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CASE

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NEW PERSPECTIVES THROUGH NEW GENERATION COMPOSITE MATERIALS: TORONTO BRIDGES

The ever higher standards reached by dental technology allow dental companies to develop more and more efficient and refined materials and techniques.

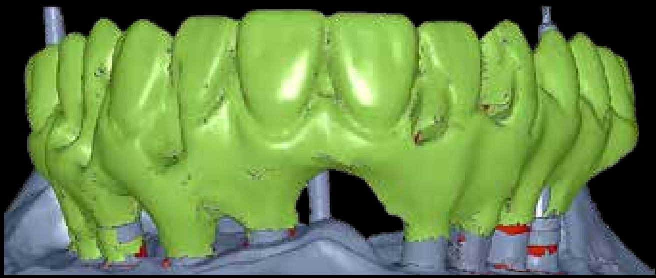
A factual and comprehensive knowledge of the features and behaviours of such materials is then paramount for dental technicians, who are to interface with clinicians in order to help them envisage the best technical, cost-effective and most of all quality-oriented approach to their patients' needs [1].

FOREWORD

Technicians are presently requested a comprehensive knowledge of both the materials and the range of technical solutions to propose.

Their final proposition will be the result of the careful analysis of the following aspects:

1. Assessment of the social and aesthetic element to be re-established or enhanced by the restoration.
2. Choice of the ideal prosthesis, led by a careful analysis of the far-reaching standards of the most sophisticated last generation materials.
3. The final and crucial establishment – together with the clinician – of the panel of options resulting from the former steps.



The fast development of CAD-CAM digital techniques is particularly helpful in the planning phase. Such technologies allow to efficiently and numerically control the set-up of the project (Wax-Up) **[2]** when a preliminary temporary polished acrylic resin replica (TEMP CAD-CAM) **[3.1]**. of the final result may be designed to simplify the building of the framework **[3.2]** to be coated in composite.

Experience has shown that, in order to guarantee a long lasting aesthetic result and material stability, it is crucial to follow a strict protocol starting from the treatment of the metal surface and of the coating masses. This proves crucial as the mechanical features of such masses must be taken into account from the very early phases of the building process (INVERSE HARDNESS LAYERING) **[4]**.

	Elastic Modulus (GPa)	Thermal Exp. CTE (x10 -6/°C	Tensile Strength UTS (MPa)
Enamel	~80	~17	~10
Dentin	~14	~11	~105
Ceramic feldspatic	~60–70	~13–16	~25–40
Composite	~17–21	~13–15	~55–60

Moreover, as our positive experience with such composite materials is widely supported by both clinical-technical and scientific evidence, it is now possible to consider them a valid alternative to mainstream ceramic solutions.

It is then vital for us to be ever ready to answer all the frequently asked questions about both the aesthetic and functional properties of composite solutions.

The number of cases solved by using composites, the constant research of repeatable and reliable clinical-technical procedures, as well as the easy management of composite prostheses, all tend to encourage the use of such materials also for the aesthetic coating of Toronto Bridges **[4.1]**.

Our final aim is then to promote composites as a winning permanent solution.

Such a practical and pragmatic approach to aesthetic and functional design is based on a series of general questions arisen from my daily practice.

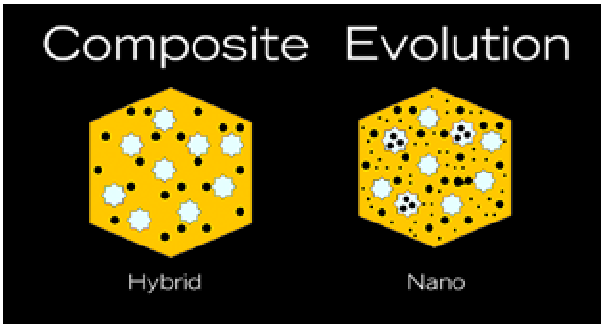
Here are some of the most relevant ones, which may eventually serve to create an individual case-analysis guideline.

