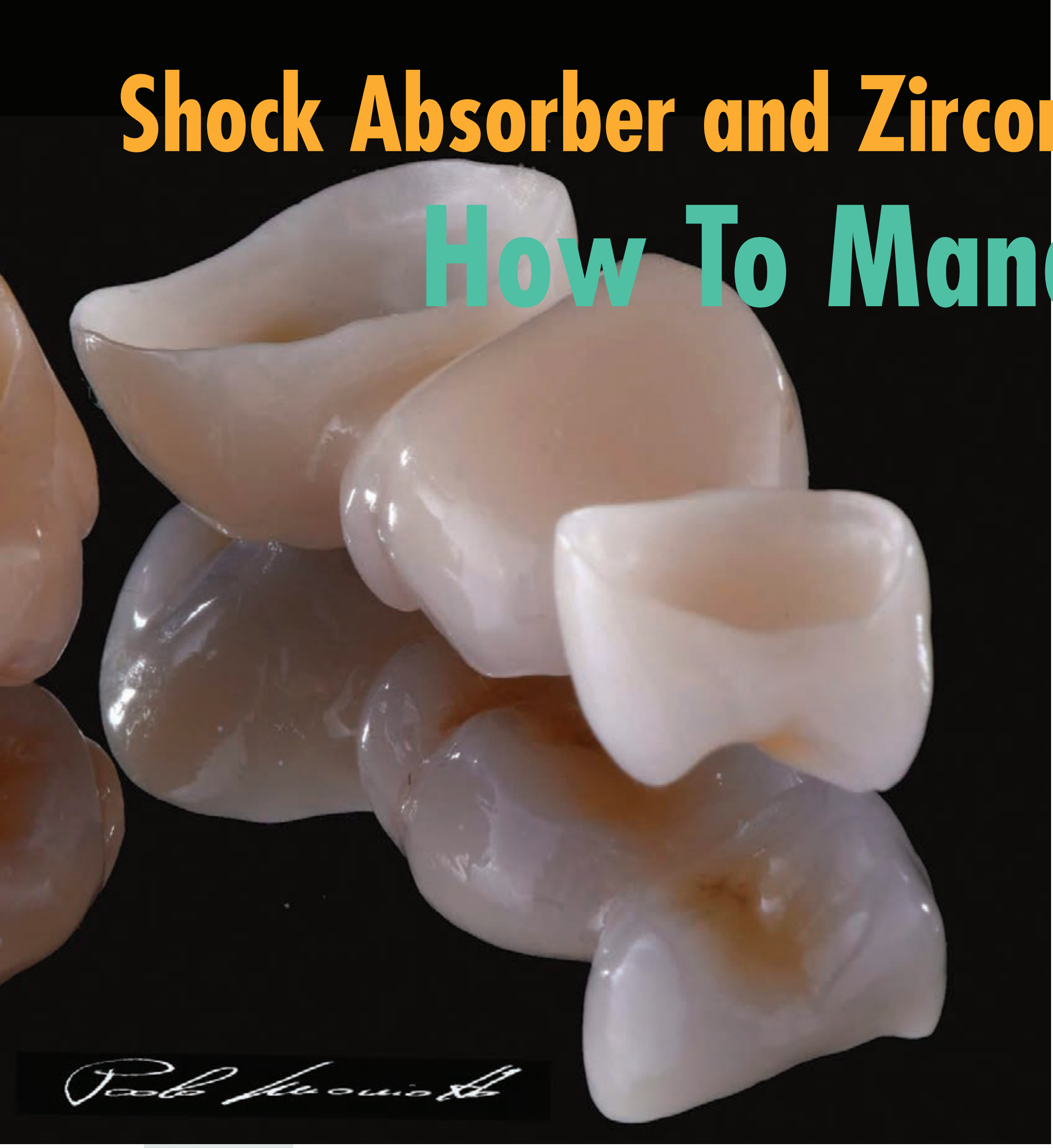
Shock Absorber and Zirconia Ceramics: How To Manage Them

Part Two: Clinical Cases Designed And Solved



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Introduction

In the first part of the monograph, we analyzed how properly handling the prosthetic device in its processing stages is crucial in ensuring clinical success. All the procedures that characterize the workflow of the dental team and dentist-technician relation must result from a "known" and "shared" practice.

Digital is now present in various clinical and laboratory protocols as well as a tool that, in many respects, has "speeded up" and "simplified" techniques that cannot always be standardized. Simplification is not synonymous with facilitation: the risk sometimes is to superficialize some aspects that then turn out to be decisive in avoiding errors that lead to rehabilitation failure.

