



## Prosthetic Gingival Reconstruction in Fixed Partial Restorations. Part 3: Laboratory Procedures and Maintenance



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*[AU: No abstract was provided with your manuscript. One has been drafted for you. Please read carefully and modify as needed to ensure accuracy.]* Part 1 of the present series presented a rationale for including prosthetic gingiva in the planning of a fixed restoration to ensure an esthetic result for patients with severe horizontal and vertical ridge deficiencies. The second part of the series focused on the diagnostic and treatment planning aspects of the use of artificial gingiva. This third and final installment in the series focuses on the laboratory and clinical procedures involved in fabricating a prosthesis with artificial gingiva and provides information on proper maintenance of these restorations. (Int J Periodontics Restorative Dent 2010;30:xxx-xxx.)

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Prosthetic gingival restorations have historically been underutilized in partially edentulous patients. The initial attempts were aimed solely at masking the patient's existing tissue loss without showcasing the artificial gingiva of the restoration, owing to the obvious esthetic limitations of the prosthetic work executed. As was highlighted in the first two parts of this article series, when comprehensively understood and correctly planned, artificial gingival restorations can predictably reestablish harmonious anatomy to the lost gingival tissue, reproducing the color, contour, and texture of the patient's gumline.<sup>1-8</sup> The planning must be carried out by all members of the reconstructive team, including the surgeon, prosthodontist, and ceramist. Ideally, all team members involved in the process must understand the clinical and technical steps necessary to correctly reestablish esthetics and function in the patient's existing defect environment. This allows for equal participation in the decision-making process and provides the patient with all relevant treatment alternatives. Prosthetic gingival restoration requires additional theoretical and technical development on the part of

the treatment team, so that these restorations display harmony, balance, and continuity of form between the natural and artificial gingivae.<sup>9-12</sup> The integration of the color of natural tissue and artificial tissue must be planned so as to minimize the visibility of this junction, restore the dimensions of the gingival architecture, and replace papilla form.<sup>3,10,12</sup> The tissue loss that occurs in patients in whom prosthetic gingiva is indicated usually makes it very difficult to create an adequate dental arrangement and provide suitable anatomy of each tooth without using artificial gingivae.<sup>13</sup>

The ceramist must understand basic clinical principles of surgery and implant dentistry, the components of a smile, the classifications of alveolar osseous resorption, and the principles of pink esthetics such as contour, color, and texture. A training in three-dimensional visualizations and the search for lost anatomic references is paramount. Morphologic research of photos or old models, as well as of the existing teeth and gingival contours of adjacent areas that may have a similar standard of dental-gingival esthetics, is also required to try to determine as accurately as possible the theoretical "original position of the teeth and ridge."<sup>9</sup> This represents the union of the principles of a conventional fixed partial denture with the those of a denture that incorporates artificial gingiva.<sup>14</sup>

## Clinical and laboratory procedures

Part 2 of this series discussed the surgical planning and the ideal three-

dimensional implant positioning for a prosthetic gingival restoration. The present article will discuss the prosthetic procedures that are needed to achieve ideal esthetic and functional properties in a prosthetic gingival restoration.

### *Exposure and implant impression*

These procedures are identical to those for a conventional screw-retained implant restoration. The clinician must ensure that the impression precisely reproduces the soft tissue that will receive the artificial gingiva and pontic. If tissue conditioning will be performed with the provisional restoration, this profile must also be captured by the impression.

### *Dental-gingival provisional*

Provisionals are an important step in the process of planning a pink porcelain restoration.<sup>15</sup> This represents the second opportunity for the technician to test the restoration design (the first chance was the diagnostic wax-up). Ideally, gum conditioning and reshaping should be done during this phase, and any needed modifications should be communicated to the surgeon.

The provisional plays several roles in the treatment process (Figs 1 to 4). It is used to test the junction between the natural and artificial gingivae, to ensure that the gingival interface is hidden beyond the lip perimeter during maximum smile. Phonetics are tested with the provisional in place. The provisional will confirm the accuracy of the planned grafts and implant

placement and can be used as a blueprint for the definitive restoration. The dentist and patient can test hygiene procedures with the provisional in place to determine the ease of maintenance. The dentist can also use this opportunity to show the patient how this kind of restoration behaves and obtain patient approval before the definitive restoration is fabricated. Finally, the provisional can be used to condition the gingival tissue.