1. Can new generation composites be presently considered an advisable option for prostheses on implant?

Last generation indirect composites feature higher optical qualities, enhanced chromaticity as well as higher tear strength. Moreover, their mechanical properties may be considerably improved by several polymerisation methods (light, heat and pressure). In this regard, we must highlight the enhancement of the mechanical-physical properties of in-lab treated composites. The use of specially designed post-polymerisation ovens combining light and heat improves the fluidity of the material and consequently its reaction to light.
Hence the importance for the lab to carefully select not only the materials, but also the tools and instruments to use to best meet our expectations and needs. This will prevent all failures unrelated to our know-how, but rather due to the lack of a suitable protocol and tool-set.

The possibility for composite restorations to fail is not significantly higher than for metal-ceramic ones. Though the increasing positive results are due to the evolution of the materials used, they also call for more and more specific material selection guidelines.

In this regard, hardness and mechanical strength are not always the main features to look for.
Abrasion strength, together with the elastic modulus are paramount values to consider when selecting the best material for an aesthetic restoration, and high refraction index composites (Hri-Micerium Enamel Plus), featuring both great optical qualities and high stiffness, are excellent options for the frontal area.
Due to their higher stiffness, such nano-hybrid composites favour the flex strength needed to support the dynamics of anterior elements, whereas high abrasion strength micro-hybrid composites (Micerium Enamel Function) are more compact and abrasion-resistant, thus proving an ideal option for posteriors, which require high resistance to compressive strength **[5]**.



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Technicians can presently reach highly aesthetic results through the existing composite universal systems, as well as through simple, effective protocols. Such protocols will include the use of transparent flasks to perfectly replicate the original design and solve even complex prosthetic situations, while ensuring time effectiveness and cost containment **[6]**.

Whenever working 'on implant', result predictability cannot be renounced while setting the strategy for prosthetic treatment.
Digital systems, both while setting the project up and during implant planning, are becoming the pillars of operative protocols as they allow to faithfully replicate our project in advance, as a prototype-on-temporary to be subsequently reproduced with permanent material.

[7]

Composite pressing technique by means of transparent flasks (Tender-Flask) **[7]** allows us to perfectly replicate morphology, and, above all, perform controlled layering. This will eventually determine a most natural effect, through the balanced combination of external layers (enamel) and internal components (dentine/chromatic effects) **[8]**.

Through this technique, finishing times will be shortened and the utmost care will be given to the polishing phase, which remains a vital step to ensure higher prosthesis durability.

[8]

2. Is composite adhesion to the framework still a complex issue and a matter of unreliability?

The interaction area between framework and aesthetic coating materials has always been a controversial issue.
Both clinical and scientific evidence today confirm that the structure/composite combination can be divided into a chemical phase and a mechanical phase: the former happens through adhesives, the latter is the result of a combination of cohesive strengths through the design and material chosen for the framework.
The primers now available on the market allow us to carefully forecast the adhesion strength between prosthetic framework and coating composite resins.
All of the adhesive systems used in a recent study about the behaviour of several materials (Cr-Co,Ti,Y-TZP) on structures have proved to comply with the adhesion standards of crowns and bridge materials on a polymer basis. Nevertheless, a few statistically significant differences have been highlighted depending on the different adhesion substrates, with Cr-Co alloy proving the lowest Shear Bond Strength (adhesion strength).
Cr-Co alloy detachment resistance has proven significantly low when compared to the results from such other substrates as Y-TZP (zirconia)[9] and Ti **[10.1]**, which have proven quite similar to each other.
SBS (adhesion strength) results are coherent with those from previous studies – both for composite on natural tooth and for ceramic on metal alloys – and further support the 'composite option' as a viable alternative to ceramic coating.
By drawing inspiration from the most widely tested clinic protocols regarding adhesive cementation techniques to ease the framework/composite interaction, the ideal lab protocol should envisage mechanical surface treatment and sanding, by means of 50 micron aluminium oxide **[10.2]**, as a first step. Then, primer should be applied before layering the photo-polymerisable opaque, which is to interact with the primer. "Inverse Hardness Layering Technique" (Tender Micerium Masses) is recommended to increase cohesion of the composite coating material **[10.3]**.
This technique takes advantage of the different elastic modulus of the materials used for the substrate on-framework. As a consequence, the improved viscoelasticity of the layering material will help to excellently imitate the behaviour of layers as in the natural tooth.
Present results uphold the use of composite resin coatings on fixed protheses, i.e. on implants, as a satisfying alternative to traditional ceramic-on-metal solutions.

