CERAMIC 3D PRINTING: A STEP BEYOND IN DENTAL PRODUCTS

WORDS: M.SC. ISABEL POTESTIO, BUSINESS DEVELOPER AT LITHOZ GMBH

Due to their excellent biocompatibility, ceramic materials are recommended as the material of choice, from dental restoration and implants to bone grafting material. Unlike metals, there is no debate around ion release or corrosion and they have long-term stability both in soft and hard tissue. In addition, ceramic materials show significant advantages when it comes to fabricating restorations that appear as natural as possible in the long-term. From an aesthetic point of view, all-ceramic restorative materials have significant advantages over metals in the optical imitation of the natural tooth; no grey shadows in gingival areas and implant collars in case of gum retractions.

Often referred to as 'ceramic steel', zirconia is commonly used in the field of prosthetic dentistry to restore lost teeth or tooth substance by means of tooth supported crowns, Fixed Dental Prostheses (FDPs) and defect-oriented restorations such as occlusal veneers. Zirconia can also be used when it comes to replacing missing teeth by means of dental implants and implant supported prosthetic parts.

Nowadays, the CAM (Computer-Aided Manufacturing) procedure for processing zirconia is performed by subtractive techniques, meaning that the zirconia parts in the aforementioned indications are milled from a prefabricated zirconia blank in a pre-sintered condition – the so-called white body. In this state, zirconia has a low inherent strength. Due to this fact, during subtractive machining, thin borders can break out and consecutively lead to an evident discrepancy between the design and the fabricated part. For this reason, thin borders and edges often have to be designed over-contoured in these areas to prevent the edges from breaking out during machining. However, this also results in a considerable amount of post-processing work in these zones. Since the crown margin is, along with the occlusal surface, a very important area of a crown and bridge restoration, the post-processing must be carried out very carefully and under the stereomicroscope. This post-processing is considerably time consuming and costly. Furthermore, fissures of the occlusal surfaces also require post-processing, as rotating instruments can only reproduce the classic tapered fissure geometry to a limited extent.

With increasing aesthetic and performance demands, ceramic 3D printing rises as a solution which meets the challenges of the dental sector. It offers newfound design freedom as complex 3D metal-free applications are produced layer-by-layer while enabling the technological limitations of standard ceramic processes to be overcome.

With 3D printing there are no limitations to where the milling burst can get into and no limits to the thickness of the restoration. Minimally invasive veneers can be reliably fabricated with very thin borders and feather edges down to 100 µm and with better mechanical stability compared to milled veneers. In addition, aesthetic results of monolithic reconstructions can be achieved as 3D printing can produce geometries which resemble the nature of an occlusal surface.

For replacing a missing tooth, endosseous screw-type dental implants offer a suitable treatment option. Using Lithography-based Ceramic Manufacturing, it is possible to manufacture complex shaped and patient-specific ceramic implants in large numbers in a highly reproducible manner. In a production environment, machines are capable of producing upwards of 60,000 items per year.

Furthermore, ceramic 3D printing offers different applications within the field of cranio-maxillofacial surgery and treatment of critically-sized bone defects in the lower jaw. The challenge in treating such large defects is that, without proper measures, the bone itself will not be able to heal the defect. Thus, a dual approach is presented here, with a shell of high-strength zirconia giving the proper support during the healing phase and the inner volume of the implant being made of bioresorbable beta-Tricalcium Phosphate (ß-TCP). It has been proven that ß-TCP has good osseointegrative properties and that by choosing suitable pore and strut dimensions, the bone ingrowth can be significantly influenced. The ß-TCP will be resorbed by the cells and replaced by newly formed bone, while the zirconia cage can be left in place due to its biocompatibility.

SHOWN:
ZIRCONIA IS USED TO RESTORE LOST TEETH OR TOOTH SUBSTANCE BY MEANS OF TOOTH SUPPORTED CROWNS, FIXED DENTAL PROSTHESES AND DEFECT-ORIENTED RESTORATIONS