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Nazariy Mykhaylyuk

Bogdan Mykhaylyuk

Markus B. Blatz

University of Pennsylvania

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Abstract

Objective: This clinical report describes and illustrates step-by-step protocols for interdisciplinary esthetic treatment with current digital and microscopic tools. **Clinical Considerations:** Digital dentistry is no longer limited to impression making and restoration fabrication but starts already in the diagnostic and treatment planning phase. In particular, digital smile design tools have significantly improved clinical and laboratory workflows, allowing for natural and facially driven smiles, based on the patient's specific needs and preferences. Digital technologies also facilitate high precision and accuracy in the laboratory, which are interconnected with the quality of the clinical care. Precision and minimally invasive dentistry require visual magnification aids through high-power loupes or, even better, surgical microscopes. For optimal clinical success, however, these tools must be integrated into efficient workflows and made part of a comprehensive clinical and laboratory concept. **Conclusions:** Digital and high-magnification tools in clinics and dental laboratories facilitate highly esthetic and precise outcomes when integrated into a comprehensive treatment concept. **Clinical Significance:** While a plethora of new tools and technologies is available for the dental laboratory and clinical practice, they can be daunting. Clear step-by-step workflows and protocols must be followed to apply them in a most efficient and effective manner for optimal outcomes. © 2022 Wiley Periodicals LLC.

Keywords

CAD/CAM; digital dentistry; esthetics; magnification; operative dentistry

Disciplines

Dentistry

Digital and microscopic tools for ultimate esthetics and precision

Nazariy Mykhaylyuk DDS¹ | Bogdan Mykhaylyuk CDT¹ | Markus B. Blatz DMD, PhD² 

¹Private Practice, Kyiv, Ukraine

²Department of Preventive and Restorative Sciences, University of Pennsylvania, School of Dental Medicine, Philadelphia, Pennsylvania, USA

Correspondence

Markus B. Blatz, Department of Preventive and Restorative Sciences, Robert Schattner Center, University of Pennsylvania, School of Dental Medicine, 240 S. 40th Street, Philadelphia, PA 19104, USA.
Email: mblatz@upenn.edu

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1 | INTRODUCTION

In its beginnings, digital dentistry was limited to impression taking and restoration fabrication.¹ Today, the digital workflow starts at the very beginning of the clinical care: diagnosis and treatment planning.² The first steps include intra- and extraoral optical scans and radiographic analyses (e.g., Cone beam computer tomography [CBCT]) to capture oral structures and tissues in great detail for accurate diagnostics and treatment planning. Type and sequence of periodontal, restorative,

orthodontic, surgical, and multi-disciplinary treatment are determined and guides for precise surgical and restorative treatment interventions are fabricated accordingly. Current digital workflows allow clinicians from different specialties, dental laboratory technicians, and the patient to communicate asynchronously and remotely.²

Digital smile design tools have become popular, allowing the dentist and laboratory technician to create natural-looking smiles with scans of natural teeth and based on the patient's specific facial features and personal preferences.³ Even more so, they allow the patient and dental team to communicate seamlessly, making virtual try-ins and verify them through mock-ups and provisional restorations in the mouth before finalizing the definitive restorations. The application of

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digital tools for smile design and the advantages of 3D models have been demonstrated in the dental literature.^{4,5} Digital technologies facilitate designing individual smiles based on the patient's facial features and specific needs, independent of the clinician's or technician's skills and understanding of esthetic parameters.^{6,7} Unlike hand-crafted wax ups, digital smile design software can use scan files and digital libraries of natural teeth to be selected by the patient and the restorative team, thereby facilitating truly naturally esthetic outcomes. Individual facial features ("facial flow") are included in the smile design process. Furthermore, digital articulators and jaw tracking devices facilitate inclusion of functional parameters into the design.

Despite of the advances and possibilities with virtual try in software, evaluation of the planned design in the patient's mouth through mock-ups or provisional restorations before finalization of the restorations is still an absolute necessity. The verified digital design can easily be transferred into any definitive restoration and material.

The high precision achievable with digital manufacturing technologies requires similar attention to detail in clinics. Since our vision is limited, precision and minimally invasive dentistry cannot be performed without augmented visual perception, through high-magnification loupes or, even better, surgical microscopes.⁸ There is clear evidence that use of magnification improves preparation quality.⁹ Furthermore, quality and fit of CAD/CAM restorations are directly correlated with the quality of the tooth preparation,¹⁰ and smooth and well-refined preparations lead to better-fitting restorations with improved clinical success.¹¹

This clinical report describes and illustrates interdisciplinary esthetic treatment with current digital and microscopic tools.