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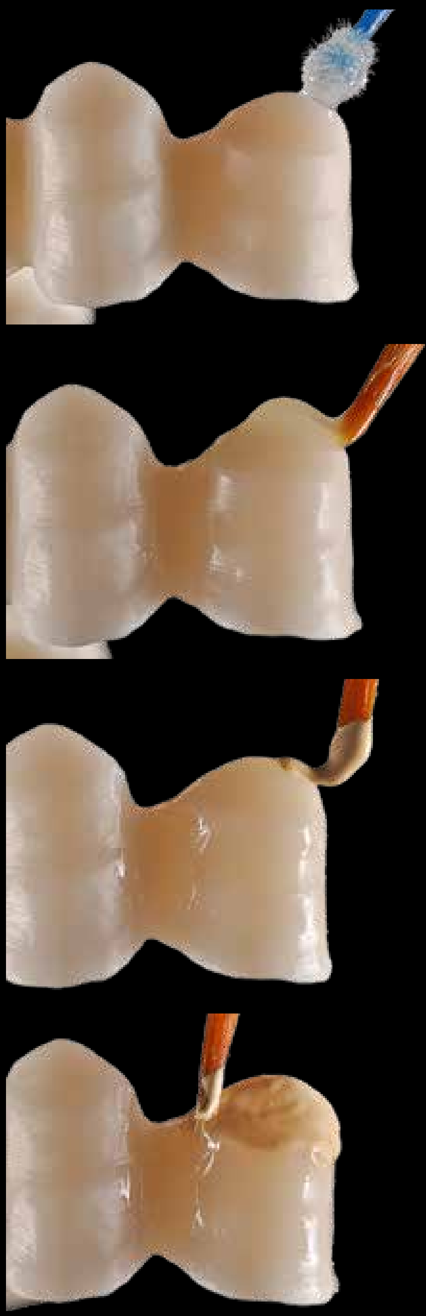