### **Gingival conditioning**

The plan for conditioning of the artificial gingiva begins at the diagnostic wax-up stage. It is begun at the moment of seating the provisional and the gingival profile can be refined when seating the definitive restoration, depending on the size of the necessary modifications. The gum conditioning procedures performed before the final impression will be reproduced on the working soft tissue model. If necessary, before fabricating the definitive restoration, the technician (with approval from the implant team) can reshape the soft tissue on the working model, trimming it ideally, so that the denture will have an ideal profile. This of course requires the dentist to reproduce this reshaping of the gingiva at the time of the final try-in of the denture.

The ridge under the pontics should be flat to allow a smooth transition between the natural and artificial gingivae and permit ideal hygiene in this area. A concave ridge for ovate pontics is not recommended because the intent in such patients is to create an illusion of continuity. An ovate pontic is therefore made to create the illusion of the crown emerging from inside the gum.

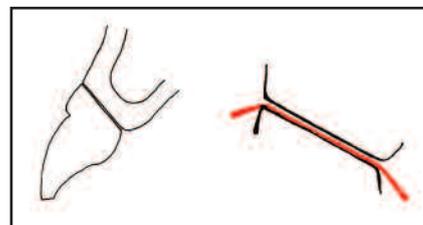
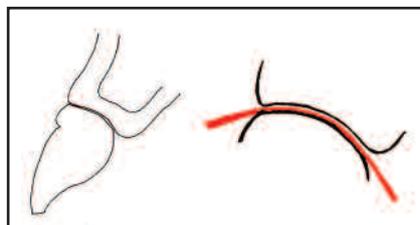
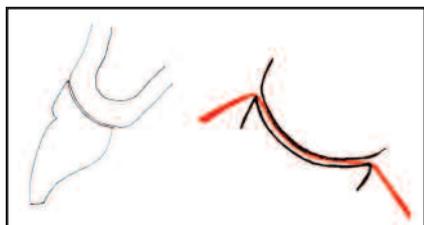


**Fig 1** (left) A silicone index is made over the diagnostic wax-up to generate the "white" aspect of the provisional restoration.

**Fig 2** (right) The provisional is placed into position and adjusted to the ideal shape before the "pink" is added. Then the gingival composite is added, reproducing the shape, shade, and texture of the missing tissue.



**Figs 3** (left) and **4** (right) The gingival composite is refined, polished, and glazed in the lab. Then the provisional is screwed back into position to serve as a "test drive" for the definitive restoration.



**Fig 5** Drawings highlighting the importance of gum conditioning and the pontic shape in esthetics and hygiene. **(left)** Nonhygienic ridge-lap pontic. The shape of the ridge generates a concave surface under the pontic. The floss is not able to touch the entire surface underneath the pontic. **(center)** Nonesthetic pontic. The illusion created by the ovate pontic is not the one desired in artificial gingiva restorations. **(right)** Hygienic and esthetic pontic. The flat shape of the ridge is a cleansable surface and produces an esthetic horizontal interface between natural and artificial gums.

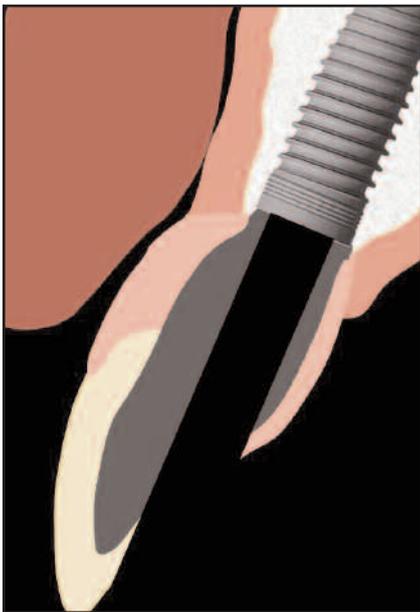
After the final adjustments are made to the pink ceramic in the mouth, the clinician can analyze the need for small modifications of the natural gum with diamond burs or a laser. At this point the dentist should also check the hygiene spots again, making sure that nothing needs to be changed (Fig 5).

