The decision-making process in interdisciplinary treatment: digital versus conventional approach. A case presentation

Nikolaos Perakis, DDS
Private Practice, Bologna, Italy

Renato Cocconi, MD, DDS, MS
Director, Face Ortho Surgical Center, Parma, Italy

Correspondence to: Dr Nikolaos Perakis
Via Albertoni 4, 40138 Bologna, Italy; Tel. Landline +39 051 6360616, Mobile +39 347 6438148;
Email: nikperakis@gmail.com
Abstract

The digital technology can be a GPS in designing a multidisciplinary treatment that involves orthodontics and restorative dentistry. A proper hierarchy of decisions and responsibilities need to be defined. Form is everything but position and size. For this reason the orthodontist first needs to set up the proper occlusion deciding the position and the available size that will be necessary for the restorative dentist to obtain the proper form with a minimally invasive preparation.

This case report illustrates with a step-by-step approach all the clinical issues of the treatment, from diagnosis to orthodontic guided position of Tads, materials of choice and laminate veneers realization passing through all the interactions between the dental team members explaining who does what and when and proposing a clear hierarchy of decision. A review of digital and classical possibilities for the realization of laminate veneers is proposed with its pros and cons.

(Int J Esthet Dent 2019;14:212–224)
Introduction

The development of new technologies and restorative techniques has led to significant improvement in patient treatment modalities and also to the specialization of dentists. A multidisciplinary approach is often necessary in order to take advantage of such innovations and improve clinical outcomes by reducing the invasiveness of treatments. A minimally invasive approach should be preferred to more invasive techniques; in fact, tooth structure preservation is of paramount importance in order to respect biology and guarantee the best biomechanical situation for dental restorations.1-4

Furthermore, it has been observed that dentin exposure during teeth preparation for laminate veneers can affect the long-term result.5,6 To optimize the results, all the team members should take part in defining the steps of the workflow. It is essential to establish the role that each professional should play in the different treatment stages: each single phase should be supervised by a team leader who makes decisions with the support of the other team members.

A digital workflow helps the team members to interact and verify each step without the need to actually see the patient.

The aim of this article is to describe our interdisciplinary workflow and to show how digital technologies can obtain very precise results and save time. The article also aims to demonstrate how combining digital technologies with traditional laboratory procedures allows for a wide range of options of currently available restorative ceramic materials.

Case presentation

The patient was a 27-year-old female with a missing maxillary left lateral incisor and a small lateral on the
other side, together with an impacted maxillary left canine. The patient’s main reason for seeking treatment was to improve her dental esthetics and smile without considering the option of orthognathic surgical intervention (Fig 1). The extraoral examination showed a mild skeletal class II with a biretrusion and a projected long nose (Fig 2). The patient did not want any change to her face.

Intraorally, the patient had significant crowding in the mandible and an asymmetrical dental arrangement in the maxillary anterior area due to a diminutive maxillary right lateral incisor and two mobile primary teeth still present in place of an agenetic maxillary left lateral and an impacted maxillary left canine (Fig 3).

In order to select the best treatment strategy for the patient, we needed to follow a specific sequence in the decision-making process (Schema 1).

**Establishing the correct tooth positions**

The orthodontist had the responsibility of defining the appropriate maxillary and mandibular incisors’ position and inclination. This affects the final decision of opening or closing spaces for maxillary laterals, considering the space requirement in both arches.

We used a three-dimensional (3D) virtual rendering to define the proper position of the anterior and posterior occlusal segments (Fig 4). After setting the occlusion, we predefined the available spaces for the volumes of the anterior maxillary teeth to maximize the esthetic outcome (Fig 5). At the beginning of the
treatment, we wanted to visualize and approximately define how to position these teeth at the end of the orthodontic treatment so as to facilitate the minimally invasive restorative procedures to be performed at a later stage. The orthodontist was responsible for deciding whether to extract the two mandibular first bicuspids due to lack of space. As a result, we decided to extract the diminutive right lateral incisor (12) and the two maxillary left primary teeth (62 and 63), to substitute the maxillary laterals with maxillary canines, and the maxillary canines with maxillary first bicuspids.

