Prosthodontics in digital times: A case report

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Dentistry has not been exempt from changes in this era of technology-driven revolution. Entire workflows are already digitalized, and restorations are designed and manufactured using computer-aided solutions. This case report describes the reconstruction of 24 teeth using digital techniques. (Quintessence Int 2013;44:29–36)

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A combination of public media,¹ new materials, and advanced techniques have fueled an esthetic cultural revolution² that has left clinicians to address the esthetic expectations of today’s patients. Since positive effects on a patient’s self-esteem and quality of life were identified during this revolution,³ an emphasis on enhancing personal appearance is demonstrated in patients’ increasing demands for esthetic procedures.⁴

Another important development has been the use of computers in dentistry, which has led to new research foci and new opportunities with regard to clinical workflows and dental restoration manufacturing.⁵⁻⁷³ Production stages in dentistry are becoming increasingly automated, as is the case in many other industries.⁷ The price of dental laboratory work has become a major factor in treatment planning and therapy, and automation could enable more competitive production in high-wage areas such as Western Europe and the United States.⁷ Only a few years ago, euphoric statements were made that impressions and computer-generated abutments would likely replace traditional restorative protocols and become the standard for dentistry.⁹ Today, this would seem to be true—with the exception of scanning large edentulous areas, digital techniques are already capable of replacing conventional workflows.⁷³⁻¹¹

In advertisements and dental journals, computer-based procedures are often praised as being safer and more economically efficient, comfortable, and precise than their predecessors.¹²⁻¹³ And indeed, although conventional putty impressions are considered equally precise as digital impression techniques,¹¹ other benefits associated with computer-aided design/computer-assisted manufacture (CAD/CAM)–generated dental restorations include access to new, nearly defect-free, industrially prefabricated and controlled materials; an increase in quality and reproducibility; data storage commensurate with a standardized chain of production; an improvement in precision and planning; and an increase in efficiency.⁷⁻⁸ As a result of continual developments in technology, new methods of production and new treatment concepts are to be expected.⁷ Clinicians must have certain basic knowledge if they are to benefit from these new procedures. This article describes the full-mouth reconstruction of a patient using an entirely digital workflow.

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CASE REPORT

A 46-year-old woman presented with a need for conservative and prosthodontic treatment. Esthetically, the patient was unhappy about the position and color of her teeth, as well as the large composite restoration in the maxillary right central incisor. In addition, she lacked the confidence to smile wholeheartedly due to the discolored margins of her posterior teeth (Fig 1). Clinically, the composite restorations in the maxillary and mandibular anterior teeth were sufficient, and the overall periodontal situation was stable. The patient decided to proceed with veneers on the maxillary and mandibular anterior teeth as an elective and entirely cosmetic procedure. In the premolar and molar regions, the teeth had previously been restored with porcelain-fused-to-metal (PFM) crowns with insufficient margins. Additionally, all crowns were splinted, thereby complicating interdental oral hygiene. The posterior teeth had been conservatively treated with clinically unacceptable resorcinol-formaldehyde resin root canal fillings (Russian red)\(^{14,15}\) and had loose and leaking core buildups. The conservative treatment plan consisted of an oral hygiene phase, the replacement of all root canal treatments, and new core buildups. The prosthodontic phase included veneering the maxillary and mandibular right canines through left canines and placing single crowns on the previously crowned posterior teeth.

Clinical procedure

Following a professional cleaning, an alginate impression (Alginat Super, Pluradent) was taken. After mounting the stone casts in an articulator, a wax-up of the maxillary and mandibular right canines was made in the dental laboratory (Fig 2). With the help of thermoformed splints, the wax-up was tried on as a mock-up to ensure that the patient was making an informed decision with regard to electively placing veneers on otherwise intact anterior teeth. After the patient opted to proceed, the posterior crowns were removed and the root canal fillings revised. The previous clinician had used a toxic resorcinol-formaldehyde resin root canal filling material (Russian red), which led to heavy discoloration of the teeth that was, in some cases, impossible to remove and replace.\(^{14,15}\) After finishing the
root canal treatments, core buildups were adhesively placed (Clearfil DC Core, Kuraray) and the teeth covered with cemented provisional restorations (Luxatemp, DMG). Three months after the endodontic treatment, none of the posterior teeth showed apical pathologies or caused pain, and the restorative treatment was started.

After the application of a local anesthetic (Septanest, Septodont), the maxillary and mandibular teeth were prepared and digitally scanned on two consecutive days using triple zero retraction cords (Ultradent) (Fig 3). Prior to scanning, a small permanent bonding (Tetric EvoFlow, Ivoclar Vivadent) was placed on the unprepared mandibular right second molar. Also, removable interocclusal records were built on the maxillary and mandibular left second molars and on the all four central incisors as a front jig (Tetric EvoCeram, Ivoclar Vivadent) to ensure a proper transfer of the impression. Before the digital impression was taken, an astringent gel (Expasyl, Pierre Rolland) was placed for 1 minute. After thorough rinsing of the gel with water, the digital impressions were taken (iTero, Align Technologies) (Fig 4). At first, the maxillary arch was digitally scanned. On the following day, a digital impression of the mandibular teeth, as well as the interocclusal records, were taken (Fig 5).

