill using a Cerec MTL Zirconia block (shade A2, size C14, Dentsply Sirona). Milling was performed in fine mode and required approximately 14 minutes (Figure 6: Milling of zirconia crown in CEREC Prime Mill).

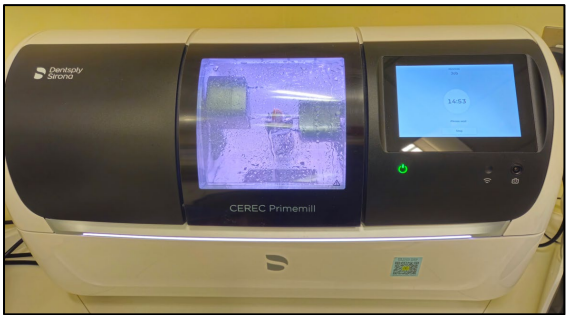

Figure 6. Milling of zirconia restoration in CEREC Prime Mill unit.

Following milling, the restoration was detached from the block, and the sprue was carefully removed under copious water irrigation with fine-grit diamond instruments. The surface was pre-polished before post-processing to refine texture and enhance the final finish (**Figure 7**: Post-milling inspection of crown).

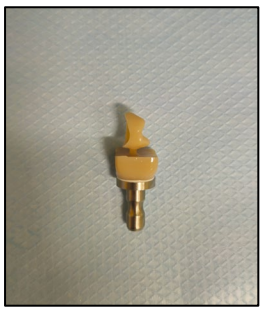

Figure 7. Post-milling inspection of crown.

Post-milling treatment was completed in the CEREC SpeedFire furnace, which provided high-speed sintering and glazing in a single cycle lasting approximately 14 minutes at ~1500˚C (**Figure 8**: High-speed sintering and glazing in CEREC SpeedFire furnace). This protocol enhanced both the mechanical strength and optical translucency of the zirconia, yielding an esthetic and durable restoration. Visual inspection confirmed accurate marginal integrity and occlusal morphology prior to intraoral try-in.

Figure 8. High-speed sintering and glazing of the zirconia crown in CEREC SpeedFire furnace.

During clinical try-in, the crown demonstrated precise marginal fit, functional occlusal contact, and good esthetic integration with adjacent teeth. Cementation was carried out using RelyX U200 self-adhesive resin cement (3M ESPE, Germany). A post-cementation radiograph confirmed full seating and precise marginal adaptation.

At one-week, one, three and six months follow-up, the crown remained functional and asymptomatic, with excellent esthetic integration and no signs of soft tissue irritation (**Figure 9**: Definitive zirconia restoration at one-week follow-up). The patient reported high satisfaction with both the treatment outcome and the convenience of single-visit delivery.

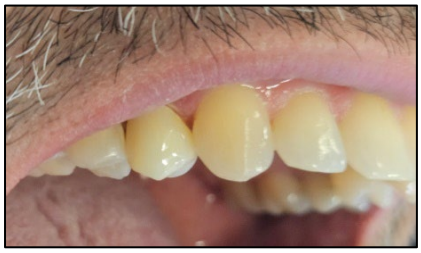

Figure 9. Definitive restoration at one-week follow-up, demonstrating accurate fit, esthetic integration, and healthy soft tissues.

3. Discussion

This case demonstrates the successful delivery of a chairside monolithic zirconia crown in a primary healthcare setting, highlighting the feasibility of integrating advanced prosthodontic technology into a government service environment. The restoration achieved excellent marginal adaptation, stable occlusion, and favorable short-term outcomes. Patient satisfaction was high, reflecting the well-documented advantage of single-visit dentistry, which eliminates multiple sessions [11].

From a prosthodontic standpoint, clinical success can be attributed to the precision of intraoral optical impressions and biogeneric CAD design. Accurate control of cement space, proximal contacts, and occlusal morphology ensured a passive yet retentive fit. These results are consistent with existing studies demonstrating that CAD/CAM-fabricated zirconia crowns routinely achieve marginal discrepancies within 50 μm - 100 μm, comfortably below the 120 μm threshold regarded as clinically acceptable [12]. In this case, the spacer setting of 40 μm was aligned with current recommendations, supporting both adaptation and long-term cement stability [13].

The biomechanical properties of monolithic zirconia justify its use in this context. High-translucency zirconia materials provide flexural strengths exceeding 900 MPa [3], allowing more conservative preparations than those required for glass-ceramics while ensuring long-term durability in posterior load-bearing regions. Unlike veneered zirconia, which is susceptible to porcelain chipping, full-contour zirconia eliminates this failure mode and provides reliable occlusal sta-

bility [4]. While lithium disilicate offers superior translucency, its lower fracture resistance makes zirconia a more predictable choice in functional premolars and molars [14]. Other materials, such as polymer-infiltrated ceramics, offer improved elasticity and faster milling but are less suitable for posterior load-bearing regions due to lower flexural strength and wear resistance compared to monolithic zirconia.