2 | CASE PRESENTATION

A 33-year-old female patient presented to our clinic with the request to improve her smile. She was concerned that the existing composite veneers looked "fake" and not like natural teeth. The shape of the teeth did not fit the natural frame of her lips and the incisal curve did not follow the contour of the lower lip (Figures 1–3).

The patient had a normal range of motion, and there were no sounds in the joints during external palpation. There was no muscle tenderness

or pain during opening and lateral movements. Mandibular jaw manipulation was unsuspecting with a range of motion within normal limits. There were no signs or symptoms of temporomandibular disorders.

During previous treatment at another clinic 3 years earlier, 20 composite resin veneers, onlays, and crowns were delivered. Overcontouring and leakage at the restoration margins were visible. Anatomic shape and size of the existing restorations were not ideal and differed between the left and right side.

2.1 | Treatment plan

Treatment planning routinely starts with a pretreatment interview and video and photographic series recording. Periodontal treatment was performed to improve patient's oral hygiene and stabilize the periodontal condition. An intra-oral scan (IOS) was made (Trios 4, 3Shape, Copenhagen, Denmark). It took about 2 min to scan the upper and lower teeth as well interocclusal records to create virtual models for further analysis and treatment planning. A face scan was made to complete a "digital patient" copy. Centric relation records were made with leaf gage.

Scans and photo/video documentation were digitally sent to the laboratory (M.Vision Lab, Kyiv, Ukraine) for 3D designing (Dental Designer, 3Shape). Among the greatest benefits of the digital



FIGURE 2 Preoperative extraoral view



FIGURE 1 Preoperative extraoral full-face view



FIGURE 3 Preoperative intraoral scans

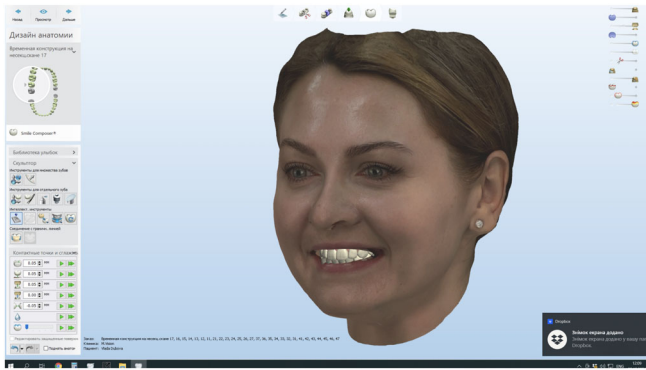


FIGURE 4 Virtual try in of digital smile design in patient face scan

workflow is time savings: all information necessary for restoration design and fabrication is sent and received within seconds, independent of the location of the laboratory.

Tissue levels in the anterior and between anterior and posterior segments were uneven, and gingivectomies as well as crown lengthening necessary. To specify and plan the exact procedure, manual bone sounding and CBCT were used as tools to assess sulcus depths and marginal bone levels. Figure 3 depicts a preliminary scan, indicating the preoperative shape of the existing restorations and teeth.

Copying nature as closely as possible has always been the main goal in dentistry. And while the manual skills and experience of a dental technician have always been a decisive factor, digital tools provide us with an array of advantages to not having to rely on that. Scans of natural teeth are arguably the best blueprint for natural-looking restorations. Scanning every patient's natural teeth and preoperative situation not only provides valuable information for treatment planning and fast reproduction of any existing restoration, but also allows for the compilation of a "natural tooth library" that can be drawn from for the same or future patients. Based on the smile and facial analyses as well as patient's preferences, a library of teeth was selected (Figure 4).

Models of the smile design were 3D printed in resin to fabricate a mock-up with a silicone index in the patient's mouth. All esthetic and functional parameters were verified, and the design was approved by the patient. Integrating the digital smile design in the patient's face scan provides an additional tool to evaluate the esthetic parameters of the new smile on the computer screen and even before try-in or restoration fabrication. In addition, the CAD designer made and sent digital slices of the future design over the existing teeth to visualize and understand the thickness of the mock-up and marginal adaptation.

2.2 | Clinical procedure

The restorative clinical procedure started with the removal of the existing composite restorations, which had a significant thickness and were well bonded to the teeth. For precise removal and to prevent overreduction as well as unnecessary tooth structure removal, this step must be performed under high magnification, ideally with the microscope.