After space closure, the restorative dentist indicated the final orthodontic position of these teeth to optimize a maximal intercuspation position and to set the space for minimally invasive laminate veneers.

A fully digital orthodontic approach was used for the palatal implants positioning and to obtain an adequate orthodontic supporting appliance. This was used to support a provisional, to disclude the impacted canine (23), to mesialize the canines and posterior buccal segments, and to maintain the maxillary midline position (Figs 6 and 7).

**Interaction between position and tooth shape**

As previously mentioned, when the tooth position was almost achieved, the restorative dentist directed the finishing orthodontic stage and defined the correct tooth shape. This step was essential for a minimally invasive approach with thin laminate veneers. At the first clinical restorative check, the tooth positions were very close to what had been defined at baseline in the digital wax-up. Only a few modifications were required. The positions of teeth 14 and 13 were correct, and their axes were compatible with a minimal tooth preparation approach.

The gingival margins of the central incisors had to be aligned and their axes tilted. Tooth 23 had to be distalized to give more room to the interdental papilla and to better distribute the volume of the final restorations. Tooth 24 had to be torqued and intruded to reduce the invasiveness of tooth preparation (Figs 8 and 9).
First restorative check: the axes of the anterior teeth should be corrected and the gingival margins aligned.

The maxillary left canine should be distalized to give room to the papilla.

Frontal view at the end of the orthodontic treatment. Two maxillary canines are positioned in place of the lateral incisors, and two premolars in place of the canines.

Composite mock-up performed directly in the patient’s mouth.

Final tooth shape definition and communication with the patient

At the second restorative check, once the ideal dental position had been achieved and the incisal margins of teeth 13, 12, and 23 had been reshaped, the next stage of treatment could be planned. Tooth 24 could not be intruded more due to the root position with respect to the cortical buccal bone (Fig 10). The major restorative issue of this case was to transform the maxillary canines to lateral incisors, and the first bicuspids to canines, ending up with good esthetics and a functional canine guidance.7

Overall, there were three clinical possibilities for evaluating the final shape of the anterior teeth:

- The first possibility was completely digital, with a digital smile design and virtual wax-up, as was done at the beginning of treatment. This digital simulation would then need to be tested in the patient’s mouth before tooth preparation. A mock-up would then need to be prepared in a second appointment, once the new shape of the anterior teeth had been accepted by the patient.8,9

- The second possibility was to send a series of explanatory notes to the laboratory for a classical wax-up, and from this fabricate a mock-up. Both these possibilities do not allow the clinician to evaluate all the aesthetic and functional parameters from the beginning. This can only be done after the realization of the mock-up.

- The third possibility was a composite mock-up carried out directly in the patient’s mouth (Fig 11).
The final option was chosen because it involved the patient in the process of improving her smile. The composite was applied without adhesive and was polymerized for 2 to 3 s, so that it was easy to remove it at the end of the consultation. This rapid simulation allowed the clinician not only to evaluate esthetics, phonetics, and function (guidance, overbite, overjet, relationship to lips and tongue), but also to get immediate feedback from the patient, and to make any required changes and adjustments (Fig 12). Once the shape had been approved, some simple photos, an impression, and a facebow registration for the spatial orientation of the casts were taken. This 3D and functional information could be transferred to the laboratory for the wax-up, with the aim of improving and refining what was constructed in the mouth. In this case, the wax-up would be performed using the traditional technique, and the technician was able to manage the esthetic details with greater ease. At the third restorative appointment, a silicone index of the fully additive wax-up was prepared (Fig 13), and a resin mock-up was pressed onto the teeth to enable the patient to see the new appearance of her smile (Fig 14).

Minimally invasive tooth preparation

The mock-up was also used as a guide for dental reduction (Fig 15). The teeth were prepared in the most conservative way, allowing for the maximum preservation of enamel (Fig 16) and an adequate thickness of
the ceramic veneers (Fig 17). After the teeth had been prepared, an impression was taken.