### Artificial gingiva emergence profile

The emergence profile is very important in an artificial gingival restoration, because it differs substantially from conventional restorations. The technician must create artificial gingiva that reproduces the characteristics of the

lost tissue and hides the unesthetic aspects of the patient's mouth.

The goal is to produce a natural buccal contour that shifts, if possible, the transition of the gum apically and develops the profile of the artificial gum to resemble its appearance before the patient lost teeth (Fig 6). The artificial gum should emerge from the implant



**Fig 6** A seamless transition between artificial and natural gums is the goal to generate an esthetic and comfortable situation for the patient. The transition below the upper lip is important for support.

and create a sharp angle after crossing over the transmucosal area. This sharp angle will help blend the gap. [AU: which gap? Between the prosthetic teeth and the prosthetic gingiva? Please clarify.] After emerging from the sulcus, the artificial gum profile will move directly toward the artificial marginal gingiva and ceramic crown.

### *Planning the artificial papillae*

Artificial gingival restorations can have different kinds of papilla design. These variations should be planned initially with the diagnostic wax-up and should be further evaluated with the provisional. The papilla can be totally artificial when there is an absolute absence of a papilla between two crowns. It can be half natural and half artificial, when the papilla beside a crown is slightly resorbed. In this case, the emergence

profile of the restoration should be aimed at providing some pressure on the natural papilla, to push it toward the incisal, and at sharing the interproximal space with the artificial papilla and restoring the ideal volume of an esthetic papilla. Sometimes there is a need to fabricate a “floating” papilla. This is an artificial papilla that overlaps an adjacent natural tooth. These situations are more delicate to try in and adjust, as space for flossing must be retained but the gap must be obscured to create the illusion of a natural gingival margin.

### *Abutments and framework*

It is preferable to plan artificial gingival restoration cases as screw-retained. Intermediate angled abutments can be used that allow the framework to be screwed on over them (eg, Multiunit,



**Fig 7** (left) *Indexes are made over the model of the provisional to guide fabrication of the framework.*

**Fig 8** (right) *The framework with the wax crowns in position is placed in the mouth. Following the level of the natural papillae on the distal of the canines, the tips of the papillae are placed in wax. The harmony of the shapes among natural gingiva, artificial gingiva, and lips is checked.*



Nobel Biocare) if the implant positions are unsuitable for a screw-retained restoration over straight abutments. Whenever possible, it is easier to go directly over the head of the implant, which means having a narrower metal collar on the cervical area.

The fabrication will be executed on a working soft tissue model with artificial gingiva (rigid modifiable gingival mask). The framework is typically metal, but recent advancements in zirconia make this material another possibility.<sup>16</sup>

The connectors should be positioned more apically than usual, ie, shifted from the contact area toward the height of the papilla, such that the interproximal spaces are opened up for the development of correct anatomy and ceramic light transmission and shape (Fig 7). Otherwise, the framework should follow all the principles of a conventional fixed partial denture.

### *Second diagnostic wax-up and try-in (over the framework)*

This try-in enables the ceramist to visualize the planned restoration design in vivo. Verification of the general esthetic guidelines, the transition zone between the natural and artificial gums, labial support, the lip closure path, maxillo-mandibular relationships, vertical dimension, phonetics, and access for hygiene is done. After this step is accomplished, the ceramic buildup will be much more predictable.

This is the last chance to test the design and converse with the patient before proceeding to the definitive ceramic buildup. With this procedure, the clinician can test and explain to the patient that muscular repositioning may demand a period of neuromuscular adaptation, in proportion to the volume of bone loss and its capacity for adaptation. It is very effective to per-

form this over the definitive framework; this will highlight any remaining deficiencies (Fig 8).

Ideally, the laboratory technician will have performed at least one evaluation of the patient before fabricating the definitive ceramics. At the first diagnostic wax-up, the provisional restoration or wax-up is placed over the framework. After this evaluation, in the mouth or with digital photographs, the technician will have mentally developed an ideal design as he or she builds the ceramics. It is advisable at this stage to take some pictures for a dynamic evaluation of the patient smile with the prototype in place.

### *Ceramic buildup and try-in*

On the day the ceramist is finishing the ceramic buildup, a long appointment is typically required so that a few



**Figs 9 (left) and 10 (right)** Again, the silicone index is used to guide the ceramic buildup. The crowns are given their final shapes before the gingival material is added.



