Restorative

Adhesive Bridges on Partial Preparations for the Morpho-functional Restoration of the Lateroposterior Single Missing Tooth

Details of technical design and clinical applications

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Introduction

Adhesive bridges on partial inlay-onlay-overlay type restorations represent a valid therapeutic option in opposition to traditional restoration techniques of the single edentulous in the latero-posterior area. They can be realized in ceramics (Fig. 1) and fiber-reinforced composites (FRC) (Figs. 2 and 3), mostly glass. Our clinical experience leads us to prefer the latter option as the bridges in glass fibers are able to combine the advantages in terms of wear and fracture resistance of conventional bridges with metal structure along with the stability and aesthetic integrity of metal-free ceramic systems.

The advent of shapeable lab glass fiber, with their high tensile strength and high modulus of elasticity, coupled with the improvement of physical-mechanical properties of microhybrid laboratory compounds, gave substance to our hope of being able to take advantage of a procedure economically and biologically beneficial in restoring the morphological, functional and aesthetic aspects of the single edentulous. Aside from the enormous difference of restoration predictability obtained using the reinforced compound as opposed to integral ceramics, surely due to the notorious marginal and structural fragility of the later, composite resins are additionally preferable given their simplicity of use and repair with the same aesthetic results.

The use of sequential and well-coded operational steps in the clinical and dental procedures, limiting the discretion of the operator, are able to balance the large handicap of adhesive techniques: being an operator with a great degree of sensitivity (restoration predictability proportionate to the operator’s manual ability and experience).

Evaluation of the impressions

The presence of margins that are almost totally extra- gingival makes the impression phase, for this specific type of restoration, rather simple as opposed to more traditional restorations. It is much easier to obtain satisfying and legible impressions, so long as all indications provided by the material producer have been followed, in terms of manipulation and timeframe of use. If sectioned impressions were viable for simple indirect adhesive restorations, the use of whole impressions made of last generation elastomers (addition-type silicone or polysiloxane vinyl) or polyethers is mandatory (Figs. 4 and 5).

Fig. 1: Example of adhesive bridge on partial preparations, created in pressed and stratified glass ceramics. The material at issue is, due to its fragility, not recommended for this type of restoration.

Fig. 2: Inlay bridges in reinforced composite with glass fibers

Fig. 3: Work completed on the model

Fig. 4: Polyether impression for inlay bridges

Fig. 5: Addition-type silicone impression (vinyl-polysiloxane) for inlay bridges

Fig. 6: Master work model, sectioned, and mounted in the articulator
In case of doubt over complex preparations or operational concerns about the aesthetic results of the final restoration, the clinician will perform a preliminary impression that will allow the dental technician to analyze in advance the excellence of the preparation.

In case of problems, these will be reported and highlighted on the model that we will return to the clinician so he can make the necessary amendments before taking the final impressions.

It is highly recommended to associate the implementation of ancillary registrations (view of the facial arc, recordings of right and left sides and protrusion) with the preparatory impressions in order to fit the models in the articulator without adjusting to average arbitrary values, as well as to streamline our work in the final phase of restoration construction.

The models and mounting in the articulator

In the case that both preparations are constituted by MO, OD or MOD type inlays, we will perform casting of hollowed stumps in class 4 plaster. These, once inserted into the impression, will develop a model with extractable stumps (Geller type model) in extra-hard plaster (Fig. 6).

This model will be employed both during modelling of the restoration and in the verification of its occlusal congruity.

For preparations of cusp capping (partial or total, onlay type or overlay), we primarily use hollowed stumps, but only to improve the accuracy of the finishing line. The master model, which will be mounted in the articulator, shall be realized with a second Model Zeiser type model system (or Kiefer), where the sectioned part shall include both prepared teeth (Fig. 7). The final restoration shall be built on this model and the accuracy of the occlusion shall be verified. In both cases the check of contact points shall be delegated to a non-sectioned model, which comprises even only the dental elements adjacent to the pillar teeth (Fig. 8). With regard to the antagonist model, its development is strongly recommended, in the study or lab, through the use of the same plaster employed for the master model.

The registration of the facial arc will allow us to transfer in the articulator the clinical position of the upper maxilla in relation to the cranium, with particular regard to the condyles (Fig. 9).

The protrusive wax or silicone record related to right and left side allows the regulation of the condylar fossa, identifying the maximum excursions of the mandible in anteroposterior and laterolateral direction (Figs. 10 to 12).
These settings, along with those already comprised in the preliminary modeling phase, thanks to the gnathologic waxing-up, allows for the elimination of any balancing interference during lateral movements, as well as the equally harmful interferences of the lateroposterior sectors during the protrusive movement.

