

# Safety and reliability with CAD/CAM technology

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clinical protocol. Simplicity for the dental technician primarily concerns the time required to design and manufacture a restoration. However, in order to ensure an efficient workflow, a user-friendly software interface and intuitive handling are also of utmost importance.

Current scientific findings and clinical experience underscore the need for adequate material manufacture and framework design to minimise clinical failures, such as chipping of veneering ceramics or fracture of frameworks. The most important request, especially when working with zirconia substructures, is that the framework be anatomically designed and require no manual post-processing adjustment. In the past, double scans were performed in order to achieve this goal. New software design tools eliminate these time- and cost-intensive steps, as anatomic tooth-libraries support the user in ideal coping and framework design. Automatic cut-back functions increase ease of use and provide an additional margin of safety by ensuring homogenous veneering material thickness. An equally important aspect to consider is the design and dimension of the connector cross-section for fixed dental prostheses. Only if minimum connector dimensions are respected will long-term clinical success not be jeopardised. Newly developed software tools support the user in the virtual design of the frameworks and provide immediate feedback on the cross-sectional area, connector height and width, and coping thickness.

The most eminent facts for the practitioner are that no major changes in clinical protocol are required when working with CAD/CAM technology and industrially manufactured components. Only when it comes to oxide ceramics are slight modifications of preparation design required for long-term success. These are limited to a slight chamfer margin preparation, provision of an adequate occlusal space of 1.5 to 2 mm and rounded edges (eliminating sharp transitions). The true benefit when working with materials such as zirconia or aluminium oxide is that conventional cementation protocols can be applied. Adhesive luting—a require-

**Figs. 1a & b** Application of zirconia for long-span restorations requires high manufacturing precision and excellent material quality. Only if colouring pigments are equally distributed in the framework will material properties be optimal.

**\_Today, dental technicians and** general practitioners are challenged by an ever-increasing number of CAD/CAM systems in the dental market. In order to determine which system is best suited, various aspects need to be considered. While CAD/CAM technology was initially associated with zirconia-based restorations, advanced systems offer an extensive range of materials and solutions for both natural teeth and implants. The benefits are not limited to a more cost-efficient fabrication of dental restorations in the laboratory; practitioners and patients benefit from the technological advancements equally. This article discusses the various aspects that need to be considered in the decision-making process.

## **\_Simplicity in clinical and laboratory routines**

A key aspect of the successful application of new technologies and clinical protocols is the time required to adapt to and utilise a system in a daily routine. This aspect is not only of relevance for the dental laboratory in manufacturing a restoration, but also to the practitioner considering changes in



**Figs. 2 & 3** Efficient CAD/CAM systems support the dental technician (NobelProcera System software, Nobel Biocare) by providing automated tools for anatomic framework design (Figs. 2a–c) and in manufacturing the ready-to-use components to eliminate any alterations after sintering (Figs. 3a–c).

ment for all glass-based ceramics—is only applicable in clinical situations with reduced vertical crown height or extensive preparation taper in which loosening of a restoration is likely (Figs. 1–5). Clinical simplicity is relevant not only to restoring natural teeth, but also to placing dental implants. It is important to realise that CAD/CAM-manufactured implant superstructures do not require any change in clinical protocol when compared to conventional cast restorations. Rather, the consistent fit of milled components reduces the need for chairside adjustments significantly.

### Safety for the patient

Providing the patient with a reliable and long-term successful restoration is key in today's highly competitive dental market. Product and material quality significantly influence the long-term clinical outcome. From a clinical perspective, important aspects to consider include long-term stability in the oral cavity, bio-compatibility, post-processing options (for example, type of veneering material), reasonably low costs and clinical versatility. While

the aesthetic potential was initially due to using high-strength all-ceramic restorations, the true benefit of Y-TZP/ZrO<sub>2</sub> (yttria-stabilised polycrystalline tetragonal zirconia), for example, is its excellent bio-compatibility paired with flexural strength values that allow for application in any area of the oral cavity for both natural teeth and dental implants. When in close contact with the surrounding tissues, the reduced plaque and bacterial accumulation, as well as the development of currently undefined pseudo-attachments leads to long-term tissue stability around these components (Figs. 6 & 7). This fact makes zirconia products the primary choice not only for non-compromised clinical situations, but also for pre-existing periodontal conditions whenever restorations, such as implant abutments, are in close contact with surrounding tissues.