**Fig 11** The prosthesis is placed in the mouth to check the esthetics of the crowns. Shape and shade need to be completely finished before the composite gingiva is added. The denture should be glazed first, prepared for bonding, and placed in the mouth before the gingival composite is applied directly.

try-ins can be done at specific stages. The first try-in would be after the first ceramic bake (Fig 9), when the midline, overjet, overbite, and the basic tooth shades can be checked. The second stage would be after the final bake of the crowns but before the gingivae are added (Fig 10); tooth anatomy, vertical dimension, and interdental space are checked, as these are very important to enable the correct buildup of the papillae (Fig 11). The third stage of verification is done after the artificial gingivae are added. The dentist should check the overall esthetic look and perform occlusal and interproximal adjustments. The relationship between the natural and artificial gums can be adjusted, and esthetics and hygiene are always kept in mind.

The final touchup of the artificial gingiva is done with the denture in position in the mouth. With a fine diamond bur, the margin of the artificial gum should be trimmed to blend it

with the natural gum, with the shape and grooves of the natural tissue duplicated. The surface in contact with the gum should be highly glazed, polished, and free of concavities. A flat or ovoid surface is recommended for all areas in contact with the natural tissue.

### *The artificial gingiva*

The authors suggest currently that the gingival aspect of the restoration is best constructed with composite resin when possible (Figs 12 to 14). This material is the ideal choice for many reasons: (1) it preserves the physical properties of the porcelain-fused-to-metal restoration; (2) the shape, shade, and texture of the pink esthetic factors can be controlled; (3) repair and maintenance are facilitated; and (4) the results are predictable. Fabricating the gingiva with composite is also one of the main reasons for the denture to be

planned as screw retained; any kind of repair or even a complete replacement can be done in the future without interfering with the ceramic crowns.

In some situations, creation of the artificial gingiva with pink ceramics may be recommended:

- The restoration could not be planned as screw retained because of anatomic issues and angulation, so it needs to be permanently cemented.
- Restorations are planned over natural tooth abutments that will be permanently cemented.
- When the total amount of artificial gingiva required is very small, for example, a part of a papilla, it is simply easier to add the pink ceramic while building up the crowns.
- When the amount of artificial gingiva required is very large, taking the transition line to areas outside the esthetic zone, ceramic is recommended.



**Figs 12 and 13** The denture is prepared to receive the gingival composite. Areas of mechanical retention are created, and the areas that will not receive composite are protected to allow sandblasting, etching, and silanization before the first layer of pink composite is applied.



**Fig 14** The morphology of the gingiva is completed intraorally. Then the denture is removed to refine its shape, remove any excesses and concavities under it, and polish and glaze the composite.

### The hybrid ceramic/composite artificial gingiva

A hybrid artificial gingiva is today the process of choice, with the main core of the pink in ceramic and an overlay in composite resin to facilitate optimal predictable esthetics with maximum control. This also allows the dentist to develop the submergence profile and direct soft tissue interface in pink ceramics, facilitating a more biocompatible subgingival environment. The pink composite is then only placed supragingivally, to blend into the esthetic interface. Using the same principle, a clinician can execute a pink restoration with ceramics and any needed future repairs can be done with pink composite, so that ceramic crowns do not need to be baked again after being in the mouth. This helps preserve the esthetic and physical properties of the porcelain. Obviously, this is only possible with screw-retained restorations.

### Preparing the ceramic denture for pink composite resin

The denture needs to be prepared by the technician to receive the composite gingiva (Figs 12 and 13). This preparation consists of:

- Mechanical retention
- Waxing up the surface of the denture that will not be covered by composite gingiva
- Sandblasting the surface that will receive the composite
- Acid etching
- Application of the bonding agent
- Silanization
- Application of a thin coat of composite resin (flowable pink composite)

After these steps are accomplished, the denture is ready to be placed in the mouth so that the remaining gingival material can be added (Fig 14). The fact that one can

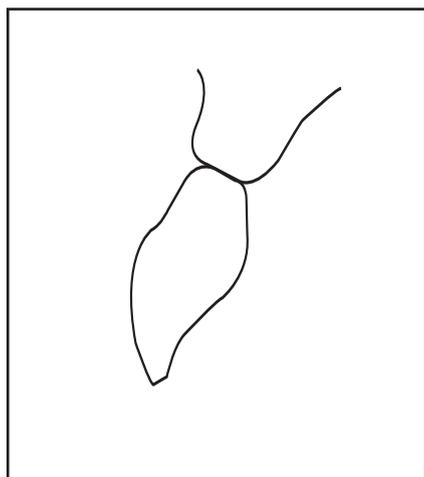
execute this procedure in the mouth makes the esthetic result much easier and more predictable, in comparison with ceramics, which is entirely done in the lab.