A well-established experience in applying "traditional" clinical protocols combined with processing that respects the characteristics of dental materials makes it possible to achieve the standard of prosthetic excellence that has always been aimed at, even before the advent of digital dentistry. New materials of a ceramic nature have long since, for the most part, replaced the evergreen metal-ceramic due to more excellent aesthetic and functional versatility. Clinical applications range from single-unit restoration to complete arch rehabilitation.

The laboratory needs in-depth research and study of the properties of ceramics and how to handle them; the clinician must know the biomechanics of these materials to facilitate their use based on the indications that the scientific literature offers. Zirconia, in recent years, has played an increasingly dominant role in prosthetic restoration on natural teeth and implants, both because of its mechanical and physical properties and because it lends itself very well to CAD/CAM machining processes.

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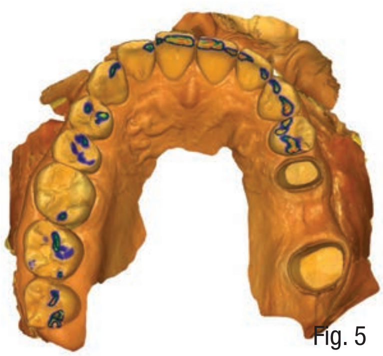

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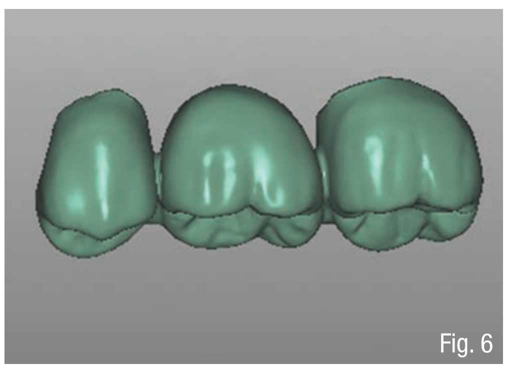

Fig. 6

Fig. 7

In the clinical cases under review, we wanted to highlight how we can use the same material in extensive rehabilitations and single elements and how digital workflow still needs to complement and implement "analog" work that is always the basis of clinical and technical therapeutic protocols.

The fabrication of single, sparsely extended prosthetic devices on natural dental elements can be a workflow managed entirely digitally. Scanning of dental preparations with current scanners results in accuracy and predictability. A vertical finishing margin allows light to reach the deepest portion of the virtual groove created by the placement of a retraction wire. A horizontal finishing line at the intrasulcular site is not always synonymous with correct optical reading (scanners in this regard have different reading potentials at the current state of software development), resulting in the incorrect fitting of the prosthetic device. A vertical type margin allows the scanner's "light" to read the over preparation allowing the dental technician to make an accurate artefact (Figs. 1 to 7).

The acquired file is exported to CAD design software with the ability to create shapes and volumes in a virtual environment. The CAM stage allows the miller to materialize the design, and the wafer is tetragonal zirconia stabilized in monolithic form. On clinical examination, the device appears to have excellent biological, aesthetic, and functional integration (Figs. 8 to 20). Furthermore, the mastery of CAD/ CAM methods makes it possible to overcome, for this type of sparsely extended work, the intermediate stages of framework and cookie testing by working on data that maintain a high value of "commitment and precision."

In the clinical case, the patient presented with the need to rehabilitate the upper arch due to incongruous, old restorations associated with the absence of numerous dental elements in quadrant one. In addition, the diagnostic picture was aggravated by an inconsistent intermaxillary relationship with a need to re-establish the correct vertical dimension of the lower third of the face (Figs. 21 to 28). Having accomplished a collection of medical history and radiographic data, the clinician's task is to communicate a treatment plan that meets the patient's functional and aesthetic needs.

"Sharing the diagnostic plan" with the patient and other team members allows us to obtain a full awareness of achievable results that are also a function of the expectations of the ultimate user of the treatment: the patient. Therefore, the possibility of preparing multiple treatment plans always remains a valid therapeutic strategy, as long as it is always accompanied by a "transparent" and "sincere" analysis of the possibilities and limitations inherent in each therapeutic action.

The treatment plans may be multiple, but the diagnosis is always unique. The clinical needs must always be combined with those of other nature manifested by the patient (time, cost, emotional states, etc.). Neglecting or overlooking them can lead to a lack of acceptance of ambitious and challenging treatment plans for us, but not for the user of our work. Analytical and diagnostic wax-ups in the early stages of treatment are, even today, fundamental tools for assessing and studying the prosthetic spaces available and planning our treatment plan.