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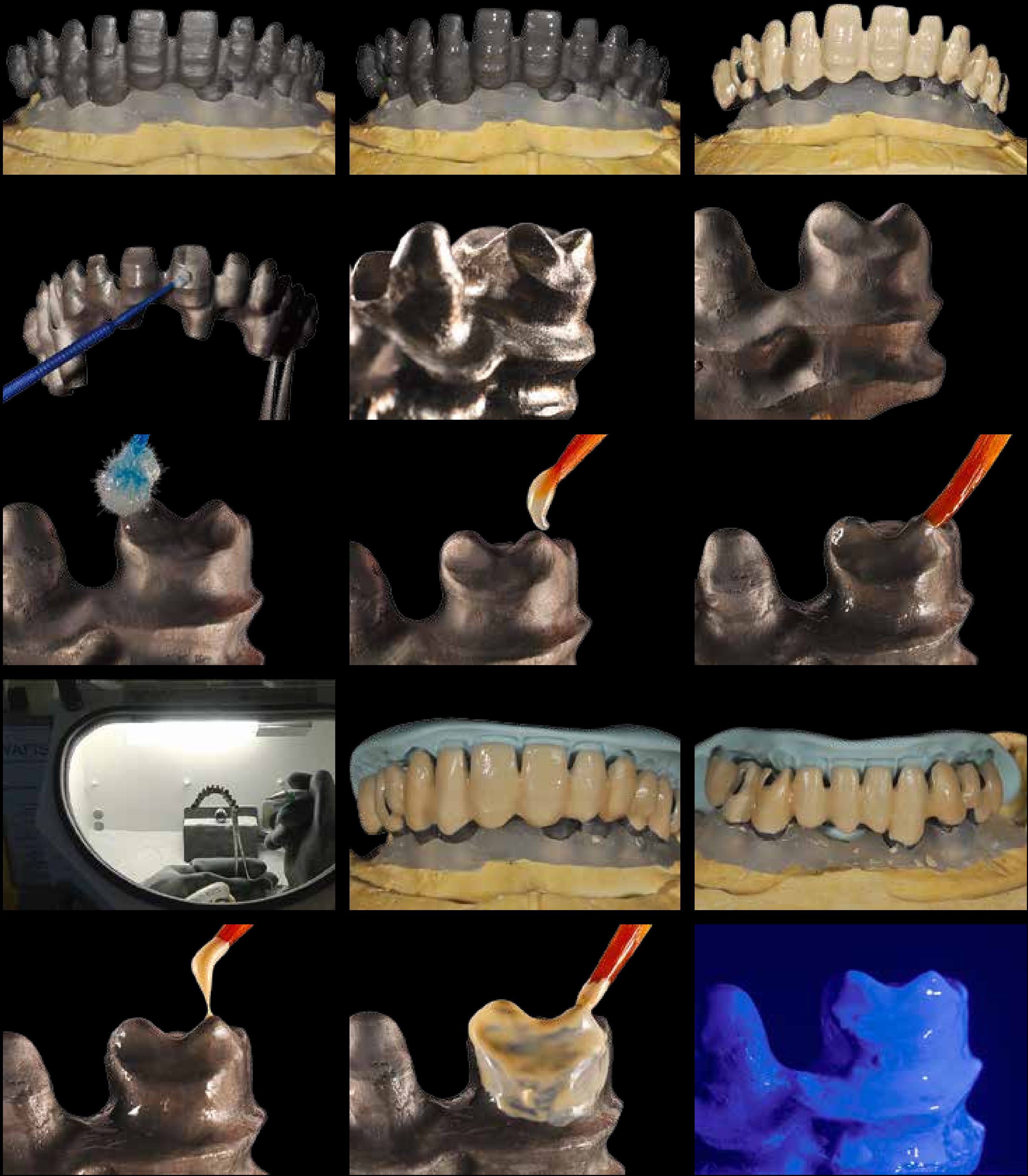

3. Are composite solutions a viable option also for restorations which also need pink aesthetic interventions?

Some cases have proven that, in order to restore appropriate tooth proportions – featuring ideal profiles and lengths – it is not enough to take into account white aesthetic only. Part of the missing gingival tissues will have to be rebuilt by using pink aesthetic procedures **[11]**.

Of course, composites can be used also in this instance, by performing the same indirect layering technique used for white materials. The fast development of composite materials, has given us the opportunity to successfully treat complex aesthetic cases involving both white and pink aesthetics.
The availability of materials having the same features as traditional ceramics or acrylic resins is a great advantage. Differently from the latter two in fact, composites offer several layering masses and stains, thus enhancing the final aesthetic result and camouflage with the natural gingival tissues.
With regard to the technical approach, to have a complete composite system at one's disposal is paramount to easily and correctly simulate the pink areas anatomy and then obtain natural optical effects through chromatic diversification.

According to the condition to be restored, and in order to enhance the camouflage effect, layering can be carried out on a previously pressed dentine basis, on which the colour and shape of the natural bone margin have been recreated **[12]**. In such cases, only the deepest parts and the ones closer to the implant will be treated with pink opaque so as to reach a denser and more chromatic shade.

The main advantages of such techniques are a better aesthetic integration, direct, on-chair case-finalization. Moreover, short and long-term implant modification, integration, adjustment will be easier, as they can be performed at the dental clinic, by the clinician himself.
All in all, composites can indeed be considered a truly reliable and adaptable ally in prosthetic treatment.