The artificial gingiva should fill in all the empty spaces along the ridge, the denture and adjacent teeth. This will prevent food impaction and help with hygiene.

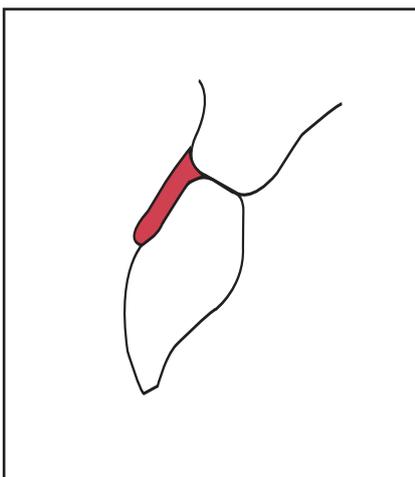
After the full contour of the artificial gingiva is finished in the mouth, the dentist should unscrew the restoration and proceed to finishing the composite resin in the laboratory. This requires removing any excess off the margins, eliminating concavities, and polishing and glazing the composite (Fig 15).

At this point it is important to determine whether the patient will be able to perform the hygiene procedures without assistance. If he or she cannot, changes should be made to facilitate patient hygiene. This issue is always a challenge because hygiene

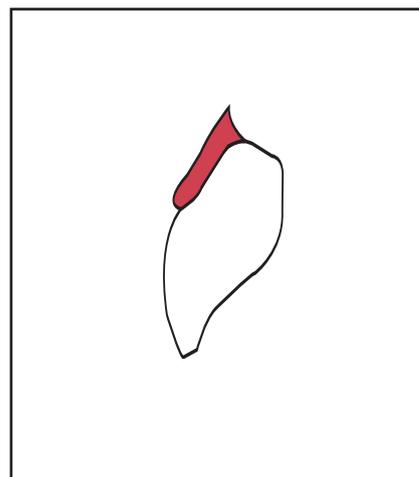
**Fig 15** Steps involved in shaping the composite resin gingiva intraorally.



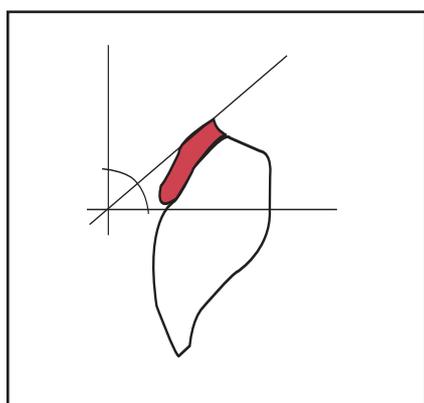
**Fig 15a** The pontic is in position over the ridge before gingiva is added.



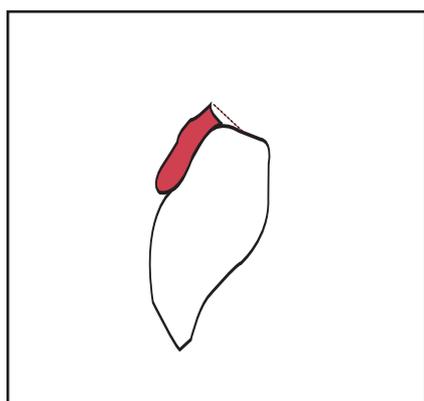
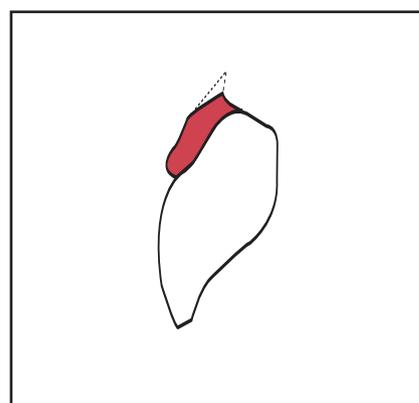
**Fig 15b** The gingiva is added intraorally.



