

CAD/CAM Technology Concerning Biocompatibility in Zirconia All-ceramic Restorations

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Replacing alloys with alternative materials is a continuous challenge in dental medicine. The study aims to present technological aspects concerning zirconia CAD/CAM all-ceramic restorations, pointing out their advantages versus classical metalo-ceramic restorations. The authors completed several zirconium oxide-based ceramic restorations using the CAD/CAM method, with Zeno Tec system (Wieland Dental). Zirconium oxide-based ceramic restorations are definitely superior to metal-based ones, on all counts: esthetic, resistance, mechanical properties, biocompatibility, resistance to corrosion. Zirconium oxide-based ceramics is a viable alternative as it represents the hi-tech approach that contributes to a superior physiognomic restoration.

Keywords: zirconium-oxide, CAD/CAM, all-ceramic restoration

CAD/CAM systems are computer-aided design (CAD) and computer-aided manufacturing (CAM) systems which have been used in dental medicine since 1980. They represent a hi-tech approach used in long-term physiognomic restorations. The dentures produced by using this method represent a high-class alternative to hand made classical metaloceramic or fully ceramic crowns [1,2].

Experimental part

Zirconium oxide-based ceramic blocks, the so-called “ceramic steel”, are characterised by their high mechanical resistance, therefore being suited for extensive physiognomic restorations, even in the molar area. Zirconium (zirconium silicate), one of the oldest solid terrestrial minerals, was discovered in Australia, and is a natural gem (precious stone in a pure crystal state). Dental medicine uses zirconium oxide (ZrO_2), which is a white biocompatible material, resistant to corrosion, chemically inert, non-toxic, with a high tissue-tolerance, esthetic, wear-resistant, and with very good mechanical characteristics. Most of the times, zirconium oxide is combined with yttrium oxide (Y_2O_3), for a better resistance [7].

The drilling of pre-synthesised is conducted in the incomplete synthesised stage, followed by the stages of heading-contraction-synthesisation, in special ovens, until the final shape and toughness are obtained. Eventually, the prosthetic piece is plated with a special ceramic in order to cover finer porosities, and after that it is heated at low temperatures for a higher esthetic aspect and to prevent antagonist wear [6]. Plating ceramics are less tough than the ceramic used in manufacturing infrastructure blocks.

The ZenoTec (Wieland Dental) system, used by the authors, is a laboratory system, the model being manufactured based on a conventional print. The model is scanned with a 3 Shape D tri-dimensional laser system, a fully automated process that lasts for 1-2 min (fig.1).

After scanning, the working model and the antagonists can be visualised on the computer monitor (fig.2).

An individual scanning has been performed for each abutment, in order to get a high-quality virtual model.

The ends were shaped on the virtual model using the specific Zenotec Manager software (fig.3 a). The boundaries of the model are automatically detected by the software, still certain areas will need further adjusting.



Fig.1. Scanning of the model

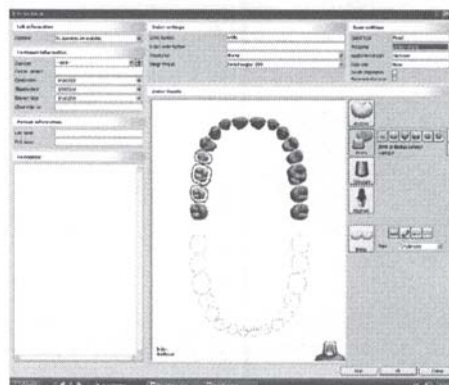


Fig. 2. Selecting the restorations

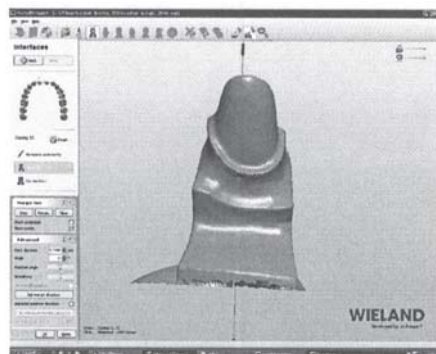


Fig. 3. Shaping the ends

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The areas that after adjusting have become too thin will be marked in red. The insertion axis and the space necessary for the cement are then established.

The next stage is making the ceramic infrastructure of Zeno Zr disks. The restoration piece is placed (virtually) in an optimal position on the zirconium disk and the supporting rods are attached (fig.4).

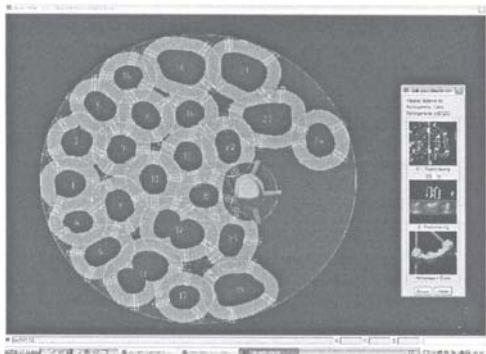


Fig. 4. Positioning on the zirconium disks

The presynthesised disk is placed in the drilling unit and the computer-guided drilling starts (fig.5). The drilling process is fully automated and it lasts for a few minutes. Afterwards, the supporting rods are severed and the frame are submerged in a special ZirColor solution.