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Fig. 9


Fig. 10


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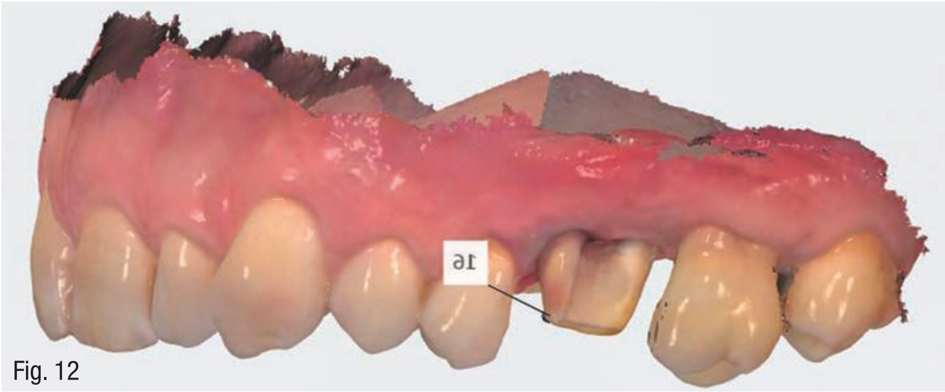
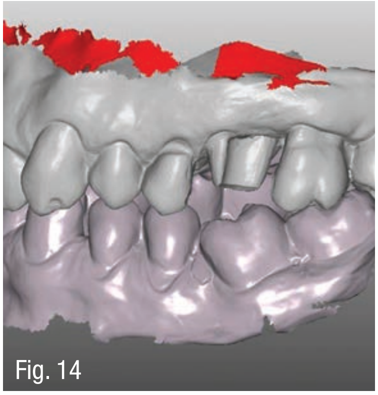


Fig. 12

In the present case, the volumetric analysis wax-up was performed in analog mode, going to simulate not only the shape and volume of the teeth involved in the treatment but also the volume of hard and soft tissues necessary for proper implant placement and maintenance (Figs. 29 to 32). The loss of bone tissue in the corono-apical and latero-lateral directions, if underestimated at this stage, could lead to surgical malpositioning of implant fixtures, which cannot always be compensated prosthetically in addition to altering the correct course of the Wilson curve with consequent functional criticalities that can be highlighted later during prosthetic crown placement.


Fig. 13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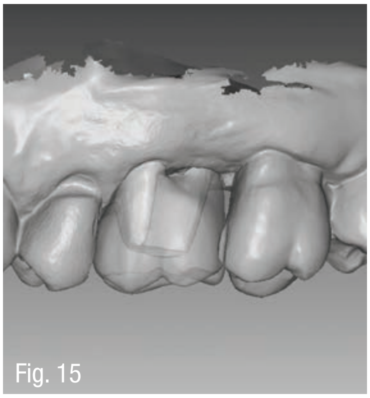
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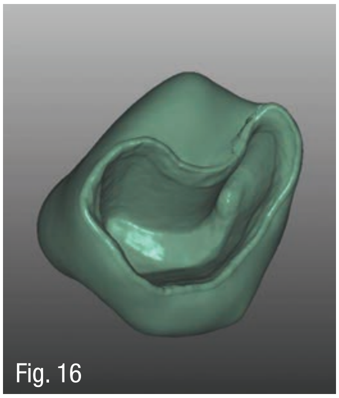
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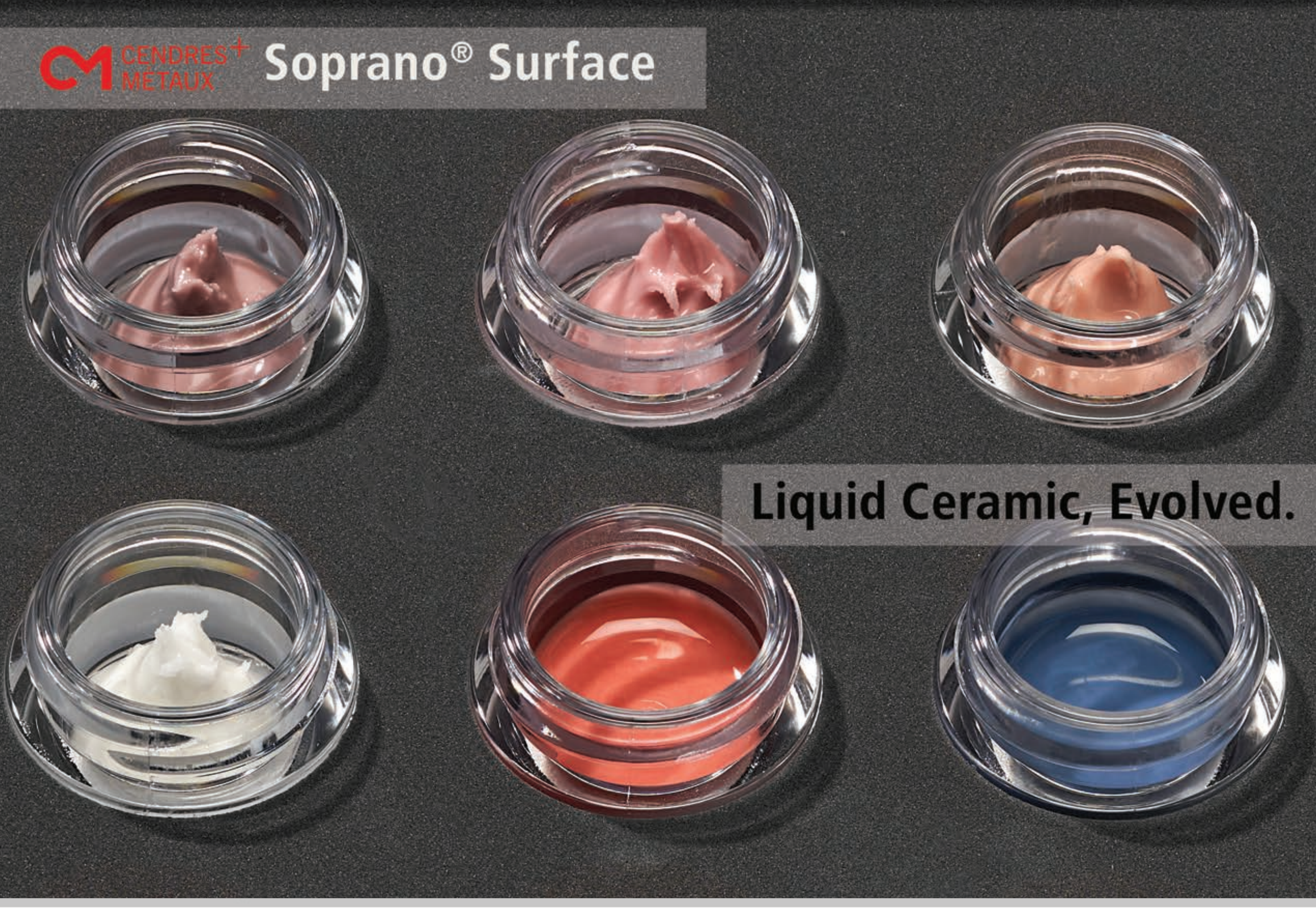

