Digital dentistry: transforming smiles using CAD/CAM technology

Frederico M. Lima dos Santos[1]
Marcelo Serra[2]
Fábio Cabral[2]
Wagner Nhoncance[3]
Marko Túlhio de Souza N. Bessa[3]
Sandro Souza[3]
Josias Santana da Silva[2]
Luis Calicchio[2]
Marcelo Moreira[2]
Marcelo Kyrillos[2]
Gustavo Giordani[2]

1) Made Me A (São Paulo/SP, Brazil).
2) Ateliê Oral (São Paulo/SP, Brazil).
3) Laboratório Precision (São Paulo/SP, Brazil).

Abstract: The relentless quest for perfection and naturalness has always been the goal of all dentists and technicians. The enormous complexity in replicating a tooth with all its intrinsic and extrinsic characteristics as well as macro and microtextures is a challenge to be overcome. Performing a restoration on a previous tooth, when it does not obey all these particularities, proves to be unsatisfactory as far as naturalness is concerned. It should allow to recreate the textures, light reflection and deflection surfaces, convexities and concavities. Thus, to achieve a result of excellence, hours of highly qualified technical training are needed, which demands a lot of time and cost. The solution for these obstacles was only possible through the union of technique and technology, and the SKIN concept was born. Accuracy, detail and predictability have become something totally attainable and replicable, thus reducing case conclusion time with the CAD/CAM system. Treatments became less and less dependent on human ability. **Keywords:** Digital. CAD/CAM. SKIN technique. Preparation. Ceramic laminate.

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Contact address: Frederico Marques Lima dos Santos, Rua Tabapuã, n. 50, conjunto 302, Itaim Bibi – São Paulo/SP
CEP: 04.533-000 – E-mail: frederico.marques@mademea.com.br

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

The success of our oral rehabilitation is aimed at achieving a balance between neuromuscular, TMJ and occlusion systems, as well as returning a natural and esthetically beautiful tooth to patients. For this to happen more quickly and efficiently, it is necessary to develop a system that unites all these premises and allows a quality service.

The CAD/CAM system (Computer - Aided Design/Computer - Aided Manufacturing) has been enhanced over the years and today is a reliable tool, making the result of prosthetic restorations predictable. The CAD-CAM technique is based on three fundamental components: dental preparation reading system (scanner), indirect restoration design software (CAD) and restoration structure milling system (CAM). The skepticism about the use of this technology in dentistry was very big years ago, but with innovations this paradigm was broken and today everyone sees in this system one more treatment option for their patients.

This transformation allowed Dentistry to reinvent itself, bringing speed to treatments, accuracy, comfort and richness to details. However, for everything to happen as designed, we, dental surgeons, also have to adapt to changes, new protocols, materials and new dynamics we are living.

Currently, many dental offices are also becoming prosthetic laboratories (chairside system). This allows a greater dynamics in attendances and speed in the deliveries of prosthetic restorations. Another great advantage is the possibility of modifying these restorations by using this system's design software (natural tooth database), and the possibility of storing all the treatment - to be repeated if necessary.

The SKIN technique allows greater participation by the patient in the decision making regarding the shape of the teeth. In this way, unpleasant surprises at the end of treatment were reduced, making the final result more predictable and personalized.

CASE REPORT

A 38 year-old white male patient presented as main complaint the shape, proportion and uneven color of his anterosuperior teeth due to these elements' composite resin restorations (Fig 1 and 2).

After the first consultation protocol, consisting of anamnesis, video, photographs, clinical examination, moldings and periapical radiographs, the diagnosis and planning of the case were performed.

In the diagnosis, it was verified:

» Slight difference of zenith between teeth #11 and #21 (Fig 3);

» Absence of maxillary teeth exposure in the partially open mouth photograph;

» Buccal inclination of tooth #22 in relation to the lower lip in the total profile mouth photograph;

» Deviation of the mandibular midline to the right relative to the maxillary and midline of the face (Fig 4);

» Class II malocclusion on the right side and Class I on the left side;

» Canine guide with interference, due to lack of tip in teeth #23 and #43; and

» Large amount of composite resin in teeth #12, #11, #21 and #22, observed in the region's periapical radiographs and in the clinical photographs (Figs. 3, 5 and 6);

As the patient used his image to work, an orthodontic treatment to correct the Class II malocclusion on the right side and the mandibular midline deviation would be totally impracticable. The planning thus consisted of:

Figure 1: Initial photograph of the face.

Figure 2: Initial smile.

Figure 3: Difference of zenith between teeth #11 and #21 and buccal visualization of resins.

Figure 4: Initial occlusion.

Figure 5: Visualization of resins from occlusal.

Figure 6: Periapical radiography evidencing large amount of resin in anterior teeth.

» Whitening of all teeth;

» Diagnostic wax-up;

» Electric scalpel on tooth #11 (to match the zenith of tooth #21);

» Resin removal of teeth #12, #11, #21, #22 and maxillary test without adhesion (mock-up);

» Preparation of teeth #12, #11, #21 and #22 (performed in the same mock-up session);

» Dual of teeth #12, #11, #21, #22;

» Restoration in composite resin of teeth #13, #23, #33 and #43 (for the canine guide's restoration and balance of the functional masticatory angle of Planas, or FMAP); and

» Rigid plate.

The phase of diagnostic wax-up is of fundamental importance in the success or failure of an aesthetic treatment. Although many CAD/CAM programs have features that guide the design of the teeth, it is necessary for prosthetics to receive guidance, as it is the dentist who knows the desires and expectations of the patient. In this sense, the guidelines for elements #12, #11, #21 and #22 wax-up in the present case were as follows:

» Increase the incisals of the anterior teeth by having tooth #11's mesial as reference.

» In an occlusal view, reduce the buccal volume of the anterior teeth, having tooth #23 as a reference.

» Leave the teeth #11 and #21 with the ratio of 11mm long by 9mm wide.

» Leave the teeth #12 and #22 with the ratio of 9mm long by 7mm wide.

» Give rectangular shape to the teeth, compatible with the face.

Based on these guidelines, the technician can be more assertive in the selection of the virtual teeth (HAIJO F1), thus reducing the chances of error and the patient's dissatisfaction in the mock-up phase.

With all this information gathered during the first consultation phase, intraoral scanning of the maxillary and mandibular arches and of the patient in occlusion was performed. After the scanning, this file was sent to the laboratory to start the project (Fig 7).

In order to perform the digital wax of this case, the technician first simulated the preparation of the teeth #12, #11, #21 and #22, since the patient presented overcontoured restorations with shape and proportion faults (Fig 8). It was necessary, then, to reduce the initial condition in order to obtain a favorable aesthetic result. After performing the virtual preparation, based on the length and width of the maxillary incisors, a donor compatible with the case was searched in a tooth library (SKIN Concept) (Fig 9). Once the donor was selected, by superposition, the teeth were placed over the preparation to evaluate both the functional and the aesthetic aspects (Fig 10).

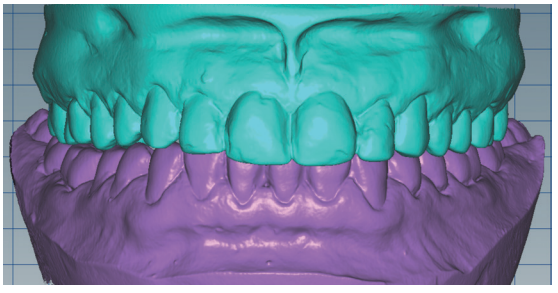
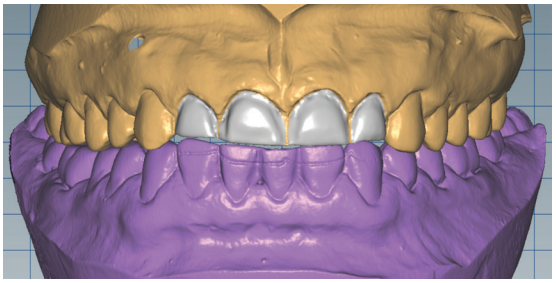


Figure 7: Initial 3D model.



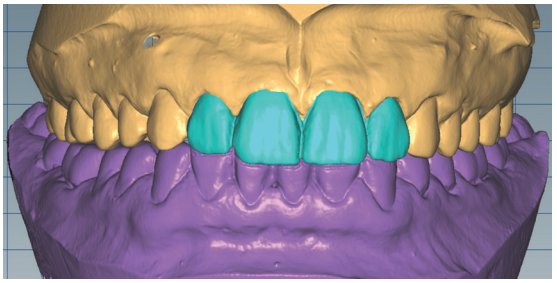


Figure 8: Digital preparation to enable adaptation of the chosen teeth to the model. **Figure 9:** HAIJO F1 toothbank.

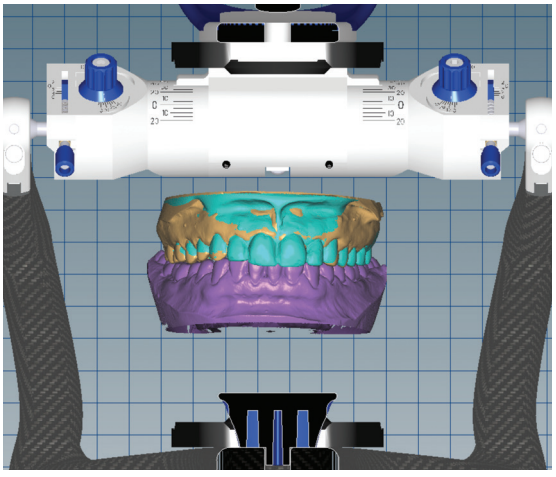
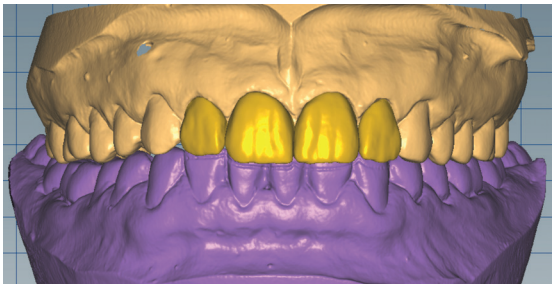


Figure 10: Overlap of the initial model in the digital preparation.



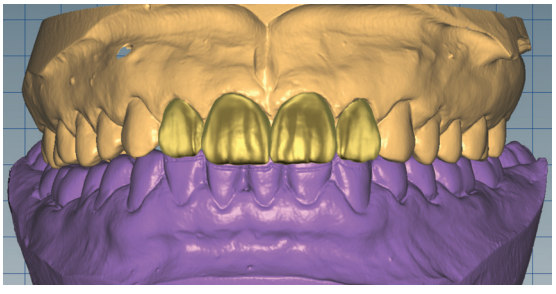


Figure 11: Final project. **Figure 12:** Final design with color change, for textures' visualization.

After the project's approval by the technician and the dentist (Fig 11 and 12), a model of the new smile was made in a 3D printer (Fig 13). On this model, total silicone and palatine walls were created to allow the digital wax-up to be transferred to the patient's mouth.

Then, the clinical phase started. Initially, all restorative material was removed from teeth #12, #11, #21 and #22 (Fig 14). After the removal of the composites, a small correction of tooth #11's zenith was performed, using an electric scalpel (Fig 14). With the total wall and bisacrylic resin, the restorative try-in or mock-up was performed for the aesthetic and functional validation of the new smile (Fig 15).

The preparations were carried out on the mock-up. It started with a depth cutting diamond bur, thus guaranteeing wear control and a thickness of 0.4mm for the future restorative material. The chamfered finish lines were better delimited and the axial and incisal angles were made, creating an ideal insertion axis for the ceramic laminates (Figs. 16 to 19).

A gingival retraction cord #000 (Fig 20) was used to scan the preparations, thus facilitating the reading of the structures and the delimitation of the margins by the technician. After the scanning, provisionals in bisacrylic resin were made using the total wall in silicone.

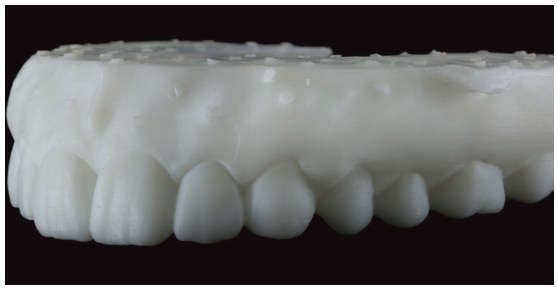


Figure 13: Printed model of the new smile.

Figure 14: Removal of tooth resins #12, #11, #21 and #22 and electric scalpel on tooth #11, to match zenith of #21.

Figure 15: Mock-up.

Figures 16-18: Preparations. **Figure 19:**Making axial and incisal angles to create an ideal insertion axis for laminates.

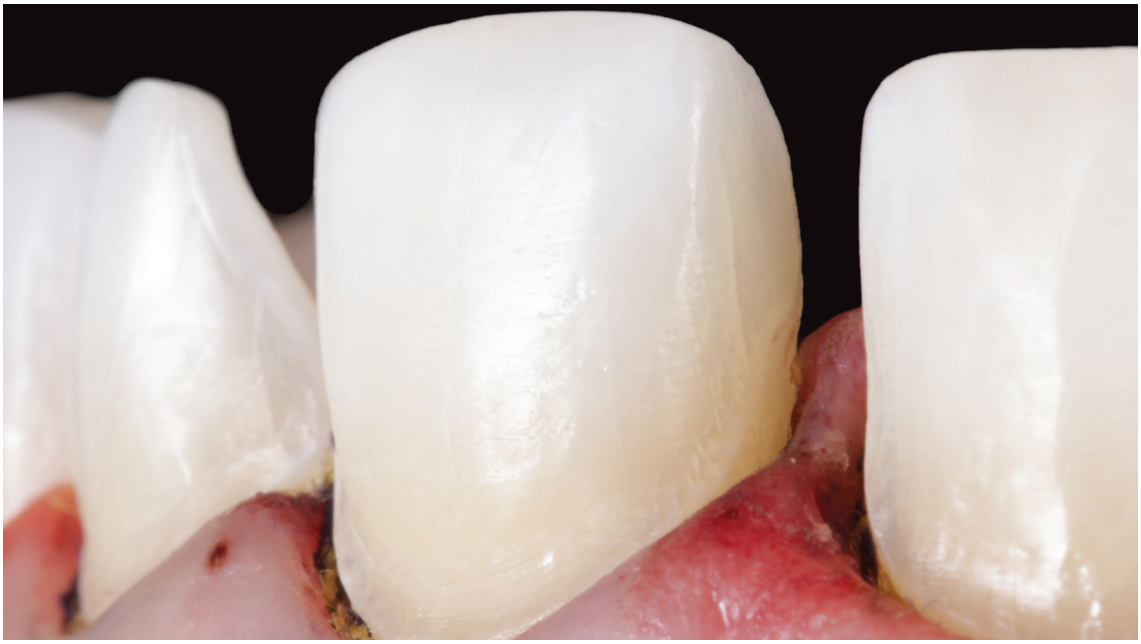


Figure 20: Gingival clearance with #000 wire for cleaning the preparations.

The files were sent to the laboratory, which confirmed their receiving and began the selection of the ceramic blocks to be milled. The E-MAX HTBL2 block was chosen because it had a coloration closer to the natural teeth thus, making it easier for a posterior make-up and characterization of the ceramics (Fig 21-24).

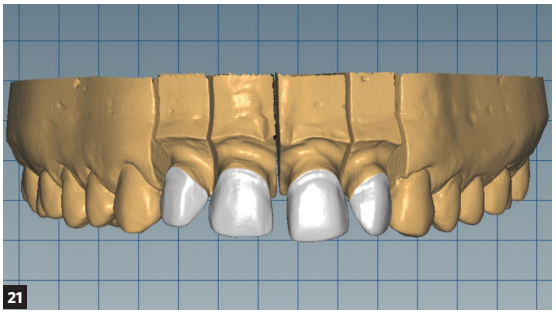
At the end of the milling, the ceramic elements went through finishing and final crystallization in the oven. This allowed the prosthetic to initiate the personalization of the teeth, through the process of pigmentation.