**Diagnostic wax-up**

To realize the concepts of occlusion in dental modeling, over the years different techniques of gnathologic wax-up have been proposed, all still based on the principle of the centric point, according to which the back teeth engage in maximum intercuspation with no possibility of movement (Figs. 13 to 18). The identification of static parameters, valid only in ideal occlusions with precise guide, has produced progressive reduction of the fields of application of the above-stated theories.
The lack of incorporation, during the mode phase, of the functional areas of the individual patient, “traced” by the dynamic components of the occlusion (jaw, lower teeth and condyles) may produce occlusal disorders in all those clinical situations characterized by occlusal schemes with wide angles and either Bennett movements or surtrusion-retrusion movements.

In consideration of the high frequency of observation, in daily clinical practices, of the occlusal schemes dependent on individual variables and progressive re-modeling of dental and articular surfaces, the use of modeling principles based on dynamic occlusal principles were implemented.

In specific, we shall use a type of model system introduced by Dieter Schultz by the name of “gnathologic wax-up”, which represents a natural evolution of the “Occlusal Compass” concept and its wax-up posed by Michael Heinz Polz, which is able to combine occlusal stability of the centric point with areas of free functional excursions for the dynamic movements of the mandible (Fig. 19). We integrate the Natural Wax-up Technique (NAT) with the principles derived by the AFG (Anatomic Functional Geometry) according to the clinical indications of the case at issue.

The occlusal compass represents the ideal design that the centric cusps of the diatoric teeth trace on the occlusal table of the antagonist during eccentric movements. The information on the occlusal and functional areas of the patient obtained from the projection of the pattern above of the occlusal surface provides numerous guide points in identifying the directions of movements of the opposing arches, by determining the position of the cusps, clearances and

![Fig. 19: General gnathologic wax-up scheme according to D. Schultz (Taken from the article by Barbesi M., Montagna F., Pillai R., published by the Magazine of Amici di Brugg)](image1)

![Fig. 20: Gnathologic wax-up of first bottom molar.](image2)

![Fig. 21: Gnathologic wax-up of first top molar without risk of filth deposits leaving any residuals.](image3)

![Fig. 22: Reproduction of the morphology through silicone lab templates](image4)

![Fig. 23: Information transfer, through the templates to their definitive](image5)

![Fig. 24: Model phase complete](image6)
compensation areas. The occlusal compass, as representation of the movement coordinates of the antagonist surface on a horizontal plane, is an essential premise for the therapeutic success as result of the overall functional situation of the masticatory organ, as well as the removal of any dynamic interferences and pre-contacts.

Additional reduction of therapeutic-diagnostic errors can be achieved by integrating the model system through the gnathologic wax-up with the information derived by the registration of the facial arc and intraoral record of the maximum mandibular protrusion position and right/left laterality.

The theoretical concepts at the base of the occlusal compass are clearly identifiable and of simple application: each direction of movement is associated to a determined color part of an international chromatic code; and the same color is used to model the anatomic structures involved in the movement at issue (Figs. 19 to 21).

A red ring, sign of the central fossa area, indicates the point of interaction between the lines that comprise the occlusal compass, determined by the tips of the centric cusps of the antagonist element. Instead, a red dot indicates the occlusal contact of the cusp cone in the fossa of the antagonist tooth. The different directions of movement are normally divided into two main functional directions, three intermediate functional directions and two limit zones.

- The main functional direction on the working area is laterotrusion (LT) and is indicated in blue; the bottom area exhibits a path slightly towards the disto-lingual direction, and towards the mesio-buccal on top.
- The main functional direction on the balancing side is the mediotrusion, coded with the colour green, which takes on a distal-buccal direction at the bottom and a mesio-palatal at the top.
- The intermediate functional directions are protrusion, lateroprotrusion and medioprotrusion. Protrusion (PT), indicated in black, is the most important intermediate functional direction. This role is due to its stability and constance, function of moving both condyles in the same direction: forwards and downwards, as parallel to the median plane as possible. This movement comes about on the occlusal surfaces, parallel to the median plane, in the opposite direction in the two arches (mesially in the superior and distally in the lower).
- Lateroprotrusion (LPT) is coded in yellow and is localized on the working side between the lateroprotrusion and protrusion movements, with a displacement towards the distolingual zone on the bottom and mesio-buccal on top.

Fig. 25: There are no surprises if all operative steps have been followed

Figs. 26 and 27: Cemented work. Connector thickness penalizes aesthetics but increases predictability

Fig. 28: Devitalized tooth with incongruous reconstruction

Fig. 29: Removal of old restoration. A vertical fracture line is present
Medioprotrusion (MPT) occurs in the balancing side and is marked in orange. It follows an intermediate path between mediotrusion and protrusion with mesiopalatal direction on top and distobuccal on the bottom. In the construction of an occlusal surface, lateral movements such as mediotrusion and protrusion indicate the directions that the spaces must take, while lateroprotrusion and medioprotrusion are the lines directed towards a cusp segment. The two limit zones are retrotrusion (RT) and Immediate Side Shift (ISS) or Immediate Bennett Movement.