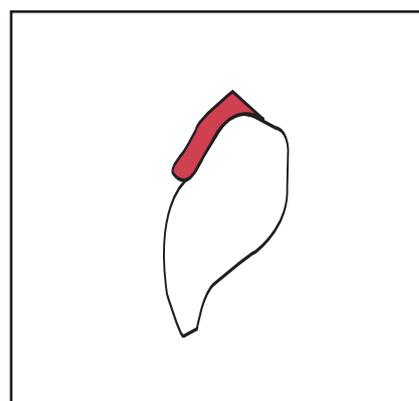
**Fig 15c** The denture is removed from the mouth, revealing a concavity under the pontic.



**Figs 15d (left) and 15e (right)** The edge of the gingiva toward the ridge is removed, but not beyond 45 degrees, so as to avoid creating an unattractive and uncomfortable situation for the lips or a food trap.



**Figs 15f (left) and 15g (right)** The final step is to remove any remaining concavity by adding more material under the denture to create a flat and hygienic surface. This addition will also create some pressure on the ridge at insertion, helping with esthetics at the transition interface and with phonetics.





**Fig 16** The surface underneath the prosthesis must allow for thorough hygiene. This is only possible if the floss can touch the entire surface between the artificial and natural gingiva. The patient must also be able to pass the floss threader between all the abutments.



**Fig 17** After the patient uses the floss threader, the floss should slide from one side of the prosthesis to the other, folding around the abutments and adjacent teeth. Superfloss is recommended for this procedure. The pressure between the natural and artificial gingivae must be similar to a contact point between teeth, ie, the floss can go through but with some resistance.



**Fig 18** The denture is placed into position after again checking the hygiene procedures and performing the final glaze of the composite gingiva. Note the facial esthetics and natural lip support of the artificial gingival restoration.

and esthetics can sometimes conflict with each other.<sup>17</sup>

### Shaping the composite resin gingiva directly in the mouth

Figure 15 details the process of adding and shaping the definitive composite resin gingiva intraorally.

### Seating and hygienic orientation

After all adjustments are made and final polishing is accomplished, the restoration is ready to be seated (Fig 16). This procedure will be the same as any conventional screw-retained denture. The blanching of the recipient tissue "interface" that occurs may be more intense, as the area under pressure is larger. At this stage, it is vital to reinforce, step by step, the importance of hygiene procedures to the patient (Fig 17) and schedule a check-up appointment in about 1 month.

### Maintenance

The size and design of the artificial gingiva are limited mostly by the factor of maintenance. Maintenance is crucial for the long-term success of such restorations. It is mandatory to include artificial gingiva from the beginning of treatment planning, including the surgical approach, ridge shape, and implants, to ensure an ideal esthetic and healthy restoration (Fig 18). Although these implant-supported restorations are designed to enable patients to perform perfect maintenance, it is strongly recommended that the denture be screw-retained, so that it may be unscrewed periodically to verify the health of the tissues involved. Furthermore, this also enables the practitioner to repair, polish, reshape, or add to the artificial gingiva if necessary.

## Conclusion

Restoring a defective environment inside the esthetic zone will always be challenging. This three-part series has highlighted a new focus for the implant team—interface development—which involves the alternative of including artificial gingiva as a predictable treatment option for fixed partial restorations in patients with severe ridge defects. The use of this solution involves a new paradigm in thinking for the entire implant team. Diagnosis and treatment planning for artificial gingiva from inception are most important for the successful outcome of this technique and may allow the team to plan a less invasive esthetic approach in any patient, decreasing the number of clinical procedures and the time required for vertical ridge augmentation. The most challenging aspect of surgery is minimized, making esthetic outcomes more predictable. Each member of the team plays an important role.

The technician must have a greater understanding of both the surgical and clinical procedures involved to be an active participant on the treatment planning team. Training to reproduce not only the teeth but also gingival esthetics and anatomy is paramount. Currently, with the commercially available materials (ceramics and composite resin) it is possible to reproduce nature when a restoration is properly designed, allowing correct maintenance and long-term predictable function to the implant restoration.

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