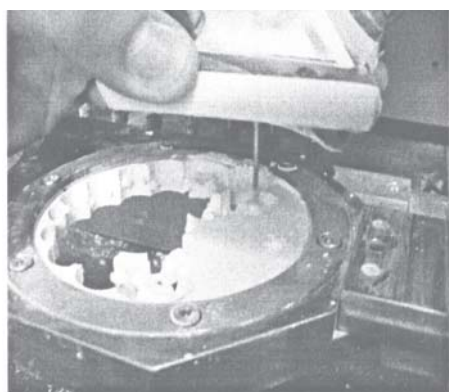


Fig. 5. The drilling unit

Approximately 10 min later, the frame have achieved in depth pigmentation and are placed in the synthesisation oven (fig.6). After selecting the appropriate zirconium frame synthesisation programme, the process starts and lasts for 11 h.

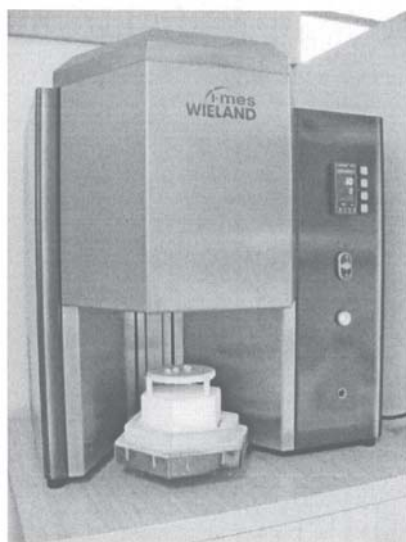


Fig. 6. Synthesisation of zirconium frame

Following synthesisation, the frames are processed, removing existing irregularities or material surplus left over from computer-guided drilling. After fitting the denture in the patient mouth, the frames are prepared for ceramic plating by smoothing the surface that is to be plated.

Plating is done with a special ceramic material, Zirox New generation Ceramics. Synthesisation is carried out in a Vita Vacumat 40T oven (fig.7), produced by the Vita Company.

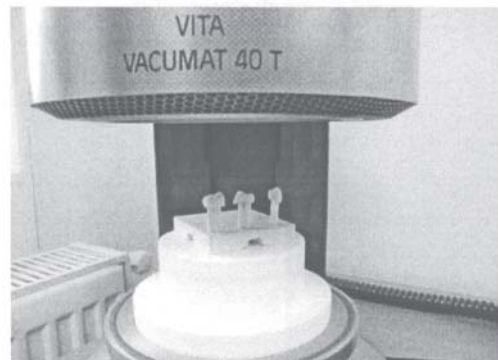


Fig. 7. Dentin and incisal synthesisation

After synthesisation, the restoration pieces are refined. The last stage is that of glazing.

In order to obtain special colour effects, certain pigments in the ceramic kit are used (fig.8), painting the occlusal surface, the grooves and the cervical third of the tooth, thus giving a more natural aspect to the pieces. The final synthesisation programme eliminates vacuum heating in order to prevent the surface migration of small air bubbles, which would confer a rough aspect.

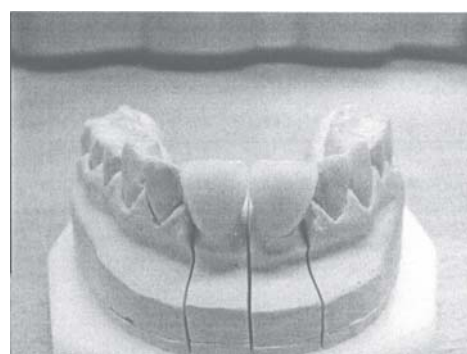
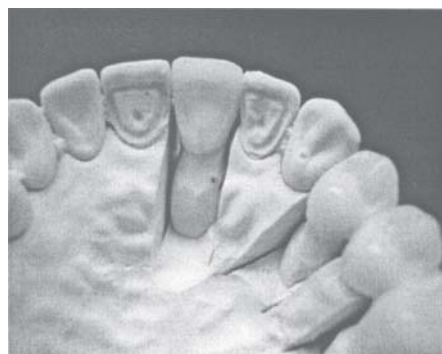


Fig. 8. Final restorations

Results and discussions

Zirconium processing technique represents a state-of-the-art development in dental restoration as it gives absolute quality, durability and total compatibility [5,7]. Unlike metal-mounted porcelain, zirconium allows light to penetrate it from all directions, the esthetics of the restoration being exceptional, with a natural and perfect

aspect [4]. Zirconium-based crowns are much lighter than metallic-based ones, consequently the patients' adaptation to the new prosthetic pieces is much faster [1,3]. This is an extremely important aspect, mainly in multi-element fixed restorations. The precision of zirconium oxide-mounted restorations is granted by the computer-guided process of cutting from a solid zirconium oxide block, which results in an extremely precise adjustment [9].

The use of CAD/CAM systems contributes not only to reducing working stages and, implicitly, the working time, but it also represents an advantage over standard ceramic, being an obvious benefit when one chooses zirconium-based ceramics [7,8].

Conclusions

Zirconium oxide is a biocompatible material, very resistant to corrosion, chemically inert, non-toxic, with a very high tissue tolerance, esthetic, wear-resistant, and with excellent mechanical characteristics [2]. Besides

being biocompatible, zirconium oxide also has the advantage that, unlike metallic structures, it does not corrode, it does not conduct electricity and temperature, it is white and can be coloured with a special solution to a shade similar to that of dentin, with exceptional esthetic results.

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