Integration of Digital Design and Artistic Stratification in a Full-Mouth Smile Rehabilitation: A case report

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Abstract. In modern dental practice, the development and application of effective methods for achieving success in comprehensive functional and aesthetic rehabilitation remains an urgent issue. In the practice of prosthetic dentistry, digital protocols are increasingly used, which helps to apply a more comprehensive and personalized approach to each patient.

Patient concerns. Patient, 30 years old with complaints about the aesthetics of the anterior teeth, the presence of old restorations and secondary caries.

Diagnoses: Functional diagnostics and digital smile design were performed.

Interventions: 28 lithium disilicate restorations were fabricated. In the anterior area, a multilayer ceramic application was performed using Creation LS, including detailed mamelons, transition zones, and incisal effects. The posterior teeth were prepared and restored with monolithic IPS e. max CAD restorations without turning and veneering, which ensured strength and precision. The use of a virtual articulator ensured predictable occlusion and minimized intraoral adjustments.

Results. In this clinical case, a comprehensive functional and aesthetic approach to rehabilitation using CAD/CAM technologies and artistic ceramic layering was presented. The uniqueness of the approach lies in the combination of digital planning with manual stratification, the use of a minimally invasive approach and highly individualized morphology of the anterior group of teeth. The protocol extends existing restorative strategies by integrating biomimetic principles with digital precision. The study achieved an effective result in terms of restoring function and aesthetic satisfaction of the patient.

Conclusions. The integration of digital design with artistic ceramic layering allows for a high level of aesthetic and functional accuracy.

Keywords: digital technologies, dentistry, aesthetics, CAD/CAM, ceramic restorations, lithium disilicate, case report.

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Introduction. In the modern context of technological development, there is a growing trend towards the introduction of digital tools in dental practice. This approach helps to improve diagnostic capabilities, optimize the planning of treatment and rehabilitation measures. The use of modern digital technologies in prosthetic dentistry allows to achieve higher accuracy and quality of diagnostic procedures, expands the potential for improving clinical processes, increases the effectiveness of treatment and contributes to increased patient comfort (Fung, Brisebois, 2020; Charavet et al., 2019; Gong, et al., 2025).

Esthetic rehabilitation in the anterior region demands simultaneous consideration of morphology, light optics, and functional integration. Modern metal-free restorative materials combine mechanical strength with translucency, enabling clinicians and technicians to create natural-looking results (Kontonasaki, et al., 2020; Amornvit, et al., 2021; Vijan, 2024). However, faithful replication of the visual and anatomical characteristics of natural teeth is impossible without anatomically and optically stratified ceramic layering (Solá-Ruíz, et al., 2020; Teng, et al., 2024; Lolos, et al., 2025).

The integration of digital and analog workflows is key to achieving individualized and predictable outcomes. Digital smile planning, 3D mock-up design, virtual articulation, and CAD/CAM milling offer new levels of precision in both diagnosis and fabrication. Nonetheless, the hand-crafted application of ceramic remains essential for creating depth, surface texture, and the light dynamics characteristic of natural enamel (Wang, et al., 2020; Almalki, et al., 2022; Lombardo, et al., 2023).

The subjective nature of dental aesthetics, which varies significantly in perception between patients and dentists, has necessitated the introduction of digital smile design tools to achieve a natural and individualized aesthetic. Digital technologies and workflows cover all stages of clinical treatment - from diagnosis to creating a smile that harmoniously matches the patient's facial features, as well as to completing restorative work (Charavet et al., 2019; Engels et al., 2022; Domínguez, Blatz, 2023; Gong et al., 2025).

This case study will help to highlight the aesthetic and functional reconstruction of a full mouth using lithium disilicate ceramics with monolithic and stratified protocols, combining the precision of CAD/CAM with artistic ceramic layering using Creation LS. Particular attention is paid to the rationale for choosing milling over pressing, as well as the value of minimal invasiveness and morpho-functional customization of anterior restorations.