The digital scans were performed using parallel confocal imaging, which utilizes laser and optical scanning to digitally capture the surfaces and contours of teeth and gingival structures. This technique captures 100,000 points of reflected laser light in a focus at 300 focal depths of the tooth structure. These focal depth images are spaced approximately 50 μm apart.

Because the interocclusal records had to be taken on three different areas (right, left, and anterior teeth), two of the three records were always placed on the antagonistic sides. After taking the digital impressions, the astringent gel was again placed for 1 minute and rinsed. Conventional impressions were then taken as controls (Rim-lock trays, Permadyne, 3M ESPE). The provisional restorations were cemented with a liner (Kerr Life, Kerr) to allow stability and at the same time, retrievability of the restorations. After sending the case to the laboratory, the initial digital file (STL format) was cleaned and processed with computer software (Align Technologies). The finalized STL file was received at the dental labora-
Fig 5  Digital images of the scanned teeth after marking the preparation margins in the dental laboratory.

Fig 6  Working and soft tissue casts made of polyurethane material using the digital set of data from the scanning procedure.
Fig 7 Virtual design of the anatomically reduced framework using the digital set of data from the scanning procedure.

Fig 8 Choosing the height of the cobalt-chromium metal blank to mill the framework of the fixed dental prosthesis in one piece.

Fig 9 Anatomically reduced milled ceramic frameworks before individualized feldspathic veneering.

The casts were milled from a solid block of polyurethane (Fig 6). The STL scan file was exported (Fig 7) to the CAD/CAM system (CS2, Straumann). Using the CAD software, the restorations were designed and checked at the dental laboratory for porcelain support and that they fitted within the milling block size (Fig 8). Restorations for the maxillary right through left first molars and mandibular right first molar through left canine were milled as individual anatomically reduced lithium disilicate glass-ceramic crowns/veneers (IPS e.max CAD, Ivoclar) (Fig 9), which provided excellent clinical results. The fixed dental prosthesis for the mandibular left first premolar to second molar was milled from a solid cobalt-chromium alloy block (Coron, Straumann).
Fig 10  Finished laboratory work on the cast produced from the digital set of data.

(Fig 9). Each restoration was checked for fit and passivity before being veneered with porcelain (Initial, GC) and hand-polished to achieve natural esthetics (Fig 10). The occlusion was checked and adjusted before the restorations were sent to the dental office.

Three weeks after the impressions were taken, the ceramic crowns were tried in clinically. After cleaning the teeth with pumice and a chlorhexidine solution, radiographs were taken to check the fit of the restorations. All full-coverage restorations were cemented with glass-ionomer cement (Ketac-Cem, 3M ESPE), while the veneers were bonded to the teeth using rubber dam and transparent adhesive cement (Variolink II, Ivoclar Vivadent). Figures 11 and 12 show the restorations at a recall visit 3 months after cementation.

DISCUSSION

Digital techniques are already capable of replacing traditional workflows. With the exception of scanning large edentulous areas, digital impressions showed trueness and precision equal to conventional techniques. One advantage of digital impressions compared with the conventional techniques with putty is that missing areas or imperfections can easily be rescanned and added to the existing virtual model, thus reducing discomfort for the patient. Another major advantage of the computer technique is the availability of the data of the virtual model and the restoration, allowing technicians to first check function and esthetics.

A useful tool in the iTero CAD workstation is the measurement of the interocclusal distance immediately after the scanning procedure. Clinically, this helps to ensure the correct material thickness and also make sure that there is enough space for the technician to design anatomically correct occlusal surfaces. For the dental technician, various benefits emerge from the use of digital dentistry. The manufactured polyurethane casts have a higher resistance to wear when used in the dental laboratory and have a plasterlike color similar to conventional casts. With the exception of a total loss of the jaw relationship, there is no need to take the bite. The occlusal jaw relationship is scanned directly and transferred to a standardized articulator, which significantly reduces time for both the clinician and dental technician. Moreover, casts can easily be replicated with the same quality since the same set of data can be reused. With regard to esthetics, the use of one cast, which serves as a working and master model when soft tissue structures are still intact, reduces valuable chair time, since fewer try-ins are necessary. Furthermore, digitalization of clinical and laboratory workflows enables the industry to process homogenous, standardized materials, which reduces material-induced failures.

Notwithstanding all the benefits for patients, clinicians, and dental technicians, the use of digitalization in dental proce-
dures still has its limitations. Digitalization cannot be utilized when removable prosthodontic concepts are applied, since the digital scanners are not able to stitch and merge large edentulous areas. Furthermore, the computer resources and stability of the software are compromised when larger sets of data are produced. Additionally, the handling of the scanner head, which can be heavy, requires practice. The greatest time and workflow benefit can be drawn from digital scanning systems when small restorations in one or two quadrants are placed.

CONCLUSION

Compared with conventional techniques, digital workflows benefit patients, clinicians, and dental technicians alike in terms of cost and precision. Future studies are necessary, however, to determine whether the longevity of restorations is also positively influenced.
REFERENCES