[12]

4. Can new CAD-CAM technologies be used for composite-oriented productions?

The final success of composite resin coated prostheses depends on a number of variables which interact almost simultaneously, i.e. proper framework shape, proper composite and framework thickness, and last but not least, the patient's occlusion. Among all these factors, composite-framework cohesion predictability is crucial.
In a recent lab-test about the superficial adhesion factor, the comparison between the average values obtained has shown the lowest SBS on Cr-Co alloy (16.5 MPa), while the best result was obtained on Ti alloy (22.6 MPa). Such a remarkable statistic discrepancy definitely champions the use of titanium alloys when opting for composite coated solutions.

In the last decade, Titanium and its alloys have become the most widely opted for solution for endosseus implants.
Due to their physical and chemical features, Ti and its alloys prove great frameworks for composite-on-implant and may be considered viable alternatives to standard noble and base metals when building crowns and bridge frameworks.
New CAD-CAM technologies are a great in-lab help, not only when working on white parts, as with polymers or Zirconia, but also when working on metals, which have proven an interesting option on implant frameworks.
As a matter of fact, metal frameworks are particularly precise and passive on implants and such stability, besides perfectly matching composite "cold working" method, can be preserved also after aesthetic layering.

Today, the use of implant converters for cementing technique allows us to build connection-free frameworks which are fixed on implant by means of last generation resin cements before completing aesthetic covering **[13]**.

This highly reliable technique allows us to further control the passivity of the framework on the implant. Also in this case, the strict protocol and the correct application of the metal primer on Titanium alloys are the bases for an ideal final result **[14]**.

On the basis of the aforementioned scientific observations, whenever peculiar aesthetic needs arise, Zirconia frameworks may safely be used as composite-friendly frameworks, thus widening the production range for CAD-CAM system equipped dental labs.
Last generation software can design the initial temporary by combining it with Ti features. Thus, an increasingly reliable framework design as well as an increasingly sophisticated model reproduction are now available and can determine a more and more accurate predictability of the final composite-coated aesthetic solution **[15]**.

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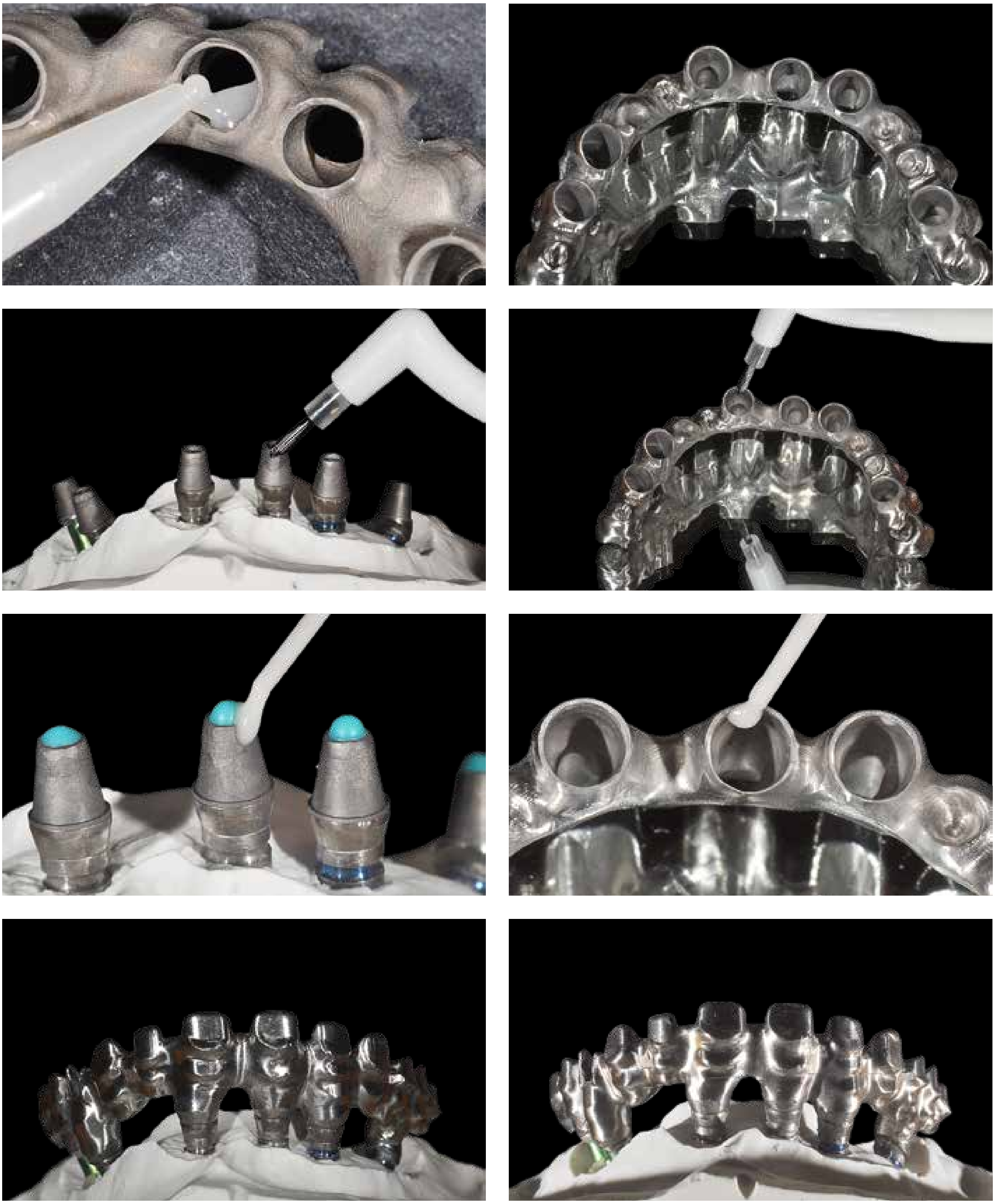