Thus, aesthetic rehabilitation in the anterior region requires simultaneous consideration of morphology, light optics, and functional integration to help ensure more accurate diagnosis, treatment planning, and fabrication of customized prosthetic structures.

Results

Clinical Findings

Patient, 30 years old man with complaints about the aesthetics of the anterior teeth, the presence of old restorations and secondary caries.

Prior to the explanation of the examination and treatment, the patient was informed and provided written consent to the study and publication of this clinical case and accompanying images.

Primary concerns and symptoms of the patient presented with esthetic concerns related to his anterior teeth, including dissatisfaction with smile appearance, discolored aging restorations (Fig. 1), and recurrent caries under composite fillings (Fig. 2).

The patient was in good general health, with no chronic systemic conditions. He reported no smoking or regular medication use. Psychosocial background was stable, with high motivation for esthetic treatment. There was no relevant family history of genetic or hereditary dental conditions.

Clinical examination revealed the destruction of enamel and dentin in the anterior teeth; asymmetry of the incisal margins; loss of natural transparency of the lateral incisors; high smile line and healthy periodontal health (Fig. 3).

A comprehensive full-mouth rehabilitation plan was developed, based on the use of lithium disilicate ceramics and guided by a digital workflow involving mock-up visualization, occlusal planning, and CAD/CAM design tools. The treatment objective was to combine functional precision with esthetic fidelity.

The proposed treatment included sixteen anterior restorations (eight maxillary and eight mandibular) using layered ceramics; twelve posterior restorations fabricated as monolithic units without veneering.

Pre-prosthetic Steps:

1. Functional diagnostics, including centric relation registration and occlusal analysis;
2. Diagnostic wax-up to visualize esthetics and function;
3. Tooth preparation (Fig. 4) and mock-up transfer (Fig. 5);
4. Fabrication of provisionals, based on the accepted design;
5. Adjustments to provisionals, optimizing length, volume, and proportions;
6. Final design approval and digital scanning for CAD modeling.

Diagnostic Assessment

Digital Design and Virtual Articulation. The final restorations were designed using CAD software based on the approved provisionals and digital scans of the wax-up. For the anterior teeth, a custom anatomical tooth library was selected to reflect the patient's facial proportions and dental morphology. Posterior restorations were designed as full-contour units, guided by occlusal parameters obtained from functional diagnostics.

Milling. Lithium disilicate restorations were milled from precrystallized blocks (IPS e.max CAD) using a 5-axis CAD/CAM unit. Anterior units were milled with designated space for hand-layering, while posterior restorations were fabricated in final anatomy without additional veneering.

Compared to traditional pressable ceramics, CAD-milled lithium disilicate demonstrates comparable mechanical performance with superior accuracy of marginal fit and internal adaptation. The digital process ensures controlled material thickness and repeatability in large rehabilitative cases.

Firing, Opaquing, and Ceramic Layering (Anterior Units). After the initial crystallization firing, the internal framework of each anterior crown underwent a multistage layering process using Creation LS ceramics. The process included:

1. Wash firing to stabilize the surface;
2. Dentin-opaque application to mask the core and establish basic chroma;
3. Artistic buildup involving;
4. Manual sculpting of mamelons using chromatic opaque dentin masses with internal opalescence;
5. Transition zones built with warm translucent dentins to add internal depth;
6. Incisal edges finished with cold, opalescent enamels and transparent masses to reproduce natural light dynamics (Fig. 6);
7. A final high-translucency enamel layer to complete the three-dimensional structure.

The stratification technique closely mimics the multilayered optical behavior of natural enamel and dentin, significantly enhancing the life-like appearance of the restoration. Creation LS ceramics are known for their ability to reproduce light refraction and internal fluorescence, which are essential for anterior esthetics (Fig. 7).

Anatomical Refinement and Microtexturing. Following final firing, each restoration underwent detailed hand-finishing using rotary instruments. Anatomic details such as lobes, developmental grooves, and surface ripples were manually carved. This microtexturing serves not only a visual but also a functional purpose, allowing light to scatter in a way that mimics natural enamel.

