

Digital Histo-Anatomic Ceramic Restorations

Jef M Van Der Zel*

Professor, Computerized Dentistry, Academic Centre for Dentistry Amsterdam, The Netherlands

*Corresponding Author: Jef M Van Der Zel, Professor, Computerized Dentistry, Academic Centre for Dentistry Amsterdam, The Netherlands.

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Abstract

The manufacturing process of highly aesthetic restorations, with tooth-colored materials, is currently dominated by manual production procedures, the outcome of which is highly dependent on the knowledge and skills of the executive dental technician. Meanwhile, because of the simplicity of the production process, monolithic CAD/CAM restorations of zirconia become more commonplace in everyday routine. Layered aesthetic restorations show significant advantages over monolithic restorations, but are more difficult to manufacture with the aid of digital technology. The most important factor for the success of automated digital production of aesthetic front restorations appears to be the anatomy of the individual dentine core. This article describes the Primero (Prosthetic Mimetic Restoration) method for layered restorations with the histo-anatomy of natural teeth.

Keywords: Histo-Anatomic Structure; CAD/CAM; Zirconia Ceramic; Dental Crowns; Porcelain

Introduction

Lately monolithic restorations are more often used in particular for fear of chipping of the porcelain with layered restorations. Chip-resistant porcelain and innovative technology now make it possible, however, to produce very durable layered restorations. This technology puts an end to the never-ending quest for biomimetic simulation with CAD/CAM [1,2]. In this regard, the most important factor for the optical integration and aesthetic appearance of dental restorations is a thorough understanding of the histo-anatomical structures and dynamic light interaction of natural dentition. In particular, the three-dimensional shape of the dentine core, as defined by the dentin-enamel transition (DET), and the special three-dimensional surface of the dentine core with its S-shaped curvature, turns out to be decisive for the optical appearance of a crown. The DET and the enamel outer surface (EOS) are essential three-dimensional structures of the tooth that significantly affect its visual appearance (Figure 1).

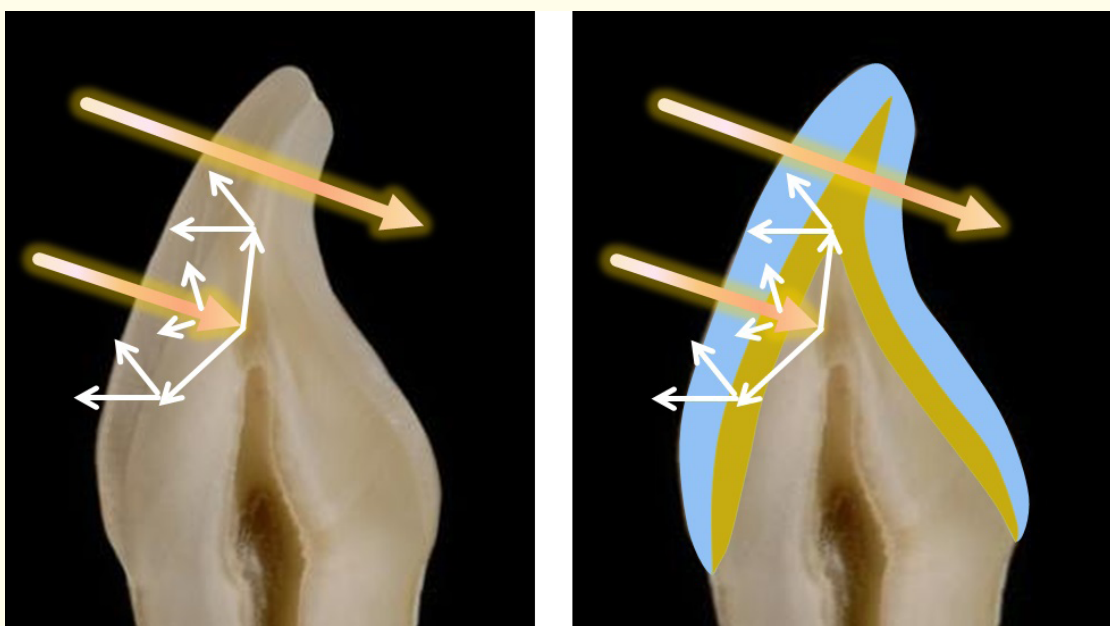


Figure 1: Natural element and crown with similar light dynamics.