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5. What are the advantages in promoting composite solutions, even complex ones, to clinicians?

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Composite materials are presently well known also among dentists, which makes their promotion far easier.

Moreover, a thorough knowledge of their features will allow the dental technician to perform in-lab intervention also for white and pink aesthetic parts, which will result in the possibility to find easier and more cost-effective solutions for the patient **[16]**.

The mechanical features appreciated in both direct and indirect techniques, meet the biomechanical needs of the patient and promote the use of composites for screwed-on-implant prostheses.

A key-aspect in this kind of solution is easy maintenance: maintenance procedures can be performed in-lab and do not require any thermal or complex procedures, which may eventually cause framework alteration (if a metal one) or coating modification (if a ceramic one).

[17]

Composite versatility also allows in-clinic re-polishing, modification, repair and subsequently long-term performance and aesthetic stability, provided proper monitoring of the patient's biomechanical needs is ensured **[17]**.

CONCLUSIONS

Summarising the answers given above, we can conclude that composites are surely an interesting option also for prosthetic solutions, especially in the case of implants and removable prostheses (though at a clinic only). This is due to the fact that we can presently ensure a satisfactory coating material surface resistance standard, as well as good on-interface SBS.

Moreover, due to its proven versatility, composite can be easily treated either at the dental lab or at the dental clinic, following the same operative protocols.

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- 1979: Dental Technician Degree at Genoa Academy
- 1982: He started his lab in Savona and his teaching and counselling activity (Restorative Dentistry Dept, University of Chieti-Pescara; Restorative Endodontics and Dentistry Masterclass, University of Siena; State School for D.T.)
- Publications: "Ceramic Multilayering Technique" and a lab manual about the use of composite materials, introducing his own method, named "Inverted Layering System".
- He is among the contributors to "LAYERS, an atlas of composite resin stratification" by Manauta – Salat, Quintessence Publishing.

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ROBERTO ROSSI

- He was born in Savona on 08/07/1989.
- He graduated from Dental Technician School "Mazzini" in Savona in 2008.
- He was the winner of the National Competition for Dental Technicians at "G.Plana" Institute in Torino.
- In 2008 he started his activity at Laboratorio Rondoni in Savona. He gained relevant experience while collaborating with MDT Daniele Rondoni in many fields of study and development of aesthetic and dental materials.
- Since 2011 member of the department at Siena University (Italy) participating in the Master's programme of "Endodontics and restorative dentistry".

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