Carving and highlight design create intentional zones of light reflection and diffusion. These elements:

- Accentuate natural shape and curvature.
- Enhance the optical integration with adjacent teeth.
- Allow the restoration to interact dynamically with facial expressions and ambient light.

Surface morphology plays a decisive role in the perception of esthetics, influencing how light is reflected and absorbed. The combination of surface relief, textural variation, and incisal translucency distinguishes truly natural-looking ceramics from mechanically uniform restorations (Fig. 8).

Glazing and Polishing. Final glazing was performed in a controlled manner to preserve microtexture, followed by multi-step manual polishing using diamond pastes and felt wheels. This ensured the desired luster and natural surface behavior without compromising the anatomic refinements (Fig. 9,10).

Diagnostic Challenges

Despite the availability of digital planning and functional analysis, several diagnostic challenges were identified during the initial assessment:

1. Establishing ideal preparation margins in the esthetic zone. The patient presented with a high smile line, making it difficult to determine preparation margins that would remain visually undetectable in dynamic facial movements. Macro-photographic documentation and mock-up evaluation were used to address this.

2. Determining accurate centric relation and vertical dimension. Owing to previous restorations and worn anterior teeth, functional diagnostics were necessary to define a stable centric relation. Deprogramming techniques and articulator mounting were used for accuracy.

3. Assessment of residual tooth structure under existing restorations. Secondary caries beneath old composite restorations posed uncertainty in evaluating the bondable substrate. Careful removal and intraoral magnification aided in preserving enamel where possible.

4. Balancing minimal invasiveness with mechanical stability. In anterior teeth, maintaining enamel for adhesive bonding conflicted with the need for material thickness.

Lithium disilicate was chosen for its strength at low thickness, and preparation was adjusted accordingly to provide support while staying conservative.

Tooth Preparation

Types of therapeutic intervention. Tooth preparation followed the contours of the approved mock-up and was performed in a minimally invasive manner. Enamel was preserved where possible, particularly in anterior teeth requiring ceramic stratification.

Key preparation principles included strategic reduction for space allocation of the layered structure; preservation of enamel for optimal adhesive bonding; chamfer finish lines and defined cutback zones; controlled depth achieved with silicone indices and depth-cut guides.

Milling versus Pressing: Clinical and Technical Considerations

One of the pivotal choices in this case was the preference for CAD/CAM milling of lithium disilicate over the more traditional pressing technique. Although both methods utilize the same core material (e.g., IPS e.max), their clinical behaviors and fabrication workflows differ significantly.

Milling offers several advantages in full-arch rehabilitations: superior precision of marginal fit due to digital control; reduced human error and increased repeatability; controlled wall thickness, minimizing risk of over- or under-reduction; faster fabrication cycle, eliminating wax-up and investing stages.

In contrast, pressing may offer slightly higher flexural strength due to improved crystallinity, but at the cost of longer laboratory time; higher risk of inaccuracies during manual wax-up or investing; limited ability to pre-visualize the final anatomy digitally.

Numerous studies have shown no statistically significant difference in long-term survival between CAD-milled and pressable lithium disilicate crowns, but CAD/CAM has been associated with more consistent results in high-volume or multi-unit cases. Lithium disilicate restorations have demonstrated long-term clinical success and biological compatibility, even in structurally compromised cases such as amelogenesis imperfecta.

Cementation Protocol

Zirconia, while known for excellent mechanical strength, was not selected due to its optical limitations even with multi-layered high-translucency blocks, zirconia lacks the internal fluorescence and dynamic light behavior required in esthetic zones. It also presents challenges in adhesive bonding and requires more aggressive preparation, reducing the ability to preserve enamel.

Resin composites and hybrid ceramics were also excluded. While they are suitable for single-unit restorations or provisional work, their long-term wear resistance, color stability, and esthetic depth are inferior to lithium disilicate in full-mouth applications.

Cementation was performed according to adhesive principles specific to glass ceramics (Fig. 11). The protocol included:

1. Try-in phase, intraorally and on the model, for evaluation of contacts, esthetics, and occlusion;
2. Surface conditioning of the internal ceramic with 5% hydrofluoric acid, rinse, drying, and silanization;
3. Tooth conditioning with 35% phosphoric acid, rinse, drying, and adhesive application;
4. Luting with light-cured composite resin cement, staged polymerization under controlled pressure;
5. Final clean-up and polishing of margins.

The Importance of Stratified Layering and Internal Effects

Anatomically stratified ceramic layering remains irreplaceable in the anterior region, even amidst digital advancements. The use of multiple masses – opaque dentins, translucent body layers, and opalescent enamels – creates a light interplay that mimics the internal structure of natural teeth.

Mamelon sculpting, interlobular effects, and depth zoning add a three-dimensional quality visible even in dynamic facial movement. Chromatic variation through warm and cold transitions enhances esthetic realism. Incisal transparency reproduces enamel behavior under light transmission, critical in high-smile-line cases.

Studies confirm that multi-layer ceramic systems have greater patient-rated esthetic acceptance compared to monolithic ceramics, even when the latter are color-matched.

The Role of Virtual Articulation in Functional Harmony

Virtual articulation in the CAD/CAM workflow allowed for precise simulation of occlusal dynamics. This significantly minimized intraoral adjustments, reduced postoperative discomfort, and helped in achieving bilateral balance and anterior guidance.

- Excursive movements were evaluated digitally, reducing the chance of premature contacts;
- Occlusal schemes were refined in software before any material was processed;
- The articulator module ensured a harmonious distribution of forces, essential for long-term survival of bonded restorations.

A noteworthy complication occurred during the provisional phase related to the patient's parafunctional habits and altered envelope of function. Although the initial wax-up and mock-up were aesthetically and functionally approved, the patient reported minor chipping and debonding of the temporaries on teeth #11 and #21 after several days of wear.

Adverse and unanticipated events.

Clinical examination revealed strong protrusive contacts and slight bruxism, which had not been fully appreciated during the initial functional analysis. To address this, the functional diagnostics were repeated with extended EMG and digital mandibular tracking to assess the true envelope of function.

Based on the revised data, the incisal edge positions were slightly shortened and the guidance pathways were adjusted in the final design. The digital articulator in ExoCad was recalibrated to reflect these findings, ensuring reduced stress during functional movements.

This event emphasized the importance of extended neuromuscular assessment and the need to account for parafunctional loading - even in cases that initially seem straightforward.

Microanatomy and Hand-Finishing: The Technician's Signature

Despite the accuracy of digital tools, hand-crafted refinements remain essential. Anatomical carving, microtexturing, and highlight control contribute to natural esthetic integration anatomical grooves and developmental lines recreate surface topography that diffuses light naturally; highlight zones and reflective planes enhance depth and perception of moisture and vitality; subtle contouring changes influence both light dynamics and phonetic function, especially in upper incisors.

It is well documented that the human eye is particularly sensitive to microtexture and reflection patterns, and restorations lacking this anatomical expression often appear artificial despite perfect color matching.

Final Result After Cementation

Following the completion of the cementation protocol, a final assessment of esthetics, occlusal contacts, and restoration fit was conducted intraorally. All 28 units were fully integrated into the patient's smile line, achieving harmony in tooth shape, color, and position. The outcome confirmed the accuracy of digital planning and the effectiveness of the artistic ceramic approach (Fig, 12,13). A detailed chronological overview of all clinical and laboratory steps is provided in Table 1.

No post-cementation complications were observed during the follow-up examination. The gingival tissues demonstrated optimal healing with no signs of inflammation, bleeding, or discomfort. This favorable outcome can be attributed to the precise marginal adaptation of the restorations, the use of minimally invasive preparation techniques, and the high level of polish achieved in the subgingival areas of the crowns. Careful control of cement excess removal and the use of adhesive protocols further contributed to the maintenance of periodontal health. The absence of traumatic contacts and the predictable occlusal scheme also played a key role in ensuring a smooth post-operative period and biological integration.

The patient adhered fully to the scheduled clinical visits and followed all postoperative care instructions. Tolerability was assessed through direct feedback during follow-up appointments. Minor complications, such as chipping of the provisional restorations due to parafunctional habits, were noted and addressed in the final design. After definitive cementation, no adverse events were observed, and the patient adapted well without discomfort.

Discussion

In recent years, dental practice has seen significant progress through the integration of digital approaches and new diagnostic technologies into full smile rehabilitation (Wei et al., 2023; Franco et al., 2024). Modern innovations are changing diagnostic approaches, facilitating the Integration of Digital Design and Artistic Stratification, which increases the accuracy and effectiveness of treatment outcomes (Alqahtani, et al., 2023). The implementation of digital technologies can also contribute to improving patient satisfaction and quality of life.

Digital design and virtual articulation were used in the study. The final restorations were designed using CAD software based on validated pre-models and digital scans of wax-ups. A custom anatomical dental library was selected for the anterior teeth, reflecting the

patient's facial proportions and morphology. Posterior restorations were designed as full-contour units, guided by occlusal parameters obtained through functional diagnostics. "Digital workflows provide predictable outcomes in restorative dentistry by integrating virtual wax-ups, diagnostic data, and custom anatomical libraries, improving functional and aesthetic accuracy". Digital tools such as ExoCad and virtual articulation offer improved communication and predictability at every step of planning, especially in complex restorative cases.

Virtual articulator simulation allowed for the identification of occlusal interferences and optimization of excursive movements before physical fabrication. This tool plays a key role in enhancing precision and reducing chairside adjustments during the final delivery of restorations (Doshi, et al., 2024). The integration of artificial intelligence into CAD/CAM workflows significantly enhances accuracy, efficiency, and reproducibility in restorative dentistry (Aswal, et al., 2023; Yeslam, et al., 2024).

Proper bonding of lithium disilicate ceramics has been shown to significantly increase fracture resistance and long-term success of the restoration (Teng, et al., 2024; Al-Amari, et al., 2024; Kim, et al., 2024). Silane treatment combined with light-cured cementation improves not only adhesion but also aesthetic integration by optimizing the refractive index match between the cement and the ceramic (Lolos, et al., 2025). In our study, tooth preparation followed the contours of the approved model and was performed in a minimally invasive manner. Enamel was preserved where possible, especially in the anterior teeth that required ceramic stratification.

This case illustrates a comprehensive, step-by-step protocol for full-mouth rehabilitation in a patient with high esthetic demands, successfully merging CAD/CAM precision with analog ceramic artistry. The workflow highlights key decision points that are particularly relevant for clinicians and dental technicians seeking reproducible and minimally invasive results in large-scale reconstructions.

Takeaway Lessons

This case demonstrates that:

- Full-mouth rehabilitation can be minimally invasive while ensuring mechanical durability.
- CAD/CAM technology enhances clinical precision but does not replace artistic ceramic layering, which remains essential for esthetic success.
- The collaboration between clinician and technician is critical to achieving restorations that are not only functional but emotionally lifelike.
- Biomimetic preparation and customized stratification of lithium disilicate ceramics ensure long-term success and visual harmony.

Limitations:

Despite the positive clinical outcome, this case report has certain limitations. The short follow-up period does not allow assessment of long-term performance or complication risks. Moreover, the presence of parafunctional activity was discovered only after provisional restorations, requiring adjustments to the treatment strategy. As a single case, the findings cannot be generalized to all patient types or occlusal situations. These limitations emphasize the importance of thorough diagnostics and careful treatment planning in complex full-mouth rehabilitations.

Patient Perspective

"I had felt self-conscious about my smile for a long time due to the appearance of my teeth. It was uncomfortable to smile at work or around friends. After the treatment was completed, I finally felt confident enough to smile without hesitation. The result exceeded my expectations – the restorations look natural, and I can really feel the difference both aesthetically and functionally. I am very grateful to the team for such a thoughtful and detailed approach".

Conclusion

This clinical case illustrates the synergy between digital accuracy and analog artistry in contemporary full-mouth rehabilitation. By combining CAD/CAM milling of lithium disilicate with anatomical ceramic layering, the treatment protocol achieved outstanding esthetic integration, biomechanical functionality, and minimal invasiveness.

Digital planning tools such as ExoCad, virtual articulation, and guided tooth preparation provided predictability and precision, while the artistic ceramic buildup restored optical vitality, texture, and harmony within the patient's smile line. The technician's hand – visible in every carved ridge, reflective surface, and layered transition – elevated the restorations from accurate to natural.

This approach is not a compromise between technology and craft but rather a demonstration of how their integration yields restorations that are visually convincing, biologically respectful, and clinically enduring. The protocol presented here can serve as a functional and esthetic framework for clinicians and technicians aiming to deliver customized, high-level reconstructions in demanding cases.

Clinical significance

The case presented highlights a practical and effective methodology for full-arch rehabilitation by uniting digital design with manual ceramic artistry. It emphasizes:

- the role of CAD/CAM precision in achieving reliable fit and occlusion;
- the indispensability of stratified ceramic layering for anterior esthetics;
- the clinical benefits of minimally invasive tooth preparation and adhesive cementation.

Importantly, this case underscores that the highest level of esthetic dentistry lies in balancing structured planning with expressive craftsmanship. The strategy described here is applicable across a range of clinical scenarios, offering a replicable yet individualized protocol that respects both function and form.

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TABLES

Table 1. Chronological Timeline of Clinical Procedures

Day	Clinical Stage	Description
Day 1	Initial Consultation and Clinical Examination	Patient interview, aesthetic and functional analysis, intraoral and extraoral photography.
Day 2	Functional Diagnostics	Registration of centric relation, occlusal analysis, and digital bite recording.
Day 3–4	Digital Planning	Smile design, ExoCAD modeling based on the diagnostic wax-up and facial proportions.
Day 5	Tooth Preparation, Mock-up, Form Correction, and Scanning	Tooth preparation including anterior and posterior teeth with occlusal reduction. Mock-up transferred intraorally for evaluation. Form adjusted and digitally scanned.
Week 2	Final Design, Milling, and Artistic Layering	Final virtual design and milling of lithium disilicate restorations. Layering of anterior units with Creation LS ceramic, anatomical carving, and glazing.
Day 15	Try-in, Cementation, and Documentation	Trial fitting and aesthetic/functional evaluation, adhesive cementation, final photography.
Week 4	Healing Follow-up and Occlusal Adjustment	Assessment of soft tissue healing, bite refinement, and clinical result confirmation.

FIGURE LEGENDS

Figure 1. Initial panoramic X-ray showing dental condition and bone structure before treatment.

Figure 2. Preoperative lateral view: severe wear, loss of anatomy, and discoloration.

Figure 3. Preoperative frontal view: old restoration with shape deficiency and secondary caries.

Figure 4. Prepared teeth with defined margins after minimally invasive reduction.

Figure 5. Provisional restorations placed to evaluate esthetics and function.

Figure 6. Schematic representation of ceramic layering: red indicates dentin, blue – opalescent mass, green – translucent mass.

Figure 7. Final restoration under transillumination: anatomy, mamelons, and optical zones.

Figure 8. Final restoration, lateral view: anatomical form and depth of shade.

Figure 9. Lateral view of the final restoration with defined surface texture and micro-relief.

Figure 10. Frontal view of the final restorations integrated with the gingival contour.

Figure 11. Final cementation performed under rubber dam for isolation and bonding.

Figure 12. Postoperative smile, lateral view: harmony of shape, color, and tooth position.

Figure 13. Final frontal view: esthetically and functionally completed result.