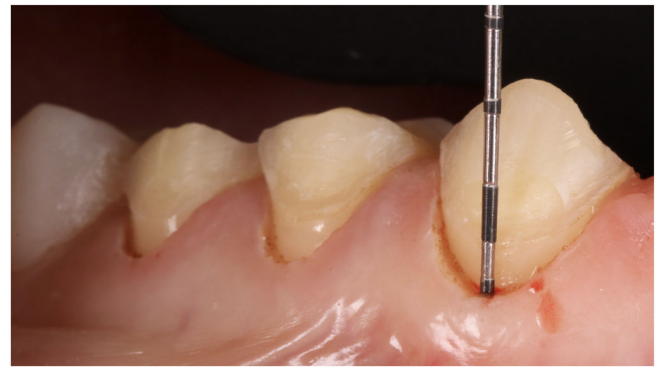


FIGURE 5 Intermittent bone sounding was performed to locate and recognize crestal bone levels



FIGURE 6 After preparation through the mock-up, retraction cords were placed in combination with a retraction paste to clearly visualize margins

Next, the digital design was transferred to the mouth with a mock-up, which, as an indicator for the position of the future restoration margins, reached over the gingival margins in the posterior segments. A gingivectomy was performed under the microscope with intermittent bone sounding to locate and recognize crestal bone levels (Figure 5). All other procedures, especially tooth preparations (M. Vision Kit, Komet, Lemgo, Germany), were also performed under high magnification, which is the only way to optimize precision. Retraction cords were placed to protect the soft tissues during preparation. Fine diamonds, gentle pressure, and ample water irrigation are essential for ideal tooth preparations. As a final preparation step, enamel chisels (Deppeler, Rolle, Switzerland) were used to finalize micro marginal zones, making them sharp and visible for the CAD designer.

After preparation through the mock-up, retraction cords were placed in combination with a retraction paste (DMG, Hamburg, Germany) to clearly visualize all micro margins (Figure 6). An IOS was made to create a digital copy of the prepared and remaining teeth. During scanning, a composite jig was placed between the anterior teeth to fixate the interocclusal situation in a stable position (Figures 7 and 8).

After the IOS was complete, a flapless crown-lengthening procedure (Figure 9) was performed with a piezo device and 3-mm



FIGURE 7 Anterior composite jig to fixate the interocclusal situation during intraoral scanning (IOS)

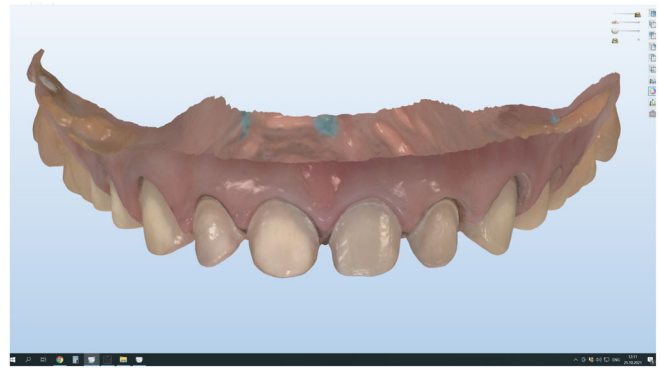


FIGURE 8 Scan of prepared and remaining maxillary teeth



FIGURE 9 Flapless crown-lengthening procedure was performed with a piezo device and 3-mm diamond-coated tip



FIGURE 10 Anterior extraoral view of provisional restorations

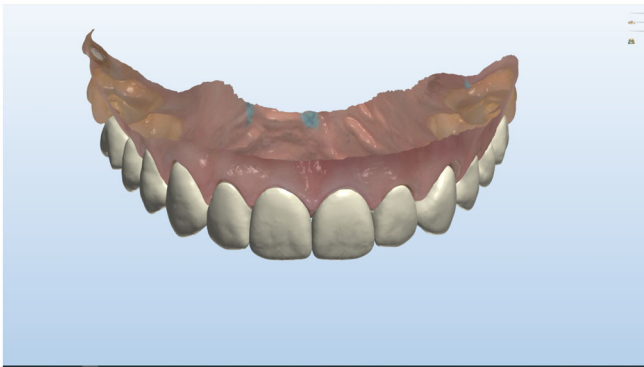


FIGURE 11 Digital wax up over prepared teeth with the same tooth library that was selected for the mock-up



FIGURE 12 Ceramic restorations were HF acid etched and a silane coupling agent was applied. Teeth were etched with phosphoric acid, followed by bonding agent application

diamond-coated tip (DentSurgePro, CV Dentus, Sao Jose dos Campos, Brazil).