Despite these advantages, it is important to understand and respect the material properties of these materials. If inadequate space or extensive leverage arms are unavoidable, alternative materials should be selected. Advanced systems such as the NobelProcera system (Nobel Biocare) offer

**Fig. 4** Shaded zirconia (NobelProcera Bridge Shaded Zirconia, Nobel Biocare) guarantees maximum strength combined with excellent aesthetic results and application of any veneering material within the CET range of zirconia.





Fig. 5a

Fig. 5b

**Fig. 5** \_Intra-oral lateral and occlusal view of definitive solutions; the clinical benefit of zirconia products is the application of everyday clinical protocols, including cementation with conventional cements.

a wide range of materials ranging from aluminium and zirconia-based oxide ceramics, titanium, acrylics and non-precious alloys.

the design and dimensions according to the anticipated final contour of the definitive restoration is achieved in a few minutes instead of taking several hours with conventional fabrication protocols.

**Figs. 6 a-d** \_Standard clinical protocols apply when restoring natural teeth or dental implants with cement-retained crowns. For long-term success, it is important to position the abutment-crown margin at the level of or slightly below the gingival margin to ensure complete removal of excessive cement.

An indispensable factor for long-term clinical success of implant-retained superstructures is the precision of fit. Depending on the complexity of a restoration, poor fit can have a significant impact on function and stability in the oral environment. In terms of reproducible precision, CAD/CAM technology clearly outperforms conventional framework-manufacturing techniques. New generation software tools eliminate the need for time-consuming framework design on the master cast. Instead, the scan of the implant position can easily be matched with the scan of a wax-up, followed by a virtual framework design in the CAD tool. Adjusting

### **\_Cost-efficient solutions for laboratory and patient**

Another aspect of providing cost effectiveness and safety is centralised manufacturing of products. Centralised milling evidently outperforms in-house systems: the workflow is permanently monitored; industrialised fabrication guarantees consistent quality; materials can be ordered as needed for any particular situation, eliminating the need for stock components; and time-consuming and expensive adjustments, updates, or repairs do not