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Fig. 17


Fig. 18


Fig. 19


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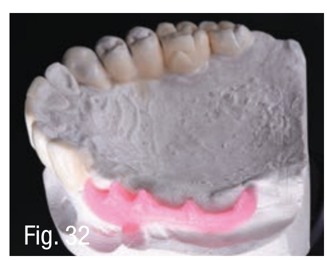
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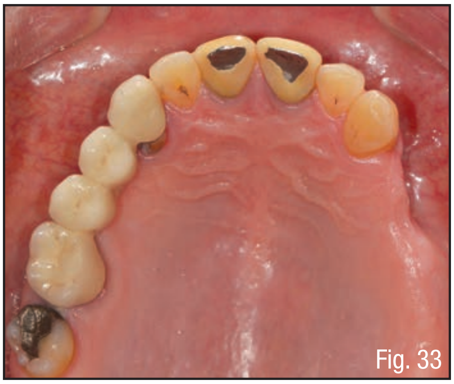

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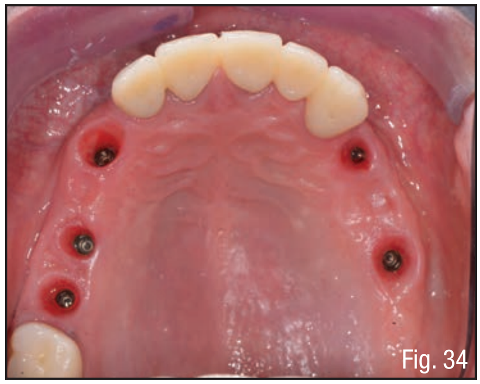

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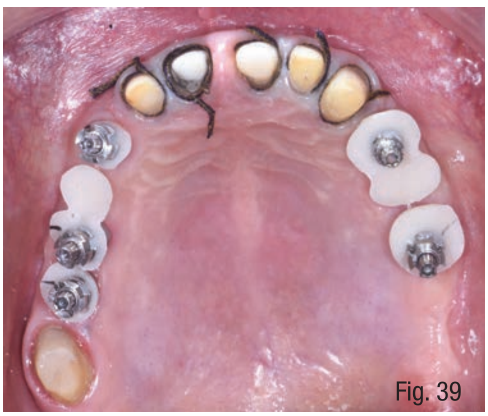