All the above procedures were completed in one appointment of approximately 3 h. Provisional restorations were fabricated with a Bisacryl material (Luxatemp, DMG) and inserted with a spot-etch and spot-bond technique, limited to the center of each tooth, to prevent tooth damaging when removing the provisional restorations. A flowable composite was used to reline the provisionals and ensure marginal precision (Figure 10).

2.3 | Laboratory procedures

The intra-oral scan was received in the lab, and the CAD designer used the same tooth library that was selected for the mock-up. In this manner, the patient will receive the exact same tooth shapes she had agreed to previously (Figures 11). The software allows close-up views, for maximum precision. In that sense, microscopic and digital dentistry



FIGURE 13 Excess cement was removed under the microscope with a scalpel blade, and margins polished with silicone discs



FIGURE 14 Preoperative occlusal view of the mandible



FIGURE 15 Postoperative occlusal view of the mandible



FIGURE 16 Preoperative occlusal view of the maxilla



FIGURE 17 Postoperative occlusal view of the maxilla



FIGURE 18 Preoperative anterior view of the maxillary teeth

complement each other in an ideal manner. The final CAD design for ceramic restorations took about 3 h in total.

Subsequently, the milling process took about 30 min per tooth. A leucite-reinforced feldspathic ceramic was used (IPS.Empress CAD, Ivoclar Vivadent, Schaan, Liechtenstein) to fabricate highly esthetic monolithic restorations. The final laboratory step entails 3D staining, which must be discussed and decided on with the patient, based on their personal preferences. For the upper arch, this took about 3 h.

2.4 | Bonding procedure

As one of the most critical steps, the bonding procedure took approximately 3 and a half hours. Rubberdam isolation is mandatory for moisture and contamination control (Figure 12). Ceramic restorations were HF acid etched (10% HF for 60 s) and a silane coupling agent was applied. Teeth were etched with phosphoric acid for 30 s, followed by bonding agent application (Optibond FL, Kerr, York, PA). A light-cure composite resin luting agent (Variolink Esthetic, Ivoclar Vivadent) was



FIGURE 19 Anterior view of the restored maxillary teeth at 1-year follow-up



FIGURE 20 Preoperative extraoral view



FIGURE 21 Patient portrait at 1-year follow up

used for final insertion. After initial tack light cure for 2 s, removal of excess composite was performed, and air block (glycerin) was applied and before the final light curie for 45 s from each side. Excess cement was removed under the microscope a scalpel blade, and marginal areas were polished with silicone discs (Figure 13). The same sequence and protocols were followed for the lower teeth, from preparation to bonding. Figures 14–17 depict the final clinical outcome compared to the preoperative situation. The clinical situation at the

1-year follow-up compared to preoperative situation is shown in Figures 18–21.

3 | DISCUSSION

This article describes the step-by-step implementation of digital and microscopic tools to achieve optimal esthetics and precision.

Stepping into the digital dentistry world is not just a decision between porcelain-fused-to-metal and all-ceramic restorations: it offers an entire workflow from diagnostics to restoration fabrication. It provides a communication tool between the clinician and the laboratory technician that is significantly more accurate, fast, and predictable than any analog protocols. In addition, outcomes can be tested on the computer and clinical steps planned in advance very accurately, saving valuable clinic time and improving the patient experience.

The high precision and accuracy achievable with digital technologies in clinics and in the laboratory are complemented by high magnification tools that allow the clinician to be minimally invasive and visualize areas where precision is critical for clinical success. In fact, minimally invasive dentistry is simply not possible without visual magnification. The main reasons for the fact that many dentists still do not “believe” and engage in these helpful tools are investment costs, but even more so, the need to learn new techniques and the extensive training necessary to become proficient with them. Indeed, there is a steep learning curve and continuous practicing involved in their effective and efficient implementation in daily practice.⁸ However, with a certain level of competence, these tools not only support better quality but also faster dentistry. Clinical and laboratory steps in the extensive clinical treatment demonstrated in this article were each completed within hours, and the case was finalized within days.

However, the greatest beneficiary of these technologies is, as it should be, the patient, who received definitive restorations that resembled the exact shape and size she agreed to during the planning and provisional phases. Ceramic customizations were made based on her personal preferences and taste. The meticulous minimally invasive preparation and surgical interventions as well as the precise and controlled bonding procedure are essential for long-term clinical success.

Digital and high-magnification tools in clinics and dental laboratories facilitate highly esthetic and precise outcomes when, as described and illustrated in this clinical report, they are integrated into a comprehensive treatment concept.

DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

Data sharing not applicable - this is a case report and no data generated.

ORCID

Markus B. Blatz  <https://orcid.org/0000-0001-6341-7047>

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