The retrusion zone or retrusion-surtrusion is represented by an area located behind the laterotrusion line, demarcated by a line that stretches for about 1 mm on the protrusion movement axis towards the distal side of the jaw and mesial side of the mandible; thereby, deviating with a slightly open angle in the laterotrusion direction.

The Immediate Bennett Movement or Immediate Side Shift (ISS) is a horizontal movement of the condyle with a mean value of 1.5 mm, which starts perpendicularly to the protrusion line and deviates at an angle at half path towards the mediatrusive line.

A dental model performed by following the principles of gnathologic wax-up of D. Schultz produces dental elements similar to natural teeth (Figs. 22 to 32), as to guarantee:

a. A mutually protected occlusion, i.e. with the back teeth in maximum intercuspal that protect the front from the physiological loads, while the front, through the incisive and the canine guide, protect the posterior teeth during eccentric movements, determining their direction;

b. Clearances for the dynamic movement of the jaw to provide no interference at all in all eccentric movements (MT, LT, LPT), and in any limit movements (RT and SSI slide in centric, freedom in centric);

c. Maximum intercuspation (like tooth-two teeth) with centric cusps of posterior teeth (palatal of the top and buccal lower), which come into contact with the central fossa and marginal ridges of the antagonists.

Selecting color

Chromatic mapping of the pillar teeth is performed by the clinician and sent to the lab to be reproduced in the definitive restoration (Figs. 33 and 34). For the sake of completeness, it is recommended that the photographs of the case be sent as well, which indicate the form and any characterizations to integrate in
the model. The importance of this step is easy to guess: a poorly performed record, with few details or outright erroneous, even in only a few of its components, would wind up compromising the aesthetic integration of the final restoration.

International literature and texts, though valid, on the topic, on their behalf, offer little or no information on the ideal execution modalities of this delicate step. Even the best willed clinician will end up “winging” it, fiddling with the color scales of the pre-selected composite system. In the end, he shall be able to identify only a few of the general elements (such as the base color of the dentinal mass and the higher or lower value of the general enamel), absolutely insufficient for a realistic yield of the dental technician’s work. Integrating our respective competencies in clinical and dental practices, we elaborated a simple chromatic mapping system (NASIS - Natural Anatomical Shade Investigation System) that we will commonly use in clinical routine, which has gained favorable acceptance from the colleagues to whom we illustrated and explained its use.

It consists of 8 variables to be recorded through the placement and polymerization, without adhesives, of small material increments in key positions of the dental preparation and/or helathy surrounding tissue.

The identification of these parameters takes only a few minutes and guarantees the registration of any single enamel/dentinal characterization of the pillar teeth. This method is correlated with the use of the principle guidelines on the proper choice of color: value, chroma, shade, translucency, opalescence and characterizations.

1. Base shade
2. Generic enamel
3. Occlusal contour
4. Translucent state (only preliminary)
5. Principle fossa
6. Internal cusp overlaps
7. Axial walls (external)
8. Definition of furrows
Fixed adhesive prostheses on partial preparations (IFPDs - Inlay Fixed Partial Dentures) can be realized in integral ceramics or in fiber reinforced composites (FRC). Among all reinforcing fibers, today we almost exclusively employ pretreated lab glass. Throughout the years, indications on the use of integral ceramics have declined progressively despite their interesting intrinsic properties in terms of resistance to mechanical wear, coefficient of thermal exposure, radiotransparency and biocompatibility. We have, indeed, witnessed a percentile of failures mostly in terms of restoration fracture, frankly unacceptable, to recommend their use on an ample scale. The early appearance of fracture rims, responsible for the clinical failure, can be attributed to the secondary traction loads that are generated, as a result of masticatory forces, in every point of the structure, on the necks and adhesive interfaces. If the material is fragile and has an elasticity modulus different from that of the dentin, as in integral ceramics, the concentration of traction loads can lead to fractures in relatively short times.

This is why we advise this particular type of adhesive restoration be performed using almost exclusively last generation composite lab material, meaning with a high percentile of filler that can also be ceramic, reinforced with glass fiber.

Analysis of literature, composed of successful cases that we have treated, has convinced us to use pre-treated lab glass fibers, at monodirectional trend, positioned in areas subjected to maximum loads (pontic base and connector).

Stratification with volumetric control and incorporation of glass fiber

From the diagnostic wax-up, we perform a series of lab silicone templates that we will use after each placing of composite material to monitor the thickness and control the management of the overall morphology of the restoration during the design phase.