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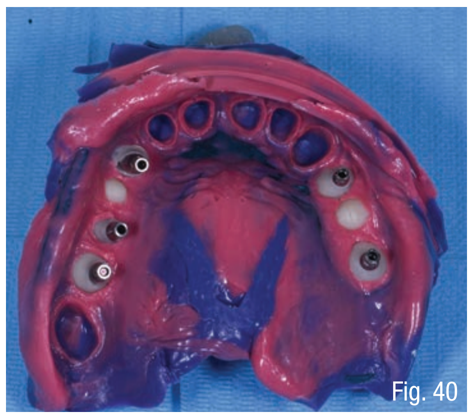
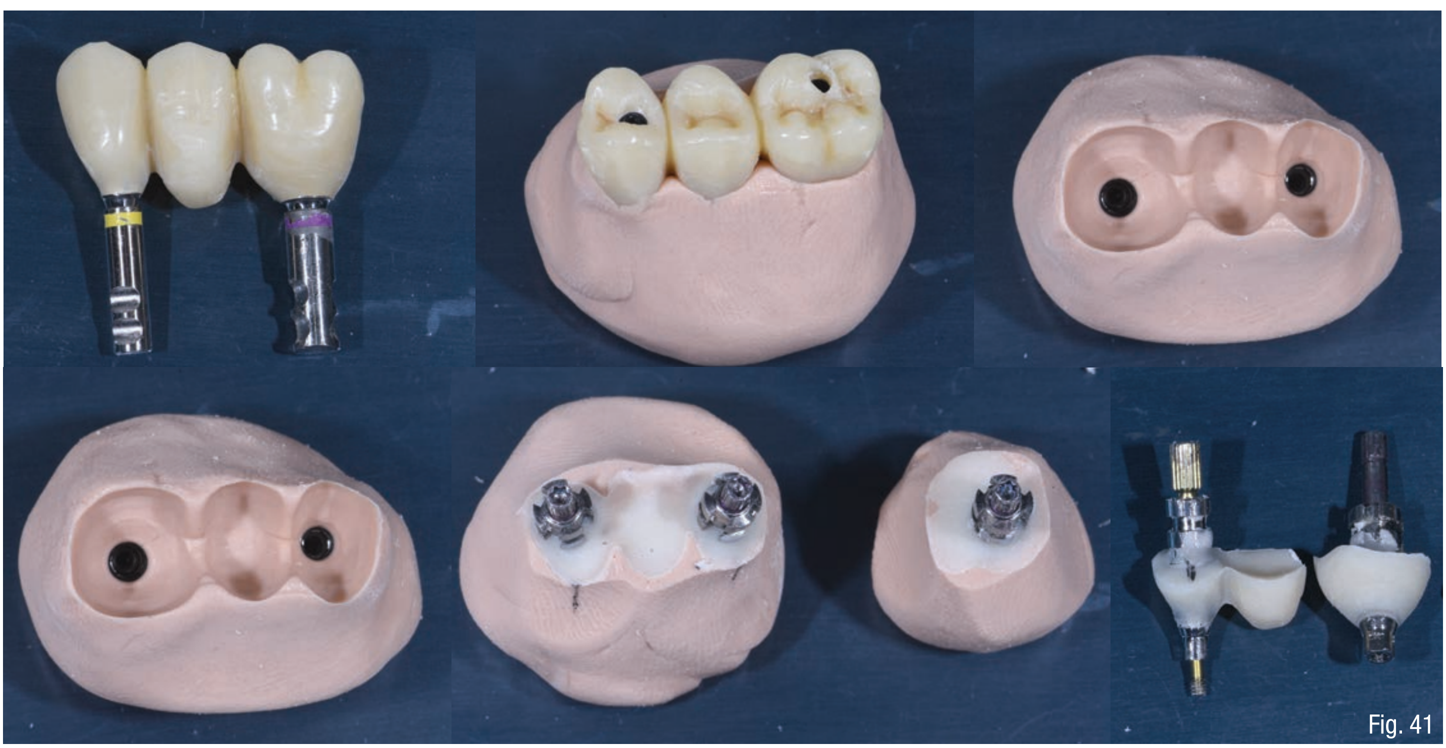


Fig. 40

Thus, following the initial analysis evaluation, followed by a more accurate diagnostic wax-up, the models were mounted in the articulator at semi-individual values and the subsequent functional wax-up, a fundamental step for the correct morphological realization in the correct spatial orientation of the master models.

Having completed the surgical phase with implant placement associated



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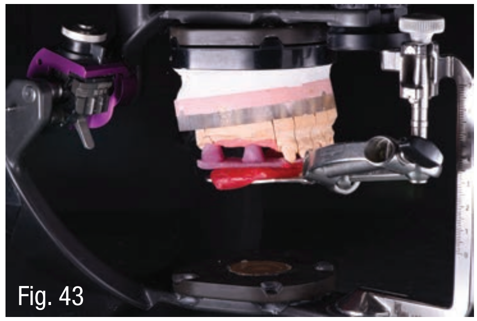
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Fig. 52

with regenerative bone techniques, the provisional remains an indispensable tool for the "stability" of a dynamic system (Figs. 33 to 38). Functionalization of an adequately executed interim allows the clinician and the patient to intercept any design errors and resolve them at a stage where reworkability is an almost taken-for-granted step in complex treatment plans. At the same time, soft tissue is allowed to biologically integrate with prosthetic devices in a time frame that is never shorter than 2 to 3 months.

The information thus acquired must be transferred to the laboratory dental technician to translate it into a different kind of material. This is one of our treatment's most delicate and error-sensitive phases. In the present case, polyetheric impression materials have played an egregious role in recording tissue position and shape. Customizing impression transfers with polyacrylic resin allowed the "reading" of the transmucosal implant path individualized by the temporaries (Figs. 39 to 41). Registration of the intermaxillary relationships with facial arch and bisacrylic resins allowed a "stable" and "certain" transposition to the dental laboratory, which, together with the cross-mounting of the patient's "functionalized" provisional, allowed refinement of the diagnostic design (Figs. 42 to 44).

The choice of yttrium-stabilized tetragonal zirconia allowed an entirely CAD/CAM fabrication process with continuous analog validation of the "digital" steps. In addition, the feldspathic ceramic layering of the upper frontal elements allowed an aesthetic upgrade by not affecting the "working" surface of the prosthetic devices.

The choice of zirconia on implants is now an established topic in the literature. Biocompatibility in the transmucosal composite combined with proper load distribution at the implant interface is synonymous with long-term stability. Correct implant positioning allows a screw-retained prosthesis always to be preferred, when possible, to a cemented one, if only to avoid the use of cement that may trigger peri-implantitis phenomena (Figs. 45 to 52). The completed case demonstrates how analog can and should associate with digital (Figs. 53 to 56).


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Fig. 55


Fig. 56


Fig. 57


Fig. 58


Fig. 59


Fig. 60


Fig. 61


Fig. 62

Integration into the dental, temporary and matching with the antagonist arch appears to be among the virtual environment's most critical and immediate functions (Figs. 72 to 77). Such a transfer of information to the laboratory, not subject to variables such as wax-up distortion or "analog" impressions, allows for the precise setting of functional pathways. The dynamic stability of the rehabilitation can be faithfully reproduced in the CAD environment and then validated with an accurate model produced with a 3D printer. The context of the patient's smile is synonymous with the correct interpretation of the aesthetic and functional parameters of the case under study (Figs. 57 to 60).

For a correct understanding of the potential and limitations of digital, it is incumbent to approach the performance of more extensive rehabilitations by taking advantage of what is already known in the analog field. In the first cases, with the help of optical scanners and CAD processing softwares, we have always tried to export "digital" steps to the "real" environment to understand their corresponsiveness better. In the clinical case under consideration, the treatment plan involved the fabrication of prosthetic crowns and bridges on the upper arch elements and the placement of two implants at the lower first molars to ensure chewing is compatible with the patient's age and biological and functional condition (Figs. 61 to 68).

The analog workflow was performed in parallel with the digital workflow.


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Fig. 70


Fig. 71

Diagnostic wax-up remains a crucial step in the fabrication of temporaries that can functionally integrate and are then "scanned" to reproduce ceramic devices in functional and aesthetic harmony (Figs. 69 to 71). Optical scanning of dental preparations, temporaries and matching with the antagonist arch appear to be among the virtual environment's most essential and immediate functions (Figs. 72 to 77). Such a transfer of information to the laboratory, not subject to variables such as wax-up distortion or "analog" impressions, allows for the precise setting of functional pathways. The dynamic stability of the rehabilitation can be faithfully reproduced in the CAD environment and then validated with an accurate model produced with a 3D printer.


Fig. 72


Fig. 73


Fig. 74


Fig. 75

The cementation phase of zirconia-ceramic placements must follow precise protocols that allow an intimate bond with the tooth substrate ensuring its retention and long-term stability. The use of resin-based self-adhesive cement combined with the conditioning of ceramic surfaces with specific MDP-


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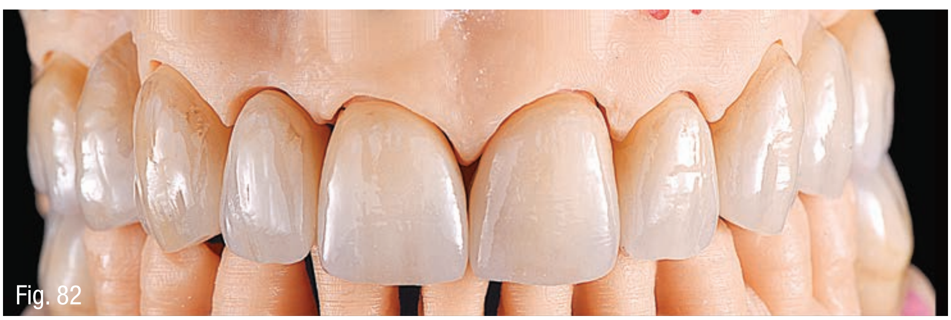
Fig. 82


Fig. 83


Fig. 84

based primers allows the creation of an indissoluble tooth-restorative unit by increasing the physical and mechanical properties of zirconia (Figs. 78 to 81). However, the authors are inclined to believe that some procedures in their current state should still be analog due to the inability of existing software to simulate the masticatory organ.

At the 12-week follow-up, the denture elements appear to be fully integrated from a functional, biological, and aesthetic point of view (Figs. 82 to 87). Cheilognathopalatoschisis (partial or complete) results from disorders during embryonic development. This tear may affect only the lip, maxilla, and labrum or the lip, maxilla, and palate (rarely only the palate). The causes of this laceration can be endogenous (congenital) or exogenous (e.g., viral infections during pregnancy, medications, vitamin, or oxygen deficiencies). A distinction must be made between unilateral and bilateral lacerations. The treatment of cheilognathopalatoschisis requires, as a rule, the synergistic co-participation of orthodontic-surgical treatment and mainly occurs within specialized facilities (specialized clinics, university clinics).

The present case presented an old restoration at sextant 2 with a noticeable loss of bridge element 2.1 associated with periodontal disease (Figs. 88 to 97). Therefore, after managing the supporting tissues with nonsurgical periodontal therapy, the old restoration was replaced with a new dentoalveolar device. Furthermore, to ensure proper cleanability and management of the prosthetic spaces, the architecture of the edentulous area (also following the extraction of element 2.1) was improved with hard and soft tissue grafts during the provisional phase (Figs. 98 to 105).

Once again, restoration of the abutments and definition of a prosthetic finishing line readable by the optical scanner combined with functionalization of the provisional and aesthetic integration allowed access to the final stage of the prosthetic procedure. Next, we moved on to a CAD design of the alveolar tooth device from a correct optical impression of the tissues


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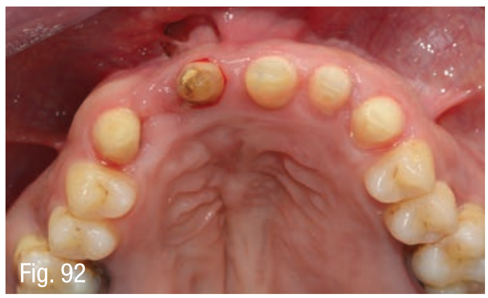
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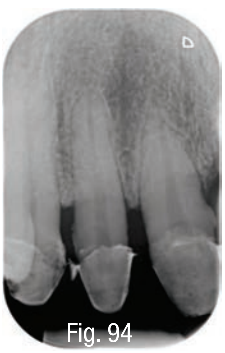
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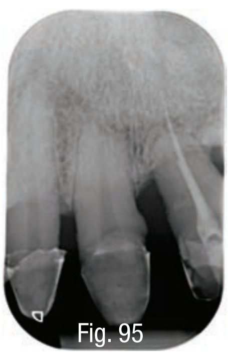
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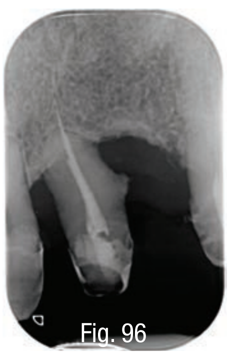
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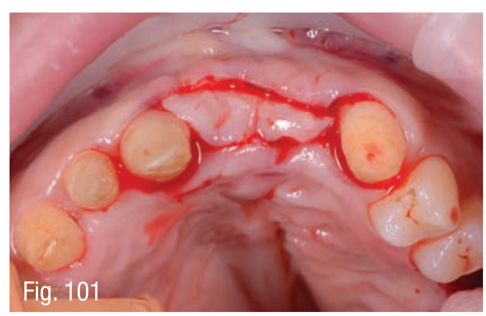
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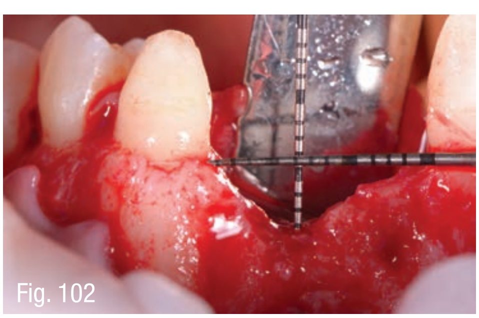
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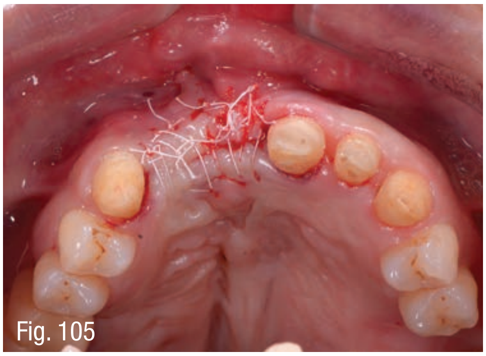