Eight ceramic laminate veneers were needed to improve the patient’s smile.

 Provisionals were fabricated using the same silicone index that had already been used to place the mock-up, so that the occlusal design could be duplicated and the patient could retain the same level of comfort. Provisional restorations could be pressed and cemented simultaneously using the spot-etch technique.13 This procedure allowed the teeth to be stabilized during the provisional phase.

**Laminate veneers realization: classical versus digital approach**

All laboratory steps have been documented in a parallel sequence in order to describe and compare the classical and digital approaches. The materials used most frequently to fabricate porcelain veneers are feldspathic ceramics baked on refractory dies and heat-pressed lithium disilicate ceramics. Both techniques need a physical cast to be realized. Computer-aided design/computer-aided manufacturing (CAD/CAM) procedures can also be used with these materials. Nevertheless, a physical cast is always necessary to finish the ceramic as well as for final checks before delivery.

In the present clinical case, eight feldspathic ceramic laminate veneers (Noritake EX-3; Kuraray Noritake Dental) were used to restore the patient’s smile.

The classical workflow started from a definitive impression recorded using a polyvinylsiloxane (PVS) material (Express; 3M ESPE). This impression was poured twice in the laboratory to obtain a working cast and a solid cast (Quadro Rock; Picodent) (Fig 18). The working cast was mounted in an articulator and its stone dies duplicated in a refractory material to fabricate the feldspathic ceramic laminate veneers. A purely digital workflow is not available at present, as the absence of a physical cast limits the material choice to CAD/CAM monolithic ceramics and does not allow for the checking of the final prosthesis before delivery. For this reason, we followed a partially digital workflow that benefits from the advantages of digital technology without having to abandon those
Classical workflow: a master cast and a solid cast were obtained from a polyvinylsiloxane impression of the maxillary arch. The stone dies were duplicated in refractory material and inserted in the alveolar cast.

Digital workflow: an intraoral scan of the maxilla was taken. The STL file was then processed through model-builder software to fabricate physical resin-printed casts.

Digital workflow: the resin dies were duplicated in refractory material.
clinical and laboratory procedures that until now have obtained the best esthetic results. The STL file derived from the intraoral scanning of the prepared teeth (Trios; 3Shape) had been processed by the technician using model-builder software (Fig 19). Digital master casts can be obtained either by milling or 3D printing. In this clinical case, a precise physical cast was obtained using two different, high-quality 3D printers (Stratasys Object Eden 500 for the alveolar cast; DWS DigitalWax 028Jplus Jewelry for the removable dies). The first printer uses a PolyJet technology, where small drops of a photopolymerizing resin are deposited on a work tray and immediately cured by UV light. Layers are 12-μ thin, allowing the casts to be very precise. The second printer uses stereolithography (SLA) technology. A building platform moves vertically into a bath of liquid resin that is cured by a UV laser. The laser beam is very thin, allowing one to obtain a very smooth surface, with an accuracy of 10μ.

The resin dies were then duplicated in refractory material and inserted in the alveolar cast (Fig 20). In this way, the dental technician could layer the feldspathic ceramic directly on the physical cast (Fig 21). Once layered and finished on the resin and stone master casts, the laminate veneers were respectively checked on the stone solid cast (Fig 22) and on the 3D-printed cast (Fig 23).

**Final control and adhesive cementation**

Before the final luting steps, the laminate veneers were evaluated in the patient’s mouth: a homogeneous and thin layer of Fit Checker (GC) material was used. The marginal precision was clinically assessed using 5x magnification loupes and a sharp probe. The quality of the interproximal contact area was verified with thin dental floss. Both digital and classical workflows ended up with precise laminate veneers. No adjustments were necessary, and, clinically speaking, no difference in precision was found.

Regarding the treatment of the restorations, feldspathic ceramic was etched with 9% hydrofluoric acid for 120 s, after which the restorations were rinsed and then placed in an ultrasound bath with alcohol for 3 min to completely eliminate etching debris. A thin
A layer of a silane (Monobond Plus; Ivoclar Vivadent) was then applied and left in place for 60 s.