Therefore, it is a prerequisite for the production of layered dental restorations copying the histo-anatomic tooth structure with three-dimensional information on the outer and also the inner architecture of natural teeth. This information forms the basis for the production of layered restorations. Korenhof [3] discovered that the dentin-enamel transition (DET) exhibits a greater degree of “primitiveness”, compared to the enamel surface (EOS): the DET has rudimentary cuspules, ridges and cingula that are not clear at the EOS. On the basis of the lack of a topographical correspondence between the DET and EOS, Korenhof suggested that the DET may be more useful than the EOS for the determination of the dynamic relationship between the two. The DET includes significant information about the outer surface of the tooth. Conversely, this can also allow for the determination of the inside architecture (DET) from the outer surface. The outer and inner geometry are dynamically linked to each other. This implies that a virtual alteration of the enamel-outer surface (EOS) in the CAD software automatically leads to a change of the corresponding inner structure [4].

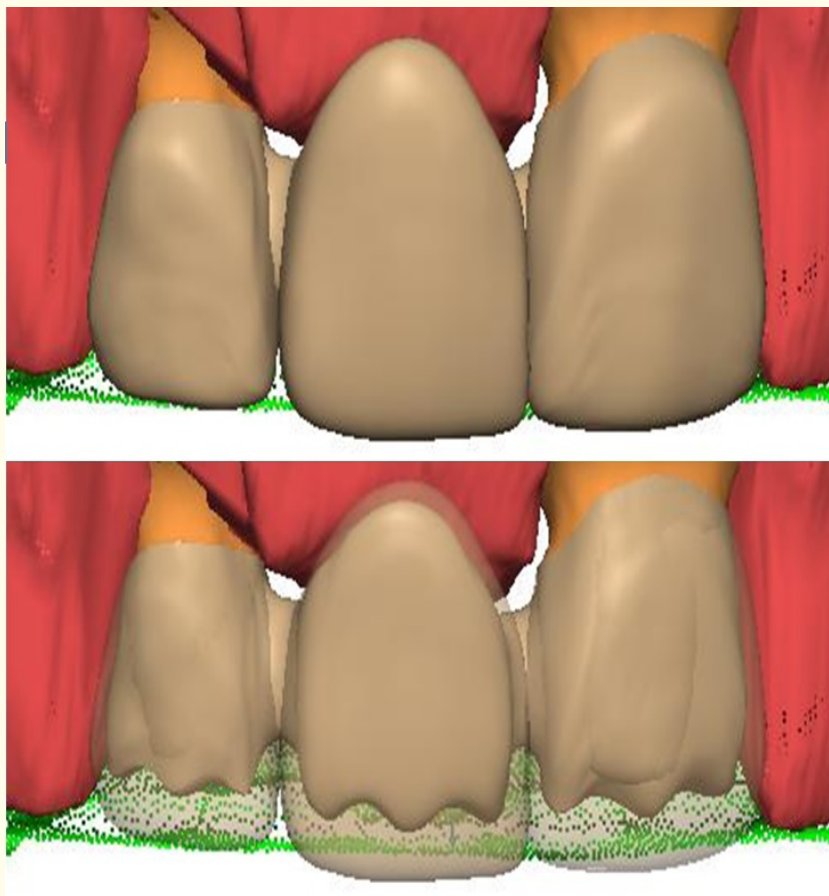


Figure 2: STL-data of layered structure: EOS (top) and DET (bottom) of the front bridge.

Technique

The capture of outside surfaces in the mouth takes place with the intra-oral scanners, or through a laboratory scan of a “3-in-1” scannable impression (the closed-mouth impression technique). The digitizing of the structure within the tooth, the dentin-enamel transition, can now be achieved with optical coherