Adaptation of traditional working methods

to the creation of Cr-Co ceramic restoration with CAD/CAM technology

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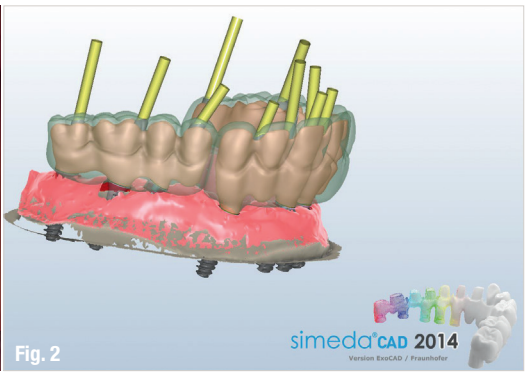


Fig. 1: Initial situation.
Fig. 2: Simeda modelling of the maxillary framework.

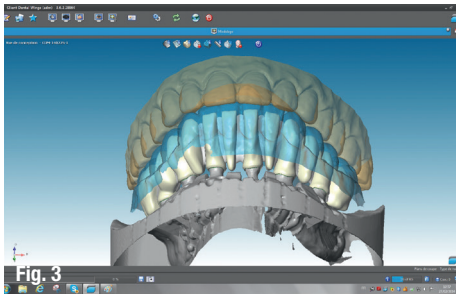
This article describes the adaptation of tried and tested fixed prosthesis work protocols to new CAD/CAM techniques. Based on a complete upper and lower bridge case, we also address technical and economic interests by offering a sealed implant prosthesis with a Cr-Co coating achieved by laser microfusion or trans-screwed by machining.

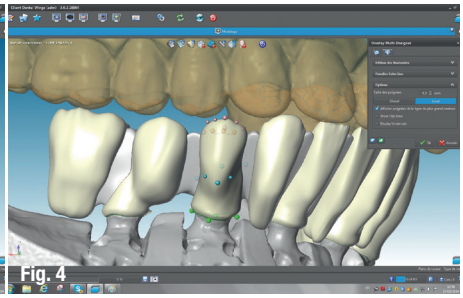
Case presentation

A 60-year-old female patient was completely edentulous and no longer wanted to use removable prosthesis. The dentist proposed placing six implants on her lower jaw. For aesthetic reasons (avoidance of occlusal screwing channels), the future ceramic bridge will be sealed on titanium implant pillars. For the upper jaw, he recommended inserting 10 implants with multi-unit pillars to facilitate the placement of a trans-screwed ceramic bridge.

Implant placement and adaptation of the existing prosthesis

The placement of maxillary and mandibular implants was delayed by several months in accordance with the patient's wishes. As the mandibular prosthesis poses the greatest problem in terms of stability and fixture, it was implanted first.





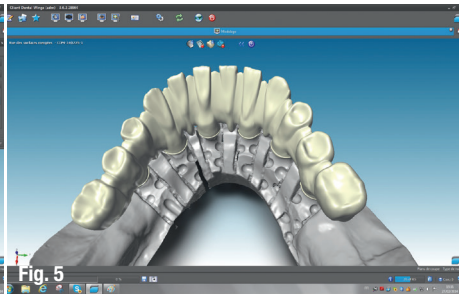


Fig. 3: Dental Wings modelling of the mandibular framework.
Fig. 4: Adjustment of the framework volume tooth by tooth.
Fig. 5: Connectors in the form of 'girders' on the entire framework.

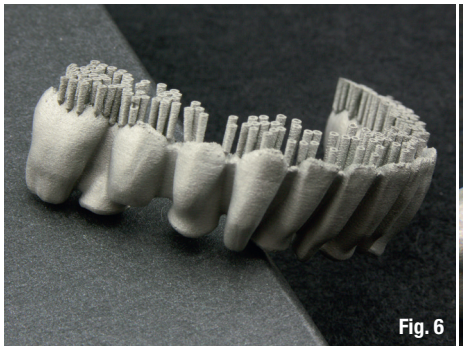


Fig. 6

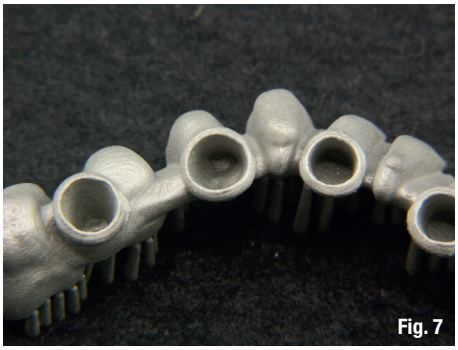


Fig. 7

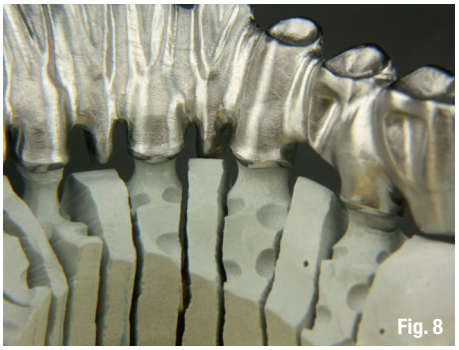


Fig. 8

Fig. 6: Cr-Co framework —Laser microfusion before scraping and finishing.
Fig. 7: View of the intrados and the smoothness of the entire framework.
Fig. 8: Adjustment accuracy of the mandibular framework.

In the same session, the apparatus was modified and rebased on healing screws so that the patient did not find himself without an appliance (denture). The same will apply to the maxillary prosthesis.

Validation key for the maxillary impression

In order to ensure the reliability of the maxillary impression a validation key must be made in plaster. This comprises a normal sized plate made of plaster with low shrinkage characteristics and which is not too hard (e.g. 'Snow White'). This is then trans-screwed by each implant in the mouth. If it does not break, it means that the model used for making it is reliable.

Articulator mounting

A practical and reliable method for mounting on the articulator is the use of temporary appliances (dentures). In fact, once the impressions have been taken and the working models have been prepared, the appliances are positioned on implant replicas of the models. By placing both appliances in intercuspal relation, it is easy to obtain the patient's occlusion. There are many benefits: it saves time as it is no longer necessary to make occlusion wax rims, and potential sources of errors are eliminated during the registration of the waxes. In order not to deprive the patient of both his/her dentures, this stage should ideally be performed in the dental surgery. If the teeth of the dentures are too worn, it is preferable to take an inter-cuspal silicone bite to facilitate interlinking the two devices at the time of placement on the articulator.

Preparation

It is essential for the dentist to take impressions of temporary appliances. The models that are created from these impressions are also mounted on the articulator so that the working model and the study model are interchangeable on the articulator. If the appliances are suitable from a functional and aesthetic perspective, they can be faithfully reproduced. In this case, as the patient's current prostheses could be improved aesthetically, we decided to create two aesthetic assemblies on a resin base (Fig. 1). The upper assembly was trans-screwed at the level of the two posterior implants and in an anterior position to give the model stability. For the same reasons, the bottom is wedged on six implant pillars.

As soon as the aesthetic assemblies are validated at a functional level (occlusal relation of both arcades, DVO, phonetic, etc) and at an aesthetic level (length and projection in the sagittal direction of the anterior tooth region of the upper jaw, laugh line, any animation, etc), they become the basis for the laboratory technician's work. In other words, these ceramic frameworks must be designed on these

Fig. 9

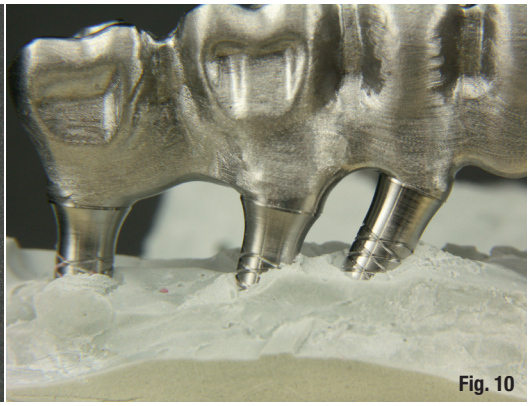


Fig. 10

Fig. 9 & 10: Cr-Co framework machined before scraping and finishing.

Fig. 11

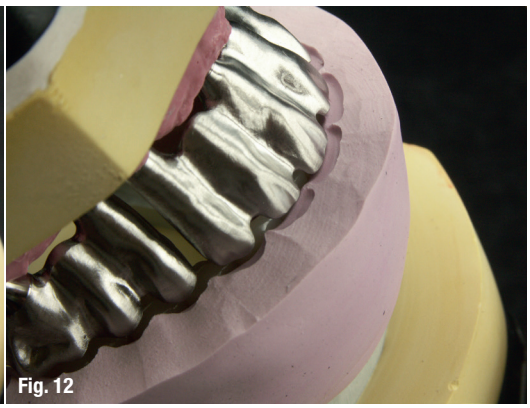


Fig. 12

Fig. 11: Anatomical silicon key.
Fig. 12: Visualisation of the support and the space provided for the structure.

attributes. Similarly, the future cosmetic material must adhere precisely to the guiding assemblies. Until now the prosthodontist has sculpted the framework in wax and casted it in alloy before adjusting and surfacing it. During the wax modelling process, he would also use models mounted on the articulator, with silicone keys representing the volume of the appliance to ensure that the framework had a good homothetic reduction. Nowadays, with CAM/CAD, it is essential to scan the aesthetic assembly or the model of the appliance to allow for this homothety.

Scanning

Scanning entails acquiring digital data on the case. In other words, it is the stage that will make it possible to transpose the physical case (models on the articulator) into a virtual case (computer screen). For the sealed mandibular framework, scanning performed at the laboratory, using Dental Wings, a leading provider of digital dentistry technologies.

A recent accessory enables the different models (maxillary and mandibular with and without guiding assemblies) to be scanned easily and reliably and to depict them on the screen with the same occlusal relationship as that determined by the articulator. It is the kit calibration for the Dental Wings scanner and a certain number of articulator brands. For the machined maxillary framework which requires even more accuracy, it is performed at Simeda (Anthogyr CAD/CAM solution).

Modelling

Once the scanning stages are completed, the modelling or design stages can be started: marking the boundaries, choosing the sealing spaces and the design. The frameworks are created on the basis of the master assembly volumes (green transparent (Fig. 2) and blue transparent (Fig. 3)). The laboratory technician uses the software to select the homothetic shrinkage parameters for the assemblies.

As it is not possible to adapt the software to each specific case, the final changes must be made to each item (Fig. 4). Lastly, connectors must be designed. In order to obtain good rigidity, which is essential in implantology, they must be modelled to obtain a tupe of girder, which is passed from one element to another with the same diameter and height (Fig. 5).

Manufacturing

The Dental Wings scanner is a so-called 'open' system, which means that the user can freely choose the company that is going to manufacture the framework. For Cr-Co frameworks by laser microfusion, we use the approved production centre Bego, Advanced Dental Factory in Montpellier. They are in fact equipped with a machine from EOS, the

Fig. 13: General overview of the mandibular framework.
Fig. 14: General overview of the maxillary framework.
Fig. 15: Both frameworks in place on the articulator.

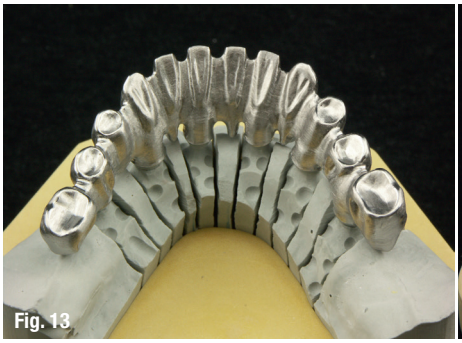


Fig. 13

Fig. 14

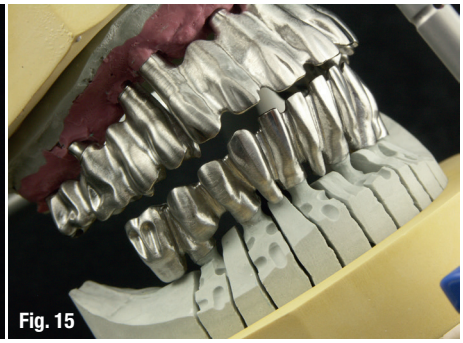


Fig. 15

Fig. 16

Fig. 17

Fig. 18

leading expert in laser microfusion. They use the entire Bego patented process and Bego know-how to manufacture these frameworks with Wirobond + alloy. We are very satisfied with this partnership, which remains the best performing microfusion solution. Advanced Dental Factory, as well as the Bego France production centre, which opened in 2013 in Lyon, are the only entities that offer this satisfactory combination.

The principle involves depositing a fine layer of alloy powder and passing a laser beam over the desired location to make the metal particles melt, thereby binding them together. This is repeated many times until the required volume is obtained (Fig. 6 and 7). The fineness of the powder and the accuracy of the laser, make it possible to achieve excellent fits (Fig. 8).

It should, however, be remembered that such results are not obtainable from all microfusion machines and they must also be operated properly. They are very temperamental manufacturing tools—calibration and maintenance are very important for obtaining a perfect copy of the file.

For Cr-Co machined and trans-screwed frameworks, the files are sent to the company at Simeda, the Anthogyr CAD/CAM solution, based in Mersch, Luxembourg. Even if they are partners of Anthogyr, they are able to machine for several other implant brands. The accuracy and density of their parts are perfect (Figs. 9 & 10). In order to check, simply use the Sheffield passivity test.

The Sheffield passivity test

It is a simple and efficient way of checking the passivity and adjustment of our implanted frameworks. This test involves attaching the prosthesis to the first analogue with a single fastening screw. It is then necessary to ensure that the framework does not have gaps on any the analogues. The process is then repeated for the second analogue and so on until the last one. If the framework is adjusted at each stage, it is because it is perfectly passive. In order to check whether the framework will facilitate adherence to the lengths and projections of the master assemblies, it is necessary for example to take an indentation key on the free rims of the maxillary assembly and to position the work model with the corresponding positioned framework (Figs. 11 & 12). This makes it possible to visualise the quantity of space left for embellishment, as well as the support given to the latter by the framework.

The cost of a microfusion framework is six times less than the cost of machining a trans-screwed framework. This is justified in various ways. Firstly, in terms of manufacturing: with machining there is considerable loss of raw material. The drills used wear out quickly and are expensive. With microfusion, there is very little loss of Cr-Co. Secondly, a part that must be perfectly adapted to an implant is more complex than a simple mounting. Lastly, the cost of the standard or customised implant pillars, which support the framework of the micro fusion framework, must not be forgotten. The sealed technique is more aesthetic as there are no access wells with visible screws

Fig. 16: Finished restoration on the model.
Figs. 17 & 18: Finished restoration—details.

Fig. 19: Finished restoration —view of the screwing channel on the intrados side.
Fig. 20: Finished restoration —details of the mandibular bridge.
Fig. 21: Finished restoration —lingual view.

Fig. 19

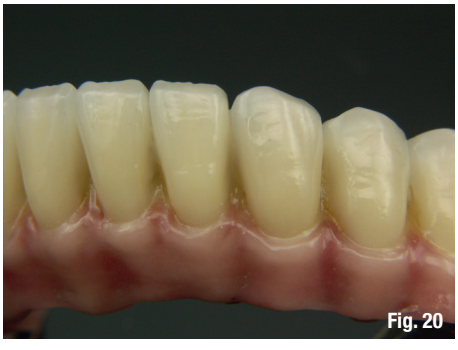


Fig. 20

Fig. 21

Fig. 22: Finished restoration —occlusal view.
Figs. 23–25: Finished restoration in patient's mouth.

(Fig. 13). It is also more comfortable. In fact, at the design stage of the implant pillars, the technician can suitably adjust their shapes in line with the future prosthesis. This then facilitates the production of ceramic crowns with the ideal shape. With trans-screwed prostheses (Figs. 14 & 15), there is less room for manoeuvre, which leads us to make more voluminous teeth in some cases. Pieces are more likely to break off ceramic crowns if the screwing channels are slightly off centre from the middle of the occlusal table. In fact, the solidity of a ceramic crown is dependent on its width and the support it derives from the framework. This is sometimes lacking in fine areas which extend the screwing channels. This is why it is recommended, if aesthetics permit, to make these areas fully metallic rather than to cover them with a fine ceramic layer. Trans-screwed prostheses, on the other hand, have the advantage of being easy to dismantle. They can therefore be easily cleaned to prevent peri-implantitis.

Finishing and polishing of ceramics

If the maxillary implant validation key has been created in advance, the occlusion is reliable and the aesthetic mountings have been validated, it is certainly possible to limit the number of dental appointments and mount the cosmetic material directly following the manufacture of the frameworks. The projections and lengths of the teeth are compared with the aesthetic assemblies once again. However, the ceramic material is not polished in order to allow the technician to make the final aesthetic adjustments (Figs. 16-25).

Conclusion

The laboratory has been equipped with CAD for more than 6 years now, which gives us a good grasp of the technology. This transition was smooth but not without problems. In fact, at the time the software did not function so well and a number of things were not as easy to perform as they are today. What is fascinating is the continuing developments. After the laboratories, the dental practices now need to discover digital tools. Work techniques will consequently continue to develop. It is important not to lose sight of what is fundamental to both our professions and to obtain, thanks to CAD/CAM, even better results, which are more practical, more rapid and, above all, more predictable.

Acknowledgement

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