A light-curing resin cement (Variolink Esthetic; Ivoclar Vivadent) with its adhesive system (Adhese Universal; Ivoclar Vivadent) was used to bond the veneers. The resin cement excesses were carefully removed, and each surface was light cured for 60 s using a LED curing unit (Elipar S10; 3M ESPE). All margins were then covered with a glycerin gel and light cured for a further 20 s.

The rubber dam was then removed and the occlusion finally checked.

After 1 week (Fig 24), and again after 1 year (Fig 25), the restorations appeared very well integrated. The patient was satisfied with the esthetics and function.

The fully digital positioning of orthodontic palatal implants and supporting structures helped greatly to achieve the final orthodontic position, and for patient communication and cooperation.

The finishing orthodontic stage aimed to produce the small changes that the restorative dentist needed so as to maximize the esthetic outcome with a minimally invasive procedure.

A fully digital restorative workflow implies the use of face scanners, optical impressions, and virtual articulators in which the patient’s movements are recorded during function. Unfortunately, it is not easy to utilize this solution because most digital interfaces are not available at present, and these tools are not linked in one integrated digital workflow. The absence of a physical cast limits the choice of material to monolithic ceramics only when realized with CAD/CAM technology. There is also no possibility of checking and finishing the prosthesis before fitting, which implies long and complicated clinical checks before cementation, especially in difficult cases.

Therefore, when choosing the restorative strategy, the following factors need to be taken into consideration:

1. The most-used materials for porcelain veneers are feldspathic and lithium disilicate ceramic.
2. These materials can be produced following the classical techniques (baked-on refractory dies and heat pressed, respectively) as well as with the digital method using CAD/CAM technology.

Discussion

In interdisciplinary cases, the exact control of the clinical steps is of paramount importance. For this reason, the treatment planning and sequence should be carefully assessed, and one should define when and how the dental team should intervene with clinical checks and suggestions. Modern digital technology allows one to visualize the final tooth position and form as well as standardize and plan all these steps. This can help the communication between the members of the team and with the patient. It can also reduce time and redundant steps. Only two clinical checks by the restorative dentist were necessary during the orthodontic phase.
3. A precise physical cast is necessary to layer and finish the ceramic laminate veneers as well as to control the precision and quality of the final restorations.

Starting from these requirements, one can examine the possible treatment options. The completely analog workflow has been used in prosthetics for decades and allows for good clinical results. Nevertheless, numerous laboratory steps can be reduced and improved upon using digital technologies. The mixed workflow proposed in this article allows one to take the most from current digital possibilities and obtain a high standard of work.

The direct intraoral scanning of the prepared teeth has several advantages. The impression process is more pleasant for the patient and avoids the imprecision associated with the use of classical clinical and laboratory materials (impression materials and stone plaster). The quality of the impression can be immediately checked at high magnification on a monitor. The space available with respect to the opposing teeth can be easily verified. The STL file of such a digital impression can be reutilized by the laboratory at any time, which seems to be more accurate than an impression obtained by the laboratory scanning of the stone casts when a CAM method is chosen. Furthermore, digital impressions allow one to obtain precise 3D-printed physical casts that can be mounted in an articulator to manage both static and dynamic occlusion, and can be used to produce laminate veneers.

Conclusion

New digital technologies have significantly improved patient treatment modalities, especially in interdisciplinary cases. A digital workflow helps the team members to plan the clinical case, to interact during the treatment, and to verify every clinical step effectively. Nevertheless, a fully digital approach in the restorative phase is not available at present. Combining digital technologies and traditional laboratory procedures may be the solution for maintaining a wide range of options of currently available restorative materials.

Acknowledgments

We express our gratitude to Mr Gianluca Dallatana and Mr Giuseppe Mignani for their precious collaboration, and Dr Francesca Zicari for her help with editing the manuscript.

References

9. Mintrone F, Kataoka S. Previsualization: a useful system for truly informed consent to...