The periodontal response to zirconia crowns is another important consideration. Zirconia's biocompatibility and low surface roughness have been associated with reduced bacterial plaque accumulation and improved soft-tissue integration compared with traditional metal-ceramic crowns [15] [16]. In the present case, well-defined emergence profiles and smooth marginal transitions contributed to a healthy gingival response in the early follow-up.

Equally important is the cementation protocol. The use of self-adhesive resin cement provided satisfactory retention, while the chemical interaction of MDP monomers with zirconia oxide enhances long-term bond stability [17] [18]. Adherence to manufacturer guidelines regarding preparation geometry and occlusal adjustments minimized risks of debonding or marginal discoloration, which remain recognized failure modes even for high-strength zirconia restorations.

Technological advances such as speed-sintering have transformed the chairside workflow. The use of a fast program in the SpeedFire furnace enabled crown delivery within a single visit while maintaining the material's microstructural integrity. Several recent studies confirm that rapid sintering protocols achieve mechanical performance comparable to conventional long-cycle sintering [6] [7]. Without this capability, same-day zirconia restorations would not be feasible in high-volume clinics. Despite promising clinical outcomes, widespread implementation of CAD/CAM in public health systems is limited by several factors beyond the initial capital cost. These include the need for continuous clinician training, regular equipment maintenance, software updates, and the higher unit cost of milling blocks compared with conventional laboratory fabrication. Workflow standardization and support infrastructure are also necessary to ensure sustainable adoption.

From a systems perspective, this case highlights the strategic value of digital dentistry in public primary care. Incorporating CAD/CAM workflows within the Primary Health Care Corporation (PHCC) can reduce reliance on tertiary prosthodontic services, decrease waiting lists, and lower indirect costs for patients, including travel and time away from work. Although the initial investment in scanners, mills, and furnaces is substantial, potential long-term savings from reduced laboratory fees and improved efficiency may justify the cost. Furthermore, structured training programs for clinicians are essential to standardize outcomes and maximize the return on investment [10].

Nonetheless, limitations of this report must be acknowledged. It represents a single case with short follow-up, and long-term clinical performance cannot be predicted. Prospective studies are required to determine survival rates, complica-

tion profiles, and biological outcomes of chairside zirconia crowns in public healthcare settings [8]. Variability in operator expertise also presents a challenge, underscoring the importance of continuous education, calibration, and quality assurance protocols when scaling this technology across multiple clinics.

Looking to the future, further research should incorporate both clinical and patient-reported outcome measures. Standardized follow-up protocols could evaluate survival rates over 5 - 10 years, compare zirconia crowns with lithium disilicate or conventionally fabricated crowns, and assess periodontal health parameters [9]. Patient-reported outcomes including comfort, esthetic satisfaction, and perceived time savings, would complement objective survival data. At the policy level, cost-effectiveness analyses are essential to guide large-scale integration of CAD/CAM systems in government settings. Finally, emerging innovations such as artificial intelligence and predictive design algorithms may soon enhance accuracy in margin detection, occlusal adjustment, and error prevention, further reducing variability between operators and increasing efficiency in high-volume public clinics [19].

4. Conclusions

This case report demonstrates that a chairside monolithic zirconia crown can be successfully fabricated and delivered in a single appointment within a government primary healthcare setting. The restoration showed excellent marginal adaptation, stable occlusion, and high patient satisfaction, confirming the clinical predictability of chairside CAD/CAM when proper protocols are followed. For an endodontically treated premolar, the selection of monolithic zirconia offered biomechanical strength, conservative preparation requirements, and favorable periodontal compatibility, making it an appropriate choice in a load-bearing region.

Beyond clinical outcomes, this case illustrates the broader relevance of digital dentistry for public health systems. Integration of chairside CAD/CAM workflows within PHCC has the potential to reduce secondary care referrals, shorten waiting times, and improve efficiency while lowering indirect patient costs. Although the initial investment in technology is substantial, long-term savings and service improvements may justify widespread adoption. Future prospective studies within PHCC should directly compare chairside digital versus conventional lab-fabricated crowns in terms of clinical longevity, cost-effectiveness, and patient-reported satisfaction, to generate evidence guiding large-scale implementation.

Limitations must be acknowledged, as this is a single case with short follow-up. Future research should include multicenter prospective studies to assess survival rates, complication profiles, patient-reported outcomes, and cost-effectiveness. Emerging innovations, including AI-assisted design and predictive digital workflows, may further enhance accuracy and efficiency, strengthening the role of digital prosthodontics in modern public healthcare.

Patient Consent

Written informed consent was obtained from the patient for treatment and pub-

lication, including all clinical images and radiographs.

Conflicts of Interest

The authors declare no conflicts of interest.

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