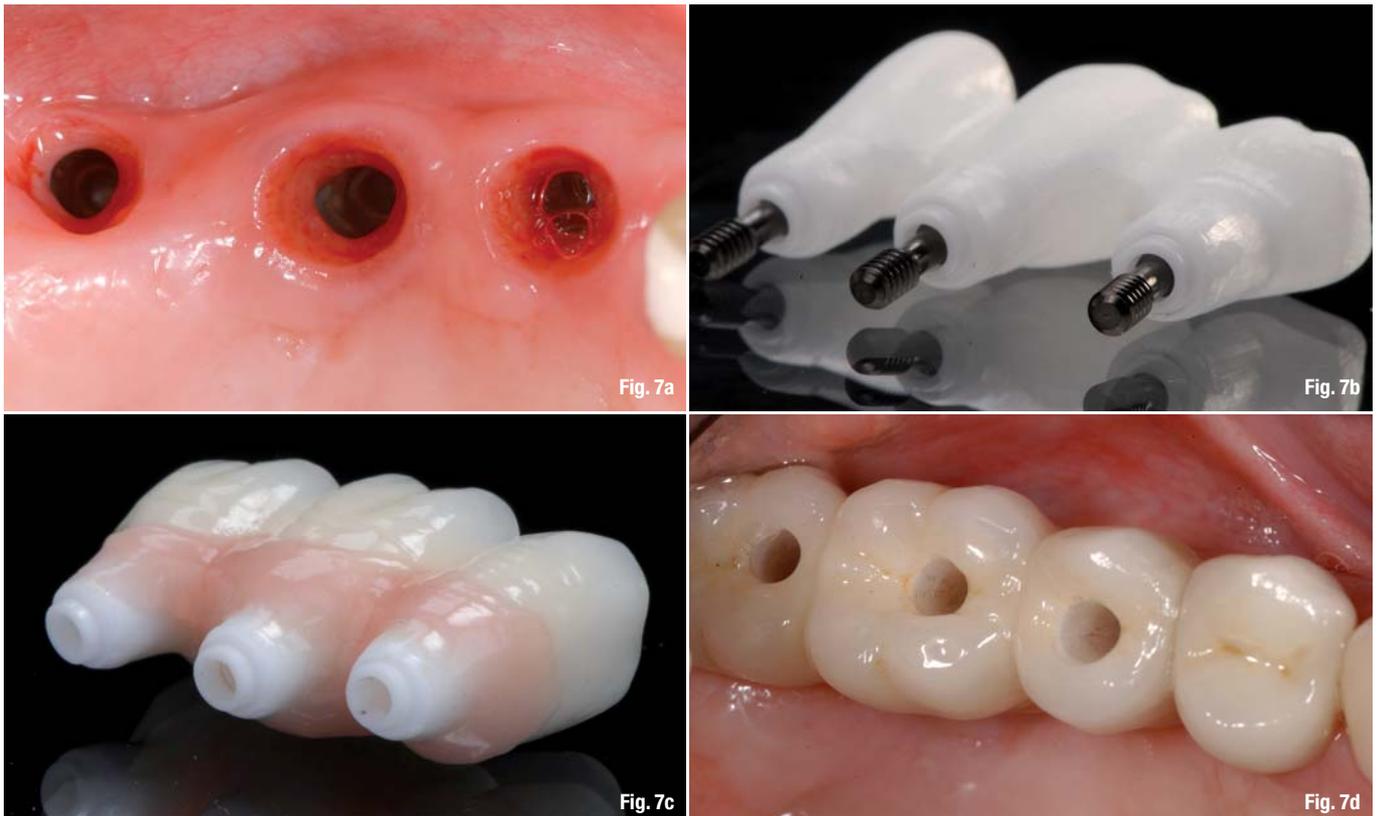
Fig. 6a

Fig. 6b



Fig. 6c

Fig. 6d



accumulate. From a cost-saving perspective for laboratories, the delivery of all metal frameworks of the NobelProcera system highly polished and ready-to-use adds to the true benefits of centralised manufacturing. The five-year warranty on all products cannot be met by conventional fabrication techniques. The warranty ensures that if complications occur during clinical function, a new product can be ordered free of charge. Here, the uniqueness of virtual planning comes into play again, as all data is always available even after years and merely requires the click of a button to reorder.

### Benefits of a versatile CAD/CAM system

CAD/CAM technology has significantly revolutionised dental laboratory techniques and protocols. Advantages related to material and manufacturing processes will promote the continuous adoption of CAD/CAM systems over conventional casting techniques, as the technology offers several benefits compared to conventional framework fabrication. This development provides true benefits for the dental laboratory, the practitioner and, above all, the patient. From a laboratory perspective, the benefits of the technology and the new NobelProcera system are obvious. Cost-efficient and time-saving workflow with only one CAD/CAM system in the dental laboratory, high-quality products with unrivalled precision and free-virtual design options, and centralised production.

The greatest advantage of the NobelProcera system is its clinical versatility. Not only the clinical situation, but also patients' expectations and means can be met. The base components such as copings, frameworks and bars always guarantee maximum precision, material homogeneity and stability for all patients. This is true whether a low-cost, non-precious alloy substructure is veneered with resin or ceramic material or a high-end all-ceramic solution is requested, whether a conventional denture set-up is retained by an overdenture bar or an implant-retained removable restoration is finished with custom all-ceramic teeth and individualised gingiva-coloured composite.

**Figs. 7a-d** Screw-retained restorations on dental implants (Nobel Active Implant, Nobel Biocare) simplify the clinical protocol by eliminating the need for correct alignment of multiple single abutments, in the case of a cement-retained bridge, allowing for easy removal if required (NobelProcera Implant Bridge Zirconia). The availability of NobelProcera restoration for use with numerous implant systems and platforms increases the laboratory and clinical efficiency of the system. The application of zirconia frameworks allows for easy closure of screw access channels with conventional composite resin.

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