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Fig. 108

and abutments. Because of its shape and structure, it required several in situ trials during the various processing stages (Fig. 106). Finally, the result obtained with zirconia layered into the vestibular and gingival framework allowed the case to be finalized excellently and the prosthesis to be integrated with respect for the oral and perioral tissues (Figs. 107 to 118).

Discussion

Fixed prosthetics nowadays use several tools that allow a more accurate representation of the natural dentition. Design software and optical scanners are helpful for the clinician and dental technician to design and fabricate prosthetic devices very similar to natural teeth. The CAM stage is the natural consequence of virtual design, whether a working model or a prosthetic crown. Some materials are better suited than others to be included in this manufacturing process, such as zirconia.

In the first part of the article, we mentioned this material's mechanical and clinical characteristics. More purely clinical features are also worth mentioning. In the cases presented, the form of zirconia used is monolithic zirconia, which, compared with layered zirconia, has more excellent fracture resistance even during simulated ageing with thermocycles. When properly used, CAD/CAM methods allow zirconia to achieve marginal accuracy of 30 to 90 microns and the possibility of proper sit-in on both vertical and horizontal preparations. Framework design can affect the improvement of mechanical qualities.

Good "support" in the shape of the framework can avoid chipping phenomena and better distribute force vectors in eccentric movements giving more stability to the system. The wear pattern also gives the occlusal stability of this material during chewing cycles, which is much more similar to that of natural tooth enamel, provided it is properly polished. For this reason, the presence of occlusal retouching could alter the surface obtained in the laboratory. Therefore, it is always advisable to carry out mechanical polishing with appropriate pastes and rubbers to avoid leaving unglazed areas that could produce antagonist wear with relative loss of occlusal stability over time.

In the cementation phase, tetragonal zirconia is an inert material and allows it to be combined with different types of cement. The introduction on the market of ceramic primers, based on stabilized silane mixes and MDP, has allowed for chemical and mechanical retention at the zirconia surface by resin


Fig. 109


Fig. 110


Fig. 111


Fig. 112


Fig. 113


Fig. 114


Fig. 115


Fig. 116


Fig. 117

cement. A sandblasting with aluminium oxide from 1 to 3 atmospheres is essential as an adhesion promoter. On the undisputed potential of CAD, it is good to remember that a system or circuit digital is an artificial dynamic system that manipulates numerical input signals, which represent the information to be processed, to produce output signals that are also numerical.

Analog-to-digital conversion is a procedure that associates an analog signal with a numeric signal. This process today is carried out exclusively by dedicated integrated circuits or hybrid circuits. The idea behind digitization is as follows: any physical quantity of interest is measured, and the value of its measurement is encoded as a binary number; if the quantity takes on different

Fig. 118

values over time, it will be calculated at regular intervals, resulting in a sequence of numbers using the following procedure:

Sampling. In signal theory, it is a technique of converting a continuous signal in time or space into a discrete signal by evaluating its amplitude at regular time or space intervals.

Quantization. When measuring a physical quantity, the set of values it can take in nature is a straight set consisting of infinite points, i.e., the amounts in question are thus "analog." However, unlike sampling, the nonlinear quantization process is not reversible. That is, it is not possible to reconstruct the actual values initially assumed by the physical quantity. Quantization is, therefore, a source of distortion that modifies the original signal, approximating its value with one that is close but not identical. Thus, the quantization process always induces approximations and distortions.

Code. In computer science, it is a system of signals, signs, or symbols conventionally designated to represent information.

Conclusion

Also, in this second part of the monograph, Analog and Digital are terms of the methods and technologies used. It is deemed proper to point out how common sense often associates analog with a meaning of old, of the past, of low quality; digital is, on the other hand, synonymous with new, innovative quality. Today, "perfect digital systems" are presented as super-performing, while analog systems are offered as outdated and inaccurate. The reality is somewhat different.

Although the authors are inclined to believe that digital is a handy working tool today in dealing with and speeding up specific procedures, they also believe that numerous techniques at present must remain analogue both because of the limitation of current software in simulating the masticatory organ in toto, and in managing what is indispensable to achieve the perfect clinical integration of each prosthetic device in making truly individual "creativity" wisely minded managed by the terminal organ of knowledge... the "instrument of instruments": our hand. Sd

Acknowledgements
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