The evaluation system identified by the color parameter allows the clinician and dental technician, through the adoption of a common “language”, to work in unison without improvisation or invention of any aspect during modeling. It will be sufficient to follow the indications of the dentinal masses, on the presence of any opalescent or intensive masses, on the characterizations and on the typology of enamel, to obtain a restoration best suited for integration with the residual healthy dental tissue.

After a careful evaluation of the models in the articulator, the stumps are isolated and any undercuts are blocked out with wax.

Depending on the chromatic characteristics of the residual dental tissue, we can use a dentinal mass with a
high chromatic saturation on the two pillar teeth, as first material increase, or a thin layer of transparent mass that depends whether disharmonic dyschromic spots are to be hidden or the natural tooth chroma and luminosity are to be highlighted. Before undertaking the model phase, we must create a suitable reinforcement structure using glass fiber (Figs. 35 and 36).

Throughout the years, we have progressively modified the type of fiber used, its duration and the criteria employed to select the recipient site. In addition, modifications were made to the sufficient volumetric fraction to increase the resistance of composite material. Today we use, as already mentioned above, unidirectional glass fibers, pre-impregnated which, in order to produce a significant increase in flexural strength and modulus of elasticity of the overall restoration, cannot represent a volumetric percentage less than 50-60% of the total. In addition, in consideration of the indications provided to us by international literature, we have been adopting a so-called “optimized design” for what concerns fiber placement, since 2009.

Based on the theoretical principle that the reinforcing fibers must be oriented parallel to the direction on which the main functional loads are exerted and perpendicular to the main fracture lines of the composite coating in case of failure, we now position the glass fibers in a decentralized fashion mostly at the base of the pontic and at connector level with a so-called "U-rounded" design (Fig. 37). It must be noted that to obtain an additional reinforcement of the connectors, sometimes adding, space permitting, a second fiber deflected slightly below the occlusal surfaces and endodontic post of the same material that is completely surrounded by the fiber, is to establish a "core" reinforcement that can effectively oppose any stress or traction.

At this point, making use of lightly heated strings of material, thus more fluid, we commence the modeling of the dentinal masses with constant reference to the silicone templates (First case figures 38 to 43, second case figures 44 to 49).

Starting at the base of the main furrow, with masses gradually less saturated and according to the guidelines of the "chromatic desaturation" technique, the cusp overlays are structured from the inside towards the outside. In this phase, we shall use a hybrid composite material with a high percentile of filler, ceramic and not, that has high bending and fracture resistance. After the completion of the tooth
components, we shall block the array with a photo impermeabilization in order to benefit from a rigid support for the layering of following masses.

At this point, we shall apply, if foreseen by the indications provided to us by the clinician, the more translucent materials followed by intensive and supercolor materials

Fig. 42: An endodontic pivot is incorporated for greater retention

Fig. 43: Startification is completed

Fig. 44: Presence of high volumetric fraction of glass fiber as efficient reinforcement system

Fig. 45: Side view
that, for a greater natural aspect, we will thoroughly spread and mix within the composites. Next comes the stratification of the general enamel and that of opalescent type, where required. The color material is applied inside the templates and molded to the model. As tooth coloring substances we shall employ a mass of micro-filled composite

Fig. 46: After the tooth masses, stratification of generic and opalescent colors is performed (if required)

Fig. 47: Definition of the definitive forms...

Fig. 48 ... with the help of the templates...

Fig. 49 ... until final cementation

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that has perfect characteristics of surface and polish ability (due to a low percentile of filler). Application of firm manual pressure will allow excess material to escape that will be removed with either a brush or painting knife.

At this point, attention goes to the template, the anatomic modeling and creation phase can be deemed complete. Before proceeding with the polymerization of color increase, it is necessary to:

• check the occlusion in the articulator,
• deepen and accent the main furrows with a thin endodontic tool,
• further define any furrows through a mixture of colored ceramic pigment and gloss photo impermeabilization lacquer.

At the end of this phase, we shall complete and optimize template curing through a final baking process in the composite resin oven.

Hence, we heat the stumps with the constructed bridge in hot water to allow the wax to melt and the template to slide away from the underlying plaster. It is now ready for finishing and polish under proper magnification.

Finishing with double model and polish

Once the restoration has been lifted from the plaster stumps, after an additional check of occlusion in the articulator, we shall check, on the non-sectioned model, the exact and passive insertion of the restoration on the preparation, as well as the presence of proper contact points. The last phase includes manual polishing with a low granulometric burr stroked several times over the surface, silicone rubbers of proper shape and diamond paste with decreasing granulometry.
Before sending the prosthesis in for cementation, we increase the retention of the contact surface through slight sanding at low pressure with aluminum dioxide. Figures 50 to 57 show several clinical cases.