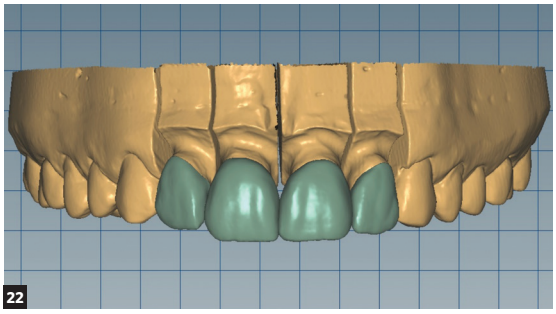
We used the Ivocollor kit (Ivoclar), Sun Set pigments in the cervical region and, in the incisal third, Basic Blue and Crack Liner Halo Opaco incisal. Once the pigment fixation was complete, a glaze layer (IPS Ivocollor PASTE / FLUO) was applied to give a more natural fluorescence on the prosthetic restorations.

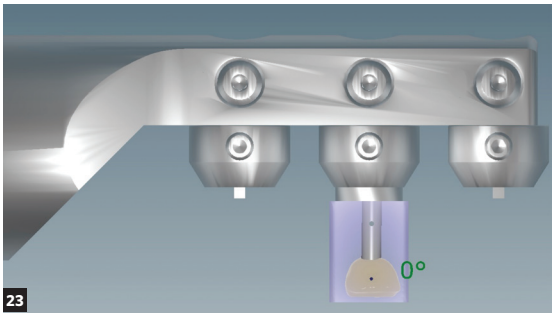
After the work was completed by the laboratory, cementing was checked by performing the dry and wet tests of the laminates (Fig 25), observing the optical behavior of the ceramics and their adaptation. Periapical radiographs also aided this step (Fig 26).

For conventional adhesive cementation, the transparent Variolink was used, only the base. In this way, the working time was better controlled and there was no interference in the color of the porcelain (Fig 27 to 32).

In the final photographs (Fig 28-32), one can note that harmony and naturalness were restored to the teeth.







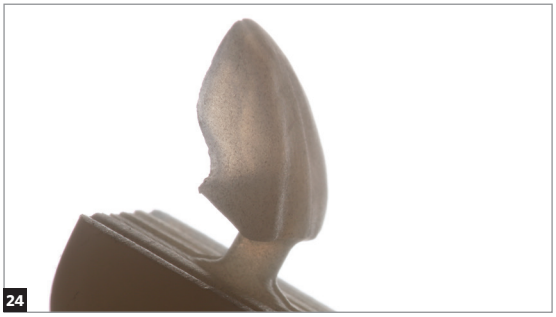


Figure 21: Scanning of the preparations. **Figure 22**: Final design ready to be machined. **Figure 23:** Selection of the block for milled. **Figure 24:**Final milling.

Figure 25: Try-in.

Figure 26: Final result - reproduction of the optical characteristics of a natural tooth.

Figure 27: Adhesive cementation.

Figure 28: Final photograph of the face. **Figure 29:** Final smile. **Figure 30:** Harmony and naturalness restored to the teeth. **Figure 31:** Final occlusion. **Figure: 32**: Approximate view of the ceramic laminates.

CONCLUSION

Digital systems are already a reality within Dentistry and have become great allies of the dental surgeon from the planning to the decision of preparation strategies and the conduction of the proposed treatments. Correct management of the system is only possible in trained and skilled hands, either in the chairside way or in a specialized prosthesis laboratory.

References:

1. Kano P, Baratieri LN, Decurcio R, Duarte S Jr, Saito P, Ferencz J, et al. The anatomical shell technique: Mimicking nature. Quintessence Dent Technol 2014;37:94-112.
2. Hatjó J. Anteriores: a beleza natural dos dentes anteriores. São Paulo: Gen; 2008.