

Fixed Dentures

Involving Prosthetic Reconstruction of the Periodontium

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Implantology has opened the door to a diversity of new and exciting, but complex fields in dental technology. Just a few years ago, our primary aim was to accurately restore the esthetic and functional anatomy of the teeth. With the advent of modern implantology, there has been accelerated growth in the demand for implant-born prostheses. Most of these reconstructions of the hard and soft tissue are achieved with the help of metal-ceramic techniques. In many cases, this is the only way to achieve a 100% solution.

Key words: Fixed dentures, gingival ceramics, implant-based prosthodontics, metal ceramics

The periodontium is a functional system comprising the tissues that surround and support the teeth. Its structures include the gingivae, periodontal ligament, cementum, alveolar and supporting bone. The periodontium sustains all forces transferred by the teeth during mastication.

Introduction

When a patient loses his or her teeth, not only the crowns themselves have to be replaced, but the periodontium with all its hard and soft tissue components as well. In the implantology of fixed dentures, when such cases are referred to, I speak of a "prosthetic reconstruction of the periodontium" or "periodontal technique" for short.

Very often, we are confronted with implant prosthetic cases where conventional methods fail to help us achieve the desired functional and esthetic outcome. Some well-known examples of negative aspects include insufficient labial support or extremely long tooth forms. In this article, I would like to present the

technical aspects required to accomplish an accurate reconstruction of lost hard and soft tissue.

"You have to know the details before you can expand your horizon and understand the whole." These were the teachings of Klaus Mütterthies. Looking back now and bolstered by my own experience, I can only agree with him whole-heartedly. We dental technicians are always striving to study our natural model as closely as possible and to give the patient a prosthetic reconstruction that most closely resembles the original. Many dental technicians are knowledgeable enough to produce individual, age-related reconstructions on prepared teeth. Today, detailed knowledge about the design and structure of soft tissue is equally as essential.

The Prosthetic Reconstruction of Periodontal Tissue

The prosthetic reconstruction of periodontal tissue is nothing new to dental technicians. What have experienced prosthodontists who are well versed in mak-

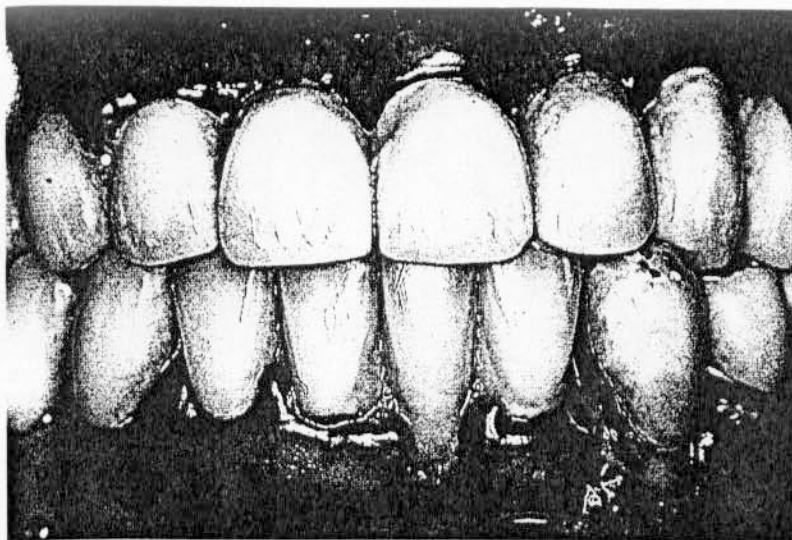


Fig. 1 This is how the 40-year-old patient presented to the dentist

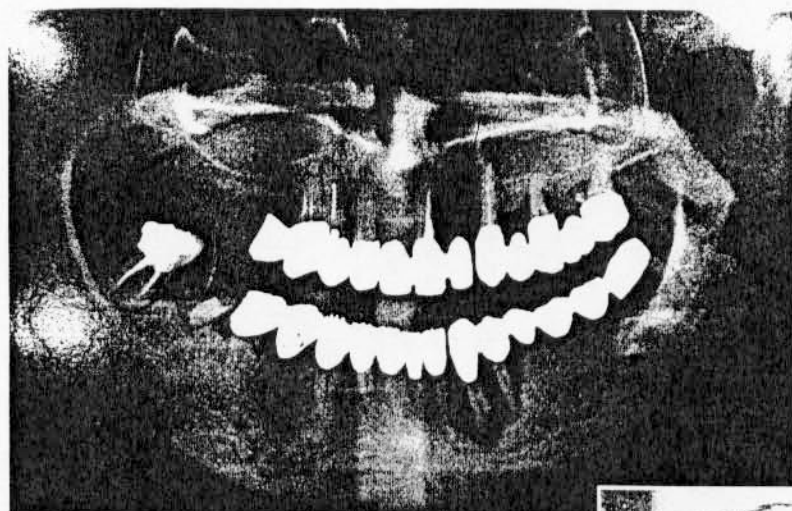


Fig. 2 The panoramic x-ray clearly illustrates the complexity of this case

Fig. 3
A diagnostic model for preparing the provisional prostheses. The aim: to restore the correct occlusal relationship and support the lips and cheeks

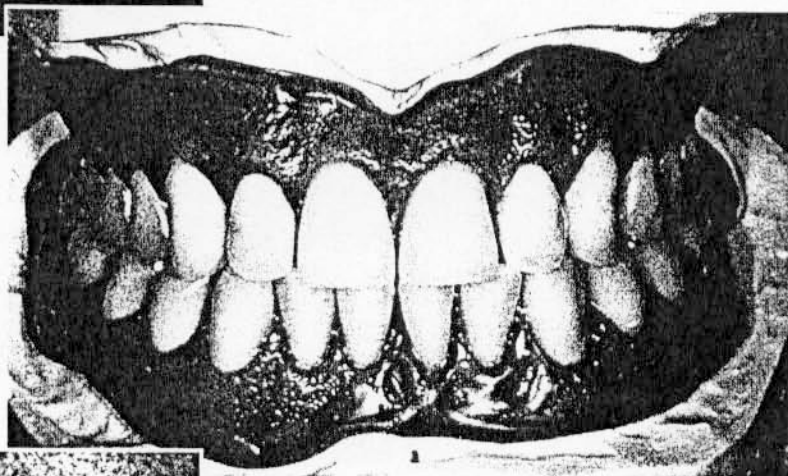
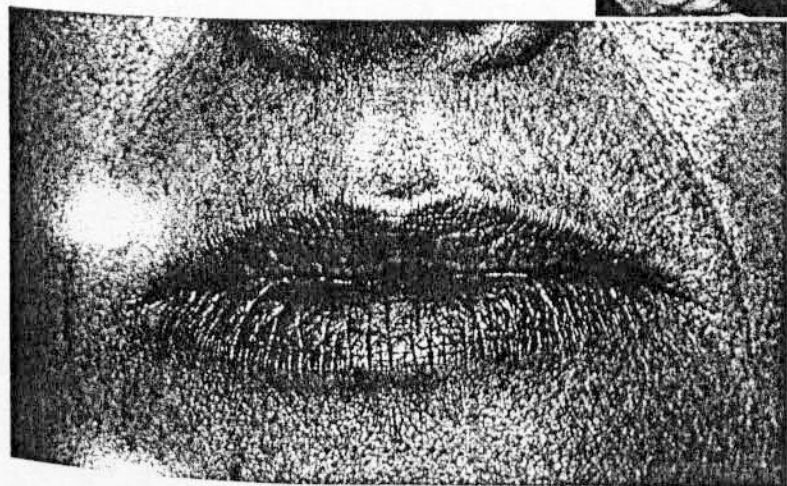


Fig. 4 The patient with the provisional prosthesis. You can see that she regained her natural appearance thanks to correct positioning of the teeth and supporting denture base



ing full dentures been teaching us for years? That the success of a complete dental prosthesis is mostly attributable to the design of its acrylic base. In the case of complete dentures, partially removable dentures, hybrid prostheses and overdentures, the reconstruction of non-dental tissue such as the alveolar process and the gingiva have always played a crucial role. Other very important aspects include the support for lips and cheeks the stability and maintenance functions provided by the pink tissues. When fabricating removable dentures, these structural aspects must be checked at regular intervals and, if required, they must be.

In the case of implant-retained dentures, different laws govern the static nature and stability of the restorations. That is why the materials and methods used for fixed reconstructions of non-dental structures will be different here. They are similar to ceramic-on-metal restorations and have less resemblance to the removable full denture. The subsequent case report will discuss and describe the technical procedure in detail.

Baseline Situation, Diagnostic Setup and Implantation

As you can judge based on the baseline situation illustrated in Figure 1, this 40-year-old patient pre-

sented to the dentist with a number of problems to be solved. The panoramic x-ray (Fig. 2) clearly illustrates the complexity of this case.

The teeth had to be extracted. We used a diagnostic model to prepare the provisional prostheses. The aim here was to restore the correct occlusal relationship and provide good support for the lips and cheeks (Fig. 3). The patient was thus able to regain her natural appearance thanks to the corrected positioning of the teeth and the support of the denture base (Fig. 4).

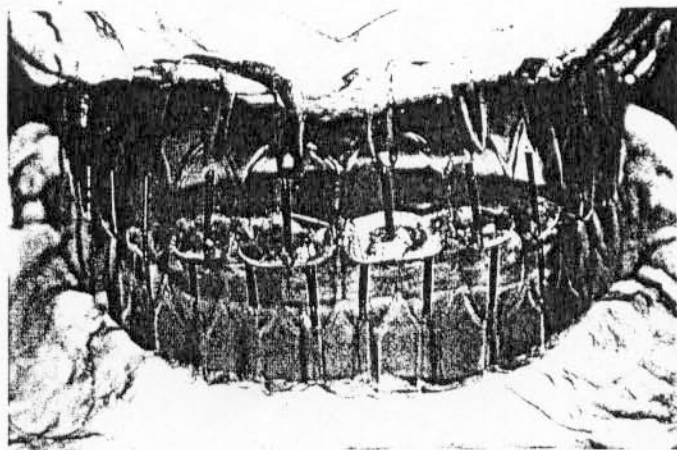


Fig. 5 and 6 Surgical stents and drilling templates guide the positioning of the implant fixtures

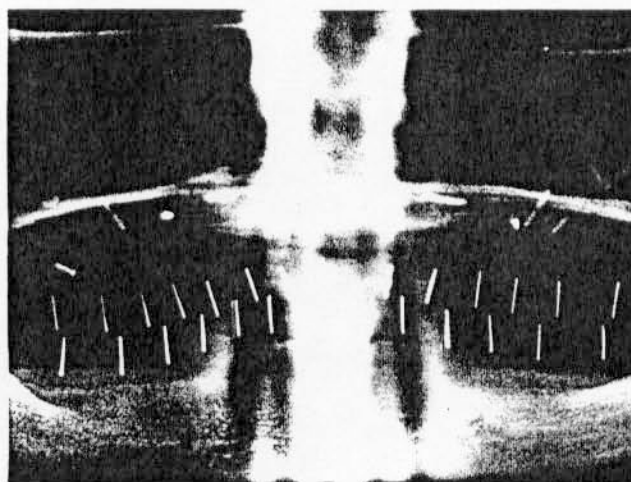
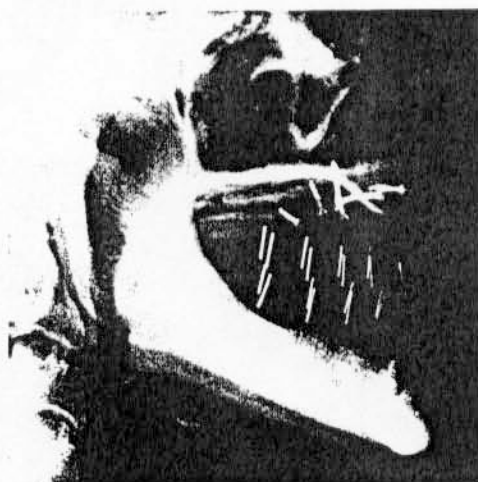
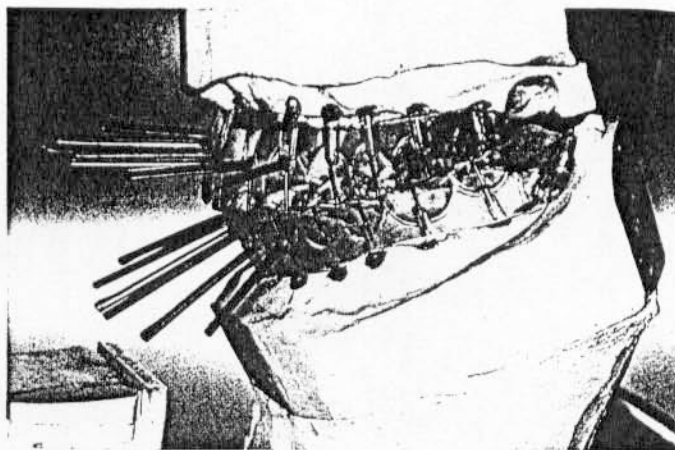


Fig. 7 and 8
The x-rays taken with the surgical guide templates in place. Note how the radiopaque pins mark the position of the individual teeth in relation to the bony ridge

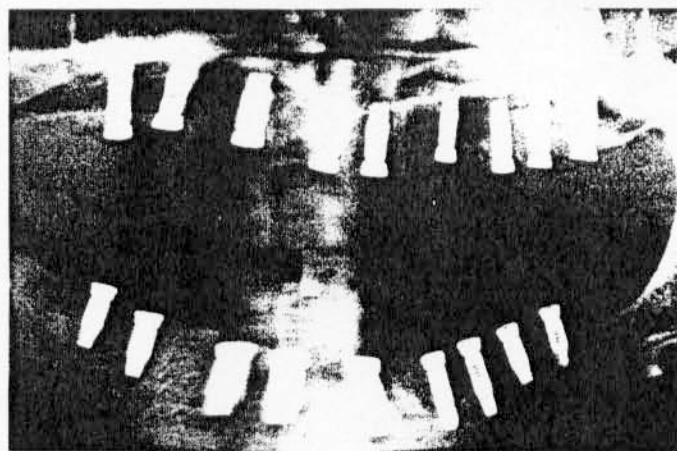


Fig. 9 The implants were positioned exactly according to the drilling template

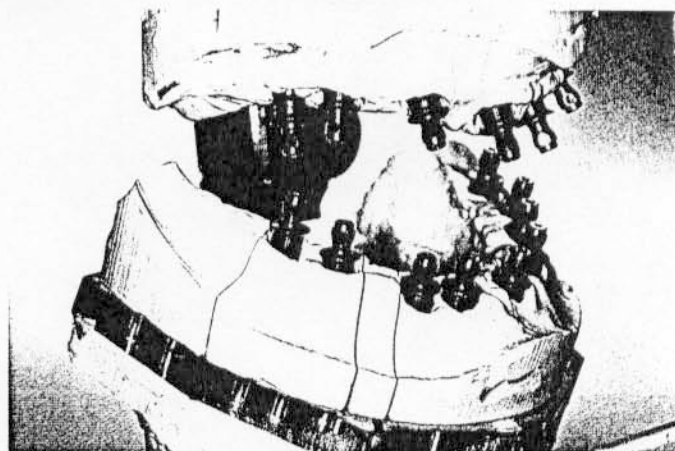


Fig. 10 Master casts mounted in the articulator

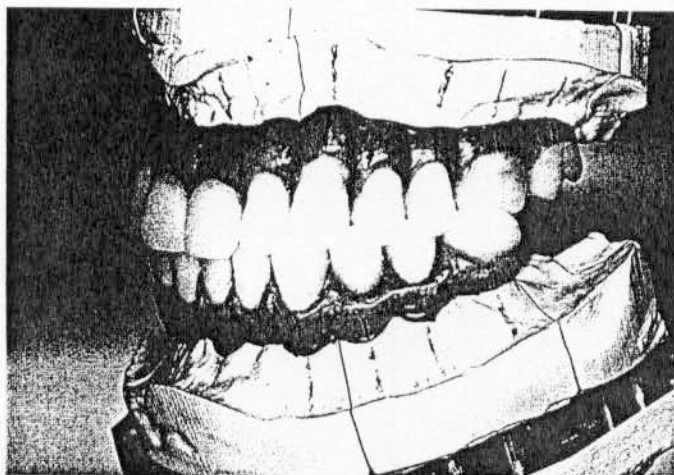
The plan was to restore this patient with an implant-retained fixed restoration. Therefore, surgical augmentation had to be carried out to improve the bone supply.

Surgical stents and drilling templates were made using our diagnostic mock-up and based on the pos-

itive esthetic and functional results achieved with the provisional denture. These were used to guide the positioning of the implant fixtures (Fig. 5 and 6).

The x-rays shown in Figures 7 and 8 were taken with the surgical guide templates. Note how the radiopaque pins mark the position of the individual

Fig. 11
Diagnostic wax-up was prepared to check the feasibility of a fixed reconstruction of teeth and gingiva



feasibility of a fixed reconstructive option chairside (Fig. 11). A clinical control of the diagnostic wax-up is made while in the patient's mouth (Fig. 12 and 13). This is very important to ensure that all previous steps have been checked: the accuracy of the impression, the precision of the models, occlusion and esthetics. The latter can continue to be modified until the patient is fully satisfied

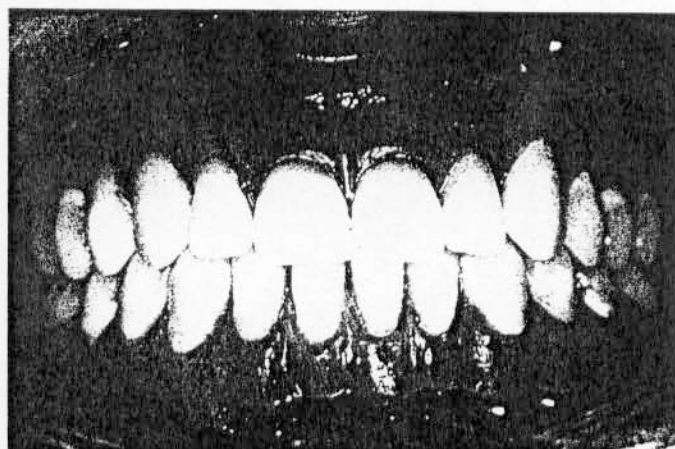
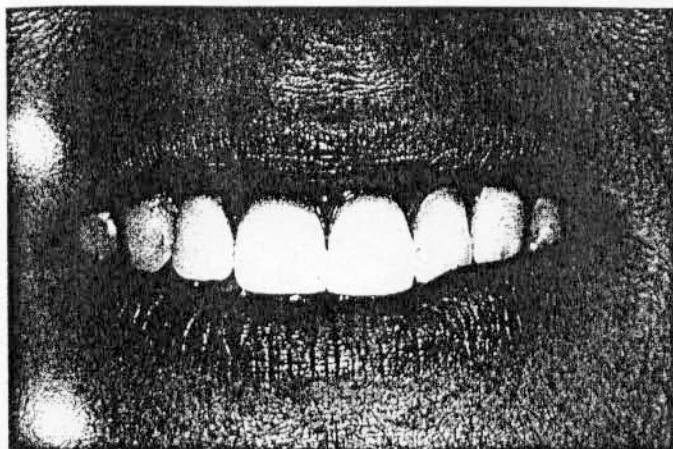
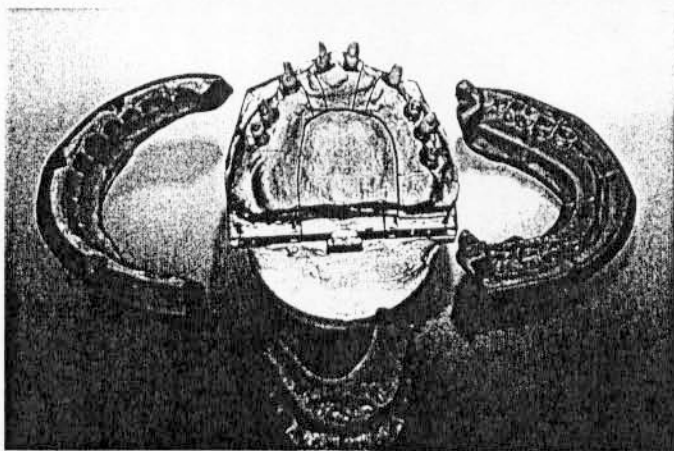


Fig. 12 and 13 A clinical control of the diagnostic wax-ups for occlusion, function and esthetics.

Fig. 14
The silicone key made from the diagnostic wax-up



Fabrication of the Mesostructure

The mesostructure or superstructure should be manufactured according to an exact protocol which follows the treatment plan and objective established to solve the specific case and agreed on by dentist, technician and patient.

The technique to be described in the following has one basic prerequisite: the mesostructure should be cast in one piece (monoblock). This method has been adapted from the technique of two of our

German colleagues Sonntag (Munich) and Valeriano (Turin).

teeth in relation to the dental ridge. It is clear to see that restoration of function means reconstruction of both teeth and gingiva.

The implants were positioned exactly according to the drilling template (Fig. 9). Such correct positioning allows us to maintain the biomechanical balance that is so essential to good implant prosthodontics.

Diagnostic Wax-Up

After taking the impressions, the master casts were fabricated and mounted in the articulator (Fig. 10). These models were used to prepare the diagnostic wax-up that allowed the dental team to check the

After the patient has worn the provisionals for between 40 to 60 days, a silicone key is made from the diagnostic wax-up on the master cast (Fig. 14). The labial, buccal and occlusal silicone keys permit the clinical situation created to be copied exactly. These keys are indispensable for waxing up and processing the mesostructure. Later, it is also used for layering the ceramic materials.

Now, using the silicone keys, we start adapting the castable gold cylinders (UCLA, 3i) (Fig. 15). They are bonded with an acrylic that burns out clean. The acrylic should be cured for at least 24 hours. Then we complete the final wax-up of the mesostructure (Fig. 16 and 17). The silicone keys are used to help perfect the work (Fig. 18 and 19).

Then the mesostructure is cast. It must provide reconstructive support for the

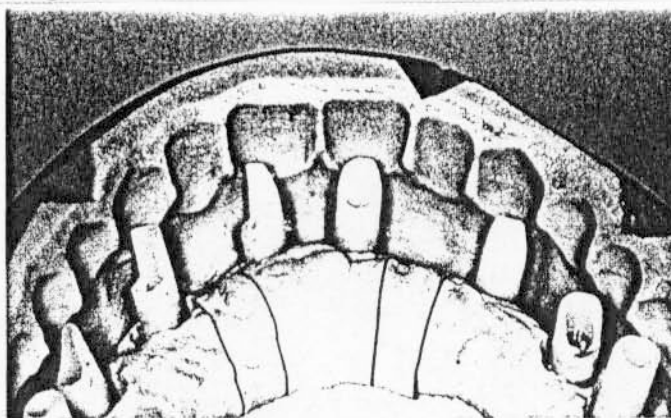


Fig. 15
Adapting the
castable gold
cylinders (UCLA,
3i)

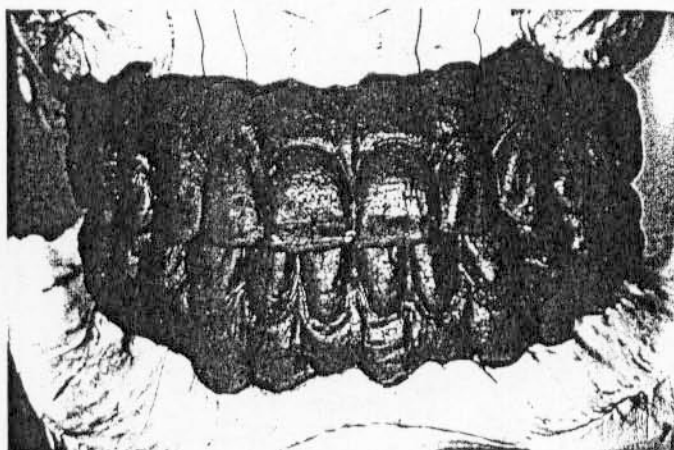
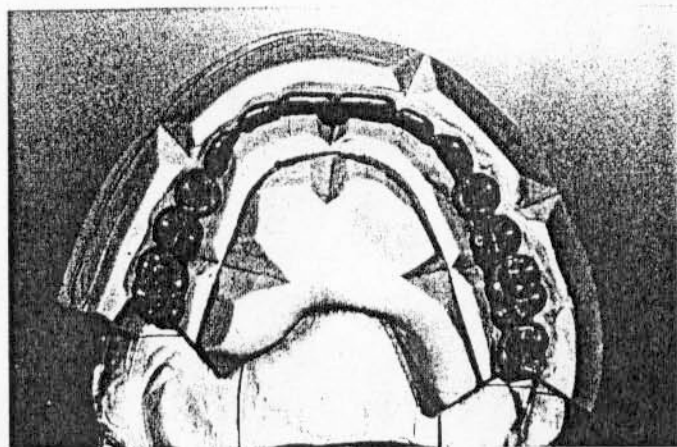


Fig. 16 and 17 Wax-up of the mesostructure before the cut-back

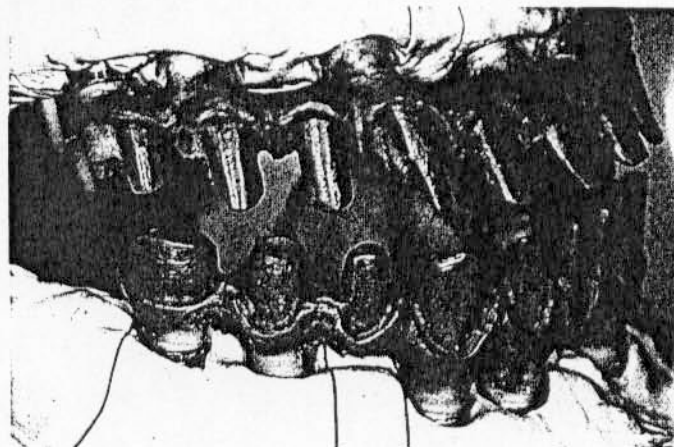
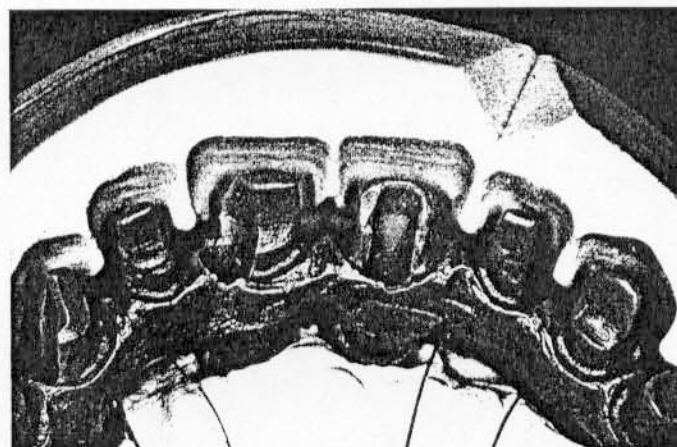


Fig. 18 and 19 The mesostructure is waxed according to the silicone key

prosthetic periodontium (gingiva) and the crowns. The result of casting is checked with the Sheffield test. This proves whether the seating on the abutments is stress-free. The test is performed by attaching the structure with one screw only. If the structure lifts up on the other side, it has failed the test. The procedure is carried out for each screw (Fig. 20 to 22).

Afterwards, the mesostructure is turned over to the treating dentist for try-in and to check the clinical acceptance (Fig. 23).

Layering Technique

Before we start with layering, we use the silicone key to check the amount of space we have available. In this article, we will not go into the layering of the crowns, but instead will deal with recreating the gingival structures with ceramic. In general, it is important to pay attention to the cast-on gold cylinders during the ceramic firings. Always make sure that their seating is not impaired in any way. If this is not the case, the long-term success of the restoration cannot be guaranteed.

Fig. 20 and 21
Details under the stereomicroscope. The fit of the cast gold cylinders must be scrutinized very closely. Every single implant must be checked as well as the overall seating of the implant (Sheffield test)

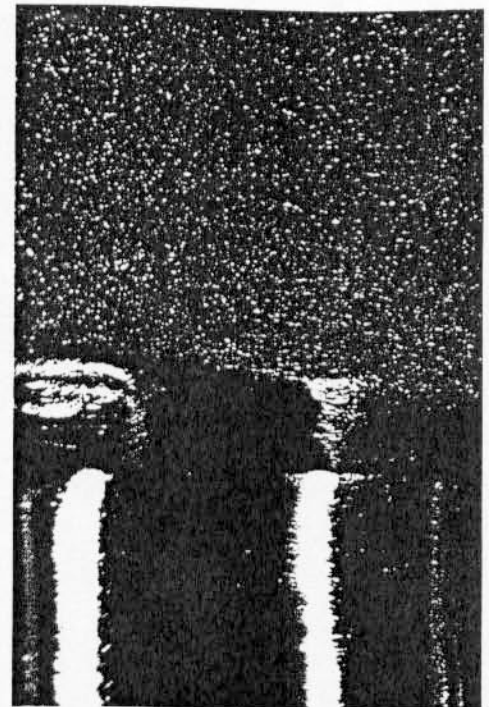
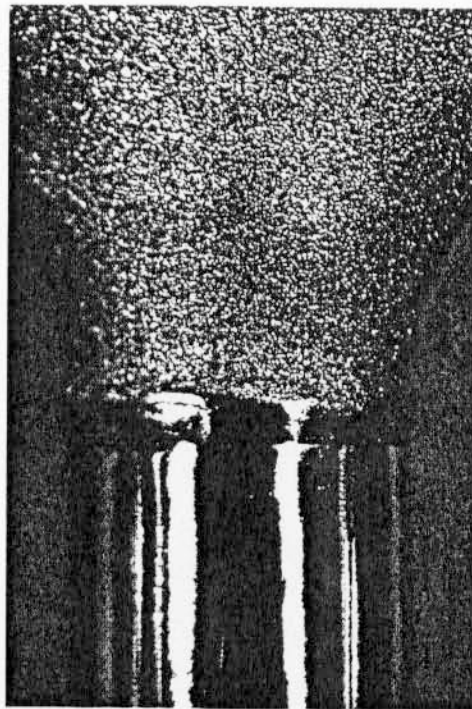


Fig. 22
The implants are exactly positioned

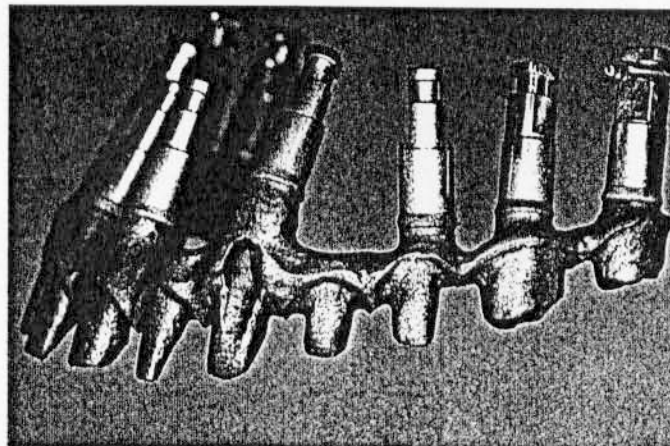
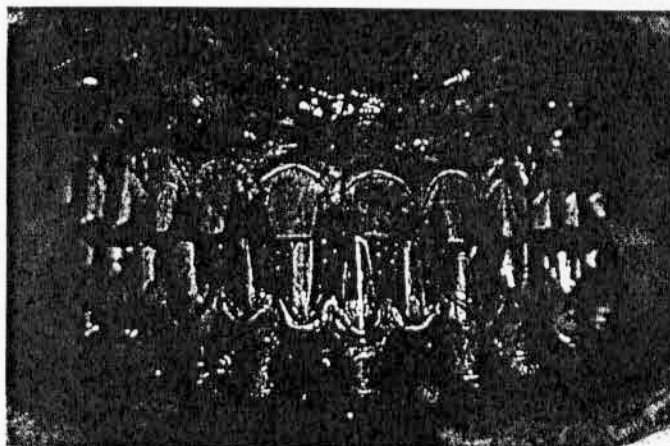


Fig. 23
In situ screw retained mesostructure looked like this



Ceramic reconstruction of the gingiva - General principles and application of the opaquer: The same principles that apply to ceramic crowns apply to ceramic gingiva. Two major aspects should never be neglected:

□ *Functional aspect.* Reconstructions of the gingiva are an integral part of the surface membrane of the oral cavity and must firstly be fabricated in such a way that the aspects of taste sensation and hygiene are taken into account. Secondly, they contribute to the proper support of the lips and cheeks.

□ *Esthetic aspect.* The esthetic reconstruction of non-dental structures is still a subject that does not receive much attention these days. Only a limited number of authors has written specifically about this topic. In this context, I would like to remind my readers that the consummate restoration that unites function with esthetics can only work if all of the gears in the dental "machinery" work in perfect harmony. If we want to avoid unesthetic, extended tooth forms and reproduce the gingiva with a natural looking appearance, then we have to devote some time to more closely studying gingiva as nature created it.

We ensure the function of our restorations by means of our methodology which involves the use of study models, diagnostic wax-ups, provisional, esthetic and phonetic try-ins, occlusal and labial-lingual silicone keys etc.

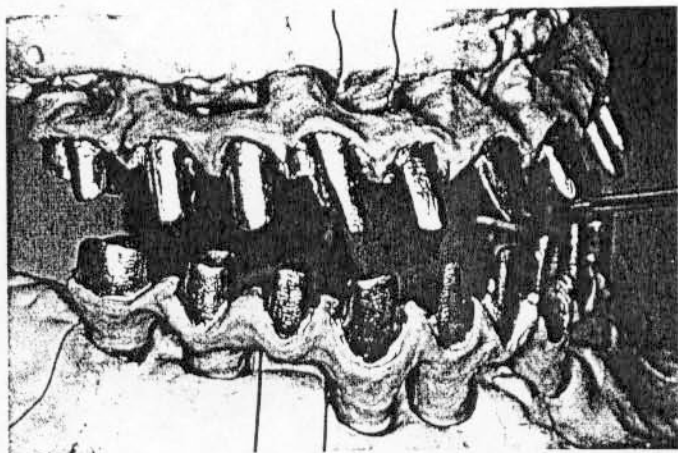


Fig. 24 The result of the clinical try-in was positive, now opaquer can be applied to the mesostructure

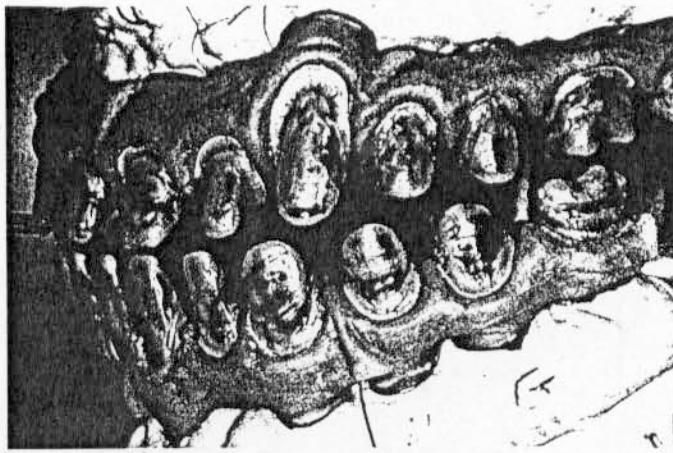


Fig. 25 The result of the first gingival firing and waxing of the copings for the crowns

These measures help us achieve proper support for crowns, lips and cheeks while creating a uniformity of white and pink tissue in form and color. It goes without saying that this type of restoration merges the boundaries between function and esthetics.

The metal is treated the same way as conventional ceramic on metal. The button is removed and the framework processed. After try-in on the patient, the

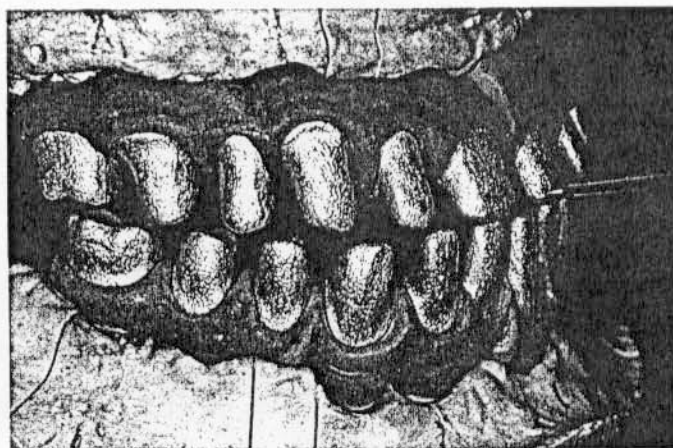


Fig. 26
The cast copings were coated with a gold-ceramic bonder.

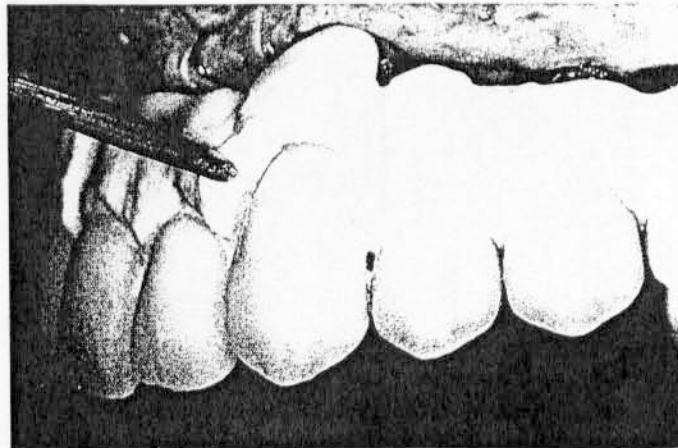


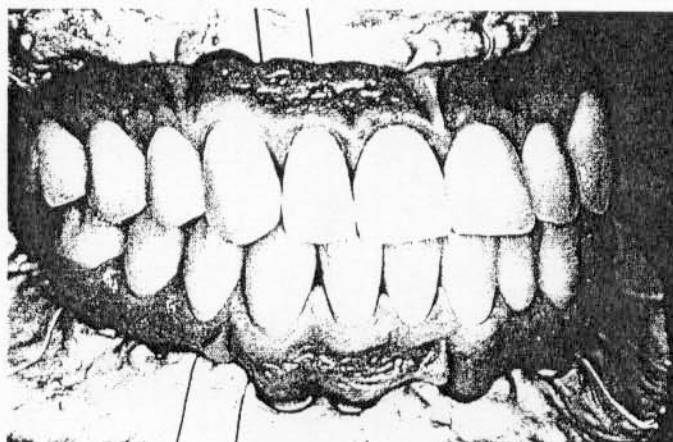
Fig. 27 and 28 Layering the gingiva. Once the definitive form of the crowns is complete exact tissue contouring can begin. Special attention is paid to the interdental papillae and the sulcus. This will enable correct insertion and cementing of the ceramic-to-metal crowns

prosthetic reconstruction phases begin: oxidation, blasting, processing of 1st and 2nd opaquer firing, 1st and 2nd dentin firing, glaze firing and mechanical polishing.

We start by applying the opaquer (Fig. 24). To enhance the natural effect, we customize with a sec-

ond opaquer layer. The zones belonging to the attached gingiva are distinguished by a reddish-brown intensive shade. The shade intensity of the unattached interdental gingiva is kept low in order to create depth. The gingival margins and the zones belonging to dental sulcus will be customized with light-pink opaque material. These are the areas

Fig. 29
The crowns and
gingival structure
after final firing
and ready for
try-in



where we want to imitate the gingival fiber bundles. They have a whitish transparent color because they consist of collagen tissue.

The first firing for ceramic reconstruction of the gingiva: Many companies market special products for layering gingival arches. I believe that these materials can be further improved by refining one's own technique and by adapting them to the requirements at hand. At the moment, the biggest and most troublesome problem is the low color value and the fact that the materials produce a purple chroma even though they are adjusted to a red shade. But since necessity is the mother of invention, we are often able to overcome such difficulties with a little imagination. After establishing the limits of the available materials, I set out on a personal trek to find all gingival materials on the market and modify them using traditional dentin and enamel materials. As a result, I now mix according to the following proportions: 2/5 dark gingival material, 1/5 dentin material (shade B1/B2), 1/5 light transparent material and 1/5 opalescent material. This mixture enables me to produce the results you see in the Figures (Fig. 36-42, 48 and 49). If the manufacturers are sensitive to the problem and our other colleagues made aware of these facts, in whatever way possible, we can surely improve these results.

Custom mixing of the materials becomes even more important when we turn our eyes to the tissue margins and interdental papillae. Gingival fibers and periodontal ligaments give healthy gingiva its pink opalescent color. This is because the dental alveolar collagen bundles are naturally lighter due to their low blood circulation. Therefore, in these areas we use a mixture of 2/5 light pink gingival material, 1/5 fluorescent dentin materials, 1/5 pink transparent gingival material and 1/5 transparent, opalescent material.

The exact way the materials are combined depends on the individual case and is determined by the need to achieve a life-like result. A perfect match with the healthy periodontal structures has not been possible so far. One reason is that there is not a perfect red shade on the market and another reason is that this perfect color cannot be produced in the laboratory because a primary color is involved (red, blue, yellow). Thus, we are forced to work with complimentary colors (purple, brown, orange and other non-primary shades). This invariably leads to a reduction in the chroma-related value

(according to Munsell).

Reconstruction of the crowns with metal ceramic.

After the first gingival firing I wax up (Fig. 25) and cast (Fig. 26) the crowns with the help of the silicone key. I do not want to spend a lot of time on the fabrication of metal ceramic crowns. However, I would like to say that the metal framework should be coated with a gold-ceramic bonder. Thanks to its color, this will have a positive effect on the esthetics. This is the only way I can avoid having the gray shadow of the metal structure shine through to the surface of the ceramic and reduce the value of the color. The crowns are brought to their final shape.

The second firing for ceramic reconstruction of the gingiva: Completion of the crowns enables me to carry out a targeted firing of the gingival structures (Fig. 27 and 28). This applies equally to the correct positioning of the gingival parameters and to the correct placement of the anatomical structures:

- ☐ Extension of the attached gingiva
- ☐ Positioning of the interdental papilla
- ☐ Extension of the free gingival margin
- ☐ Creation of sulcus areas that are suitable for accommodating the metal ceramic crowns
- ☐ Creation of lip and cheek attachments.

Today, we are able to accurately simulate healthy pigmented gingiva. For the reasons mentioned above (lack of materials on the market), we can simulate young, healthy gingiva in all anatomical areas except for in the attached gingiva zone (Fig. 29).

Try-in in situ

The reconstruction is now turned over to the dentist so that he can try it in on the patient (Fig. 30-33). If the work has been fabricated using a mesostructure as in this case, we have the advantage of being able to evaluate the different elements in isolation:

Fig. 30
Occlusal anterior close-up of
the screw retained mesostruc-
ture during the clinical try-in.
The screw access holes are
closed with inlays which also
serve as rotation protection
for the implant screws.

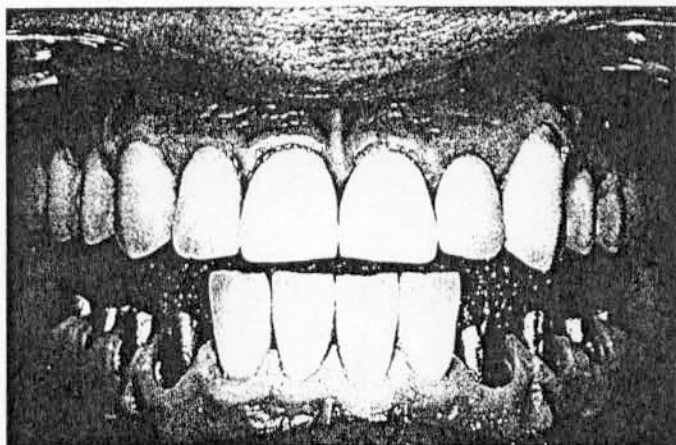


Fig. 31 Since the dentist can check the different parts of the prosthesis individually, the clinical try-in produces more accurate results. This applies to the implant elements (Sheffield test) and the crowns. Each element is tested for anterior tooth guided occlusion, cuspid guidance and occlusion: tooth-by-tooth

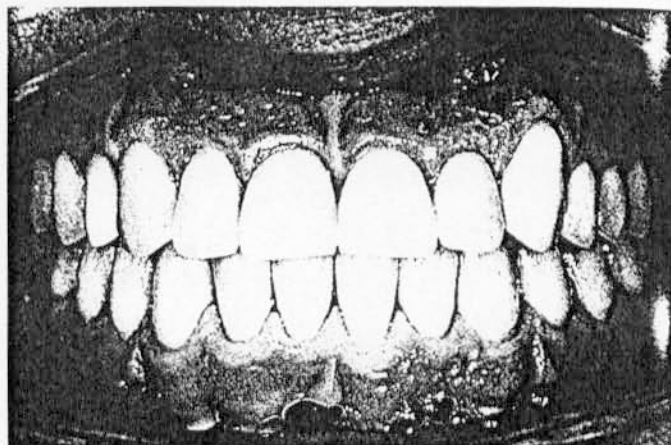


Fig. 32 The clinical try-in confirms the results obtained in the lab

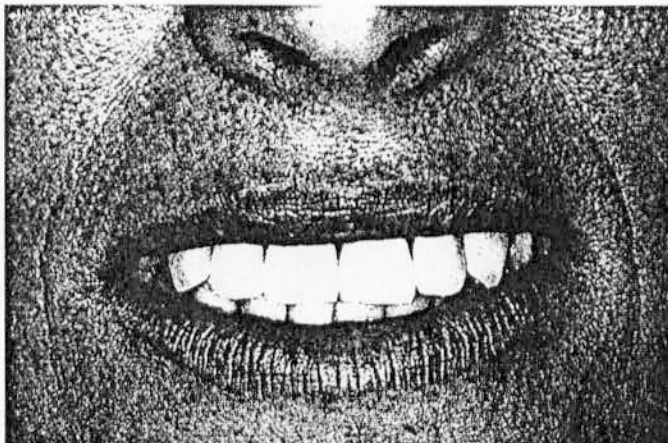


Fig. 33
Thanks to the pro-
visional-based
analysis and the
diagnostic wax-up,
there were no sur-
prises. The lips
and cheeks are
supported
correctly

- Area of the periodontium: a) clinical Sheffield test, b) hygiene test with the interdental brush, c) functional and esthetic check (lips, cheeks)
- Teeth: tooth-by-tooth occlusion test

Such a construction allows us to correct the individual areas with great precision and calm (Fig. 30 to 33).

The Finishing Touches

If necessary, we can still add minor finishing touches or characterize the effects during the glaze firings. Just as with metal ceramic, these measures tend to lower the color value of the ceramic, something we want to avoid at all costs. After the glaze firing, the gingival areas and the crowns are mechanically polished with diamond felt wheels (Fig. 34 to 41).

Fig. 34

After the in situ check, the work is completed. The figure shows how scrupulous attention to detail during the surgical and prosthetic phases enable us to produce high-quality work with regard to biomechanics (implant position and axis) and hygiene (form and surface contours).

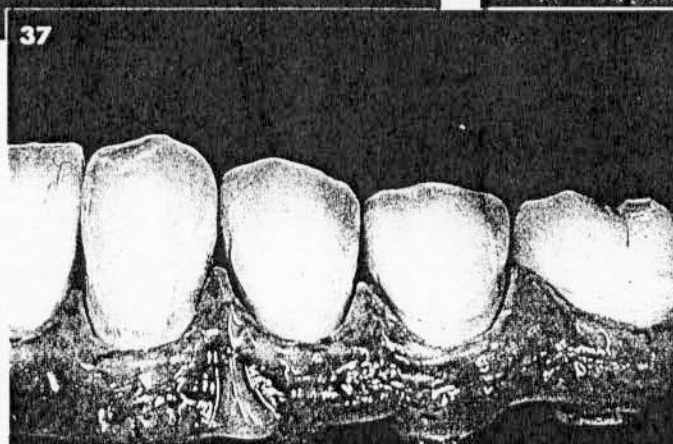
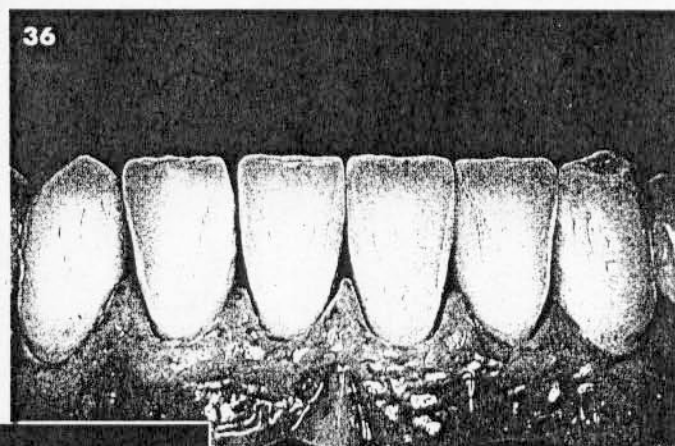
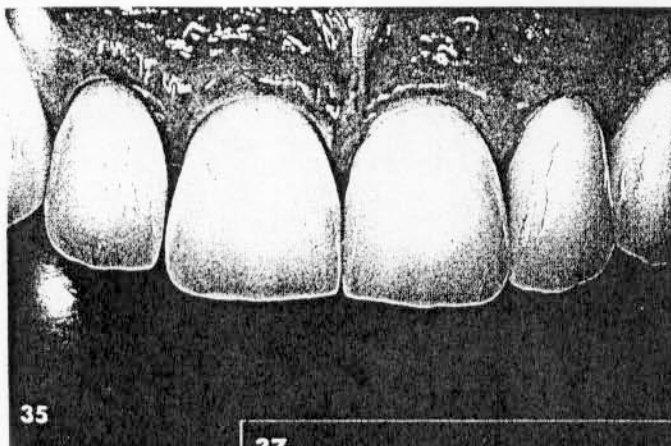
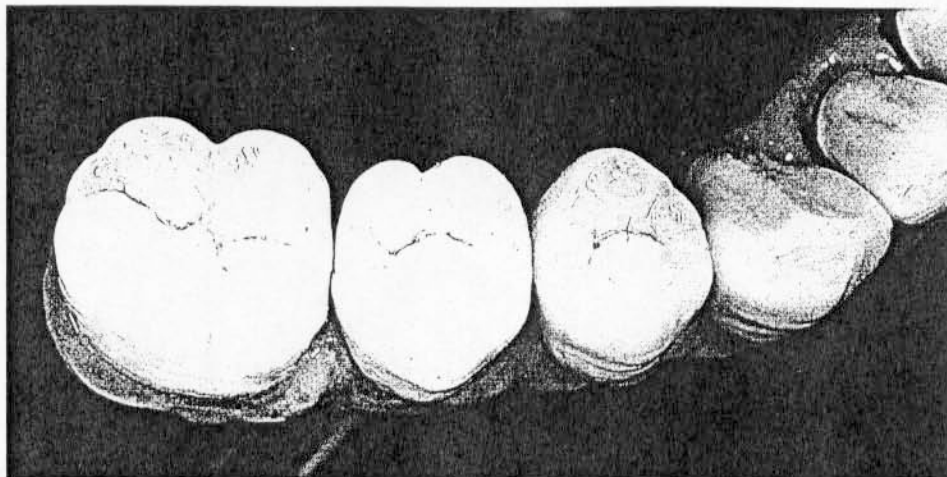


Fig. 35 to 37

Anterior and posterior details. The teeth and the gingiva are in harmony in both the maxilla and mandible. The proper layering of the gingival structures is just as visible as in the crown forms.

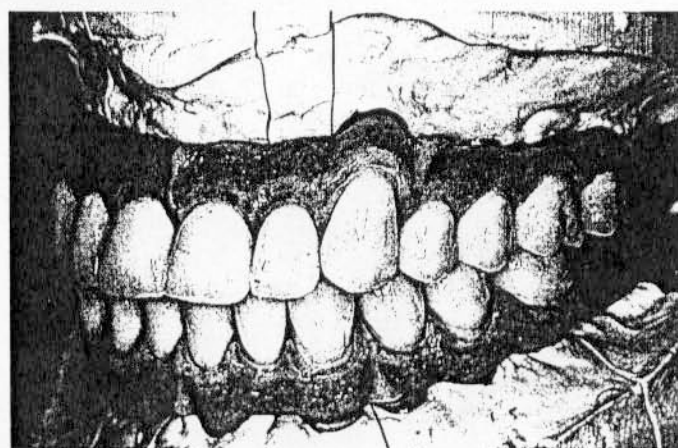
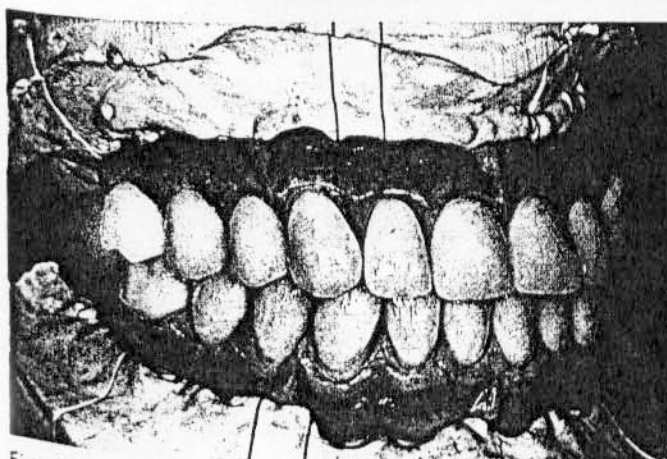


Fig. 38 and 39 Overall views of the finished reconstruction

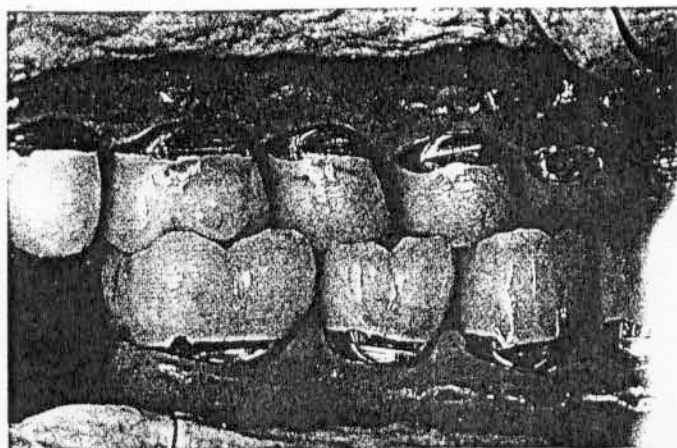


Fig. 40 Close-up of an occlusion check

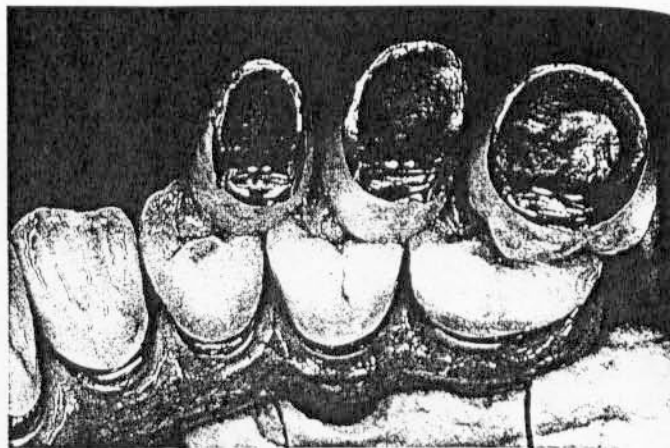


Fig. 41 The occlusal stability guarantees that the attached crowns are perfectly balanced (Celenza test)

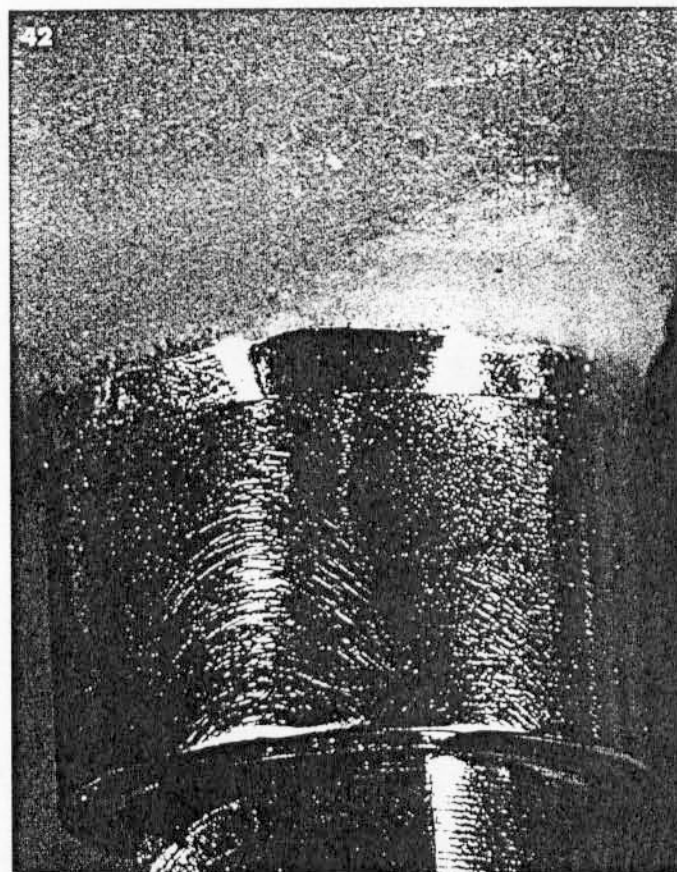
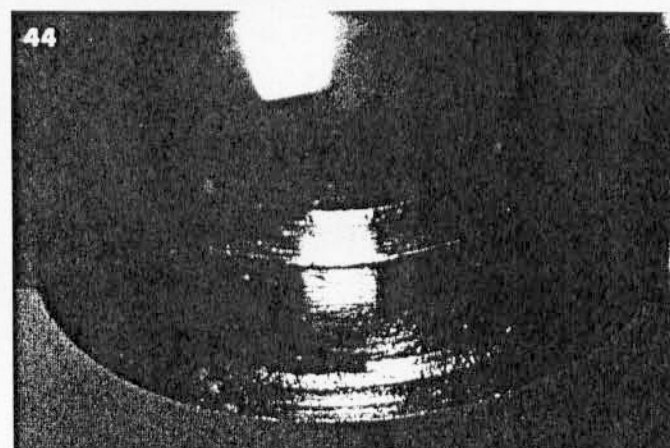
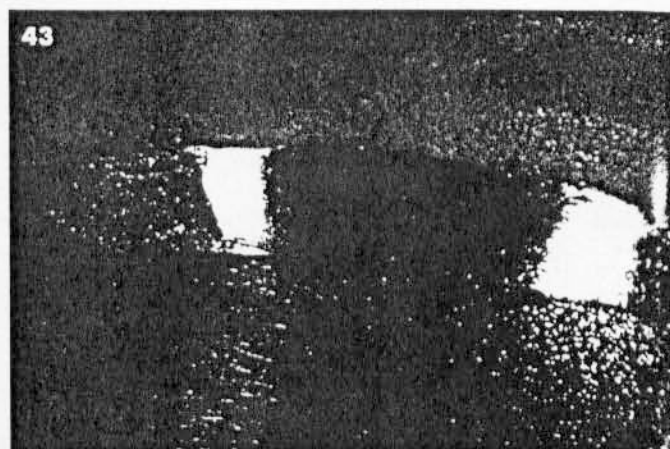


Fig. 42 to 44
Check of the UCLA gold cylinders (3i) under the stereomicroscope. No scratches or tracks should be seen.



Before the work is delivered, the visible metal parts are polished, paying the most attention to the gold cylinders. As long as the reconstruction is not complete, the UCLA gold cylinders (3i) should be protected from scratches and any minor abrasions. Otherwise, the quality of the marginal interfaces might be comprised (Fig. 42 to 44).

Result in situ

The mesostructure is now fastened to the implant fixtures and the screw holes closed with inlays. A final x-ray control is carried out (Fig. 45). Figure 46 shows a picture of the tissue frame without the metal ceramic crowns. In Figures 47 to 51, we see the details of the reconstruction – in, what we may now

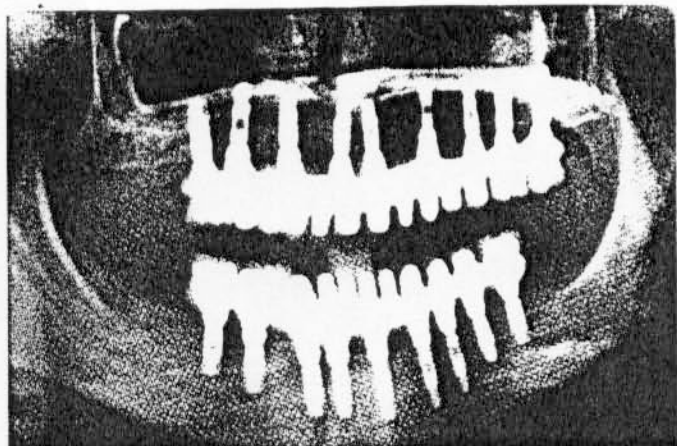


Fig. 45 The control x-ray is optimal

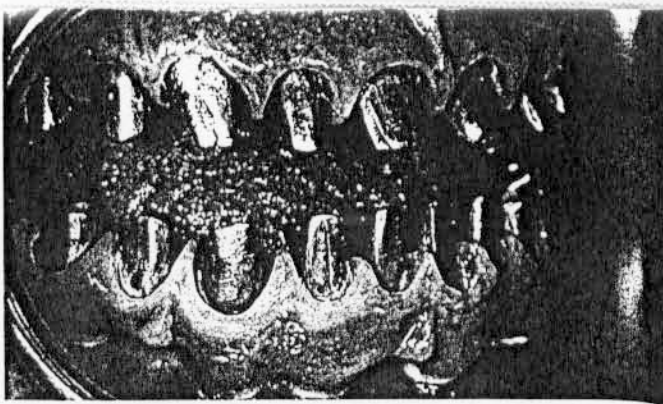


Fig. 46 In-situ result before attaching the ceramic-to-metal crowns

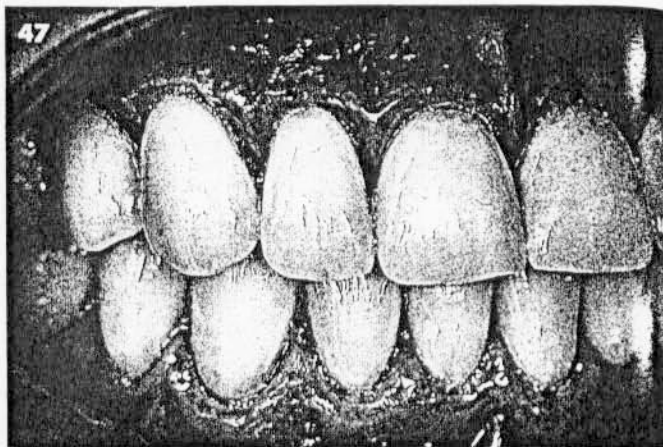
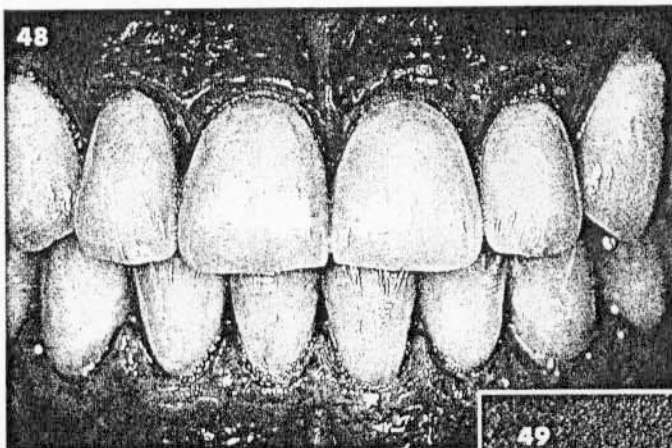


Fig. 47 to 51
Details of the restoration
in situ and in its entirety

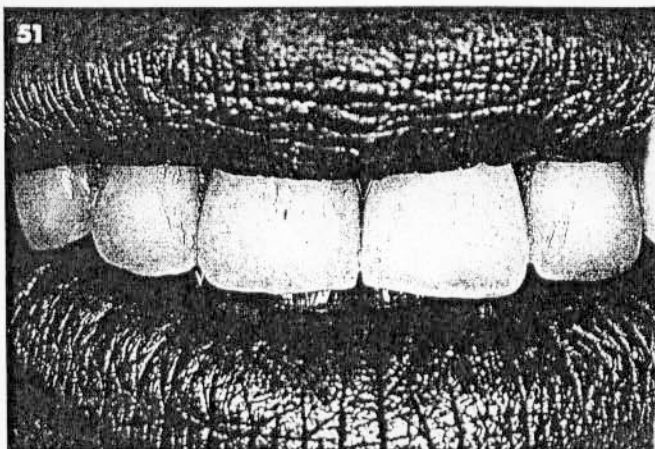
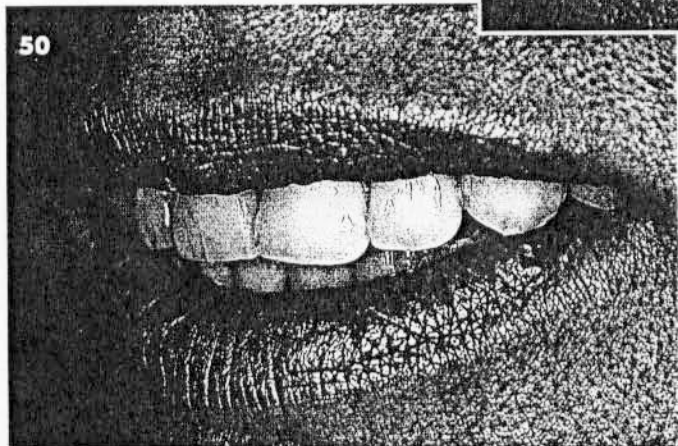
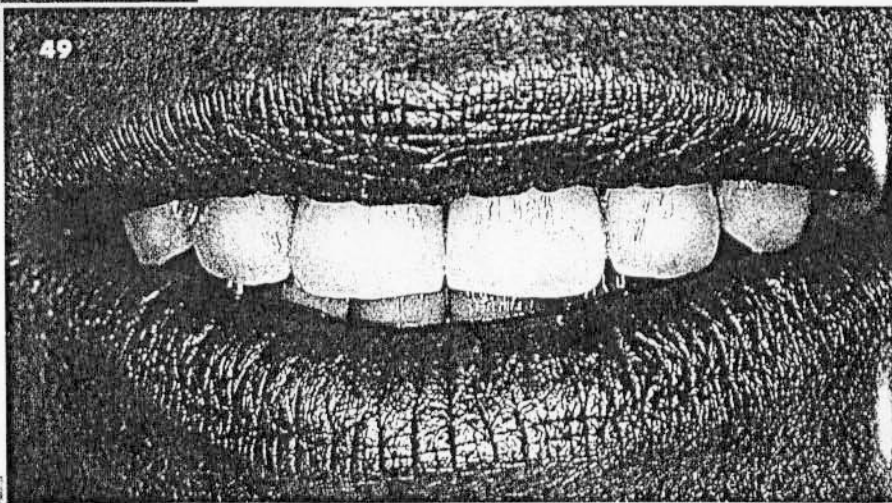




Fig. 52 to 54
Finally the day
has come. The
patient can
enjoy her fixed
restoration. It
looks esthetic
and is functional
despite the large
extension.



call, its entirety. A harmonious appearance and the self-assurance of not having neglected a single detail are the rewards earned by the dental team and the patient (Fig. 52 to 54).

Conclusion

In this article I reported on the state-of-the art in a field that has received too little attention to date. I have illustrated one possible way of restoring the gingiva and the teeth. The fact was stressed that it can be very helpful to separate the structures into their individual parts. This enables better control during layering with gingival and dental ceramic materials. By cementing the ceramic-to-metal crowns onto the mesostructure, we can create a functional shape of the occlusal surfaces without any screw access holes. This is a very timely topic that lends itself to discussion, suggestions and inspirations. In the hopes of being able to solve future cases even more effectively, feedback from colleagues, dentists and ceramic manufacturers would be greatly appreciated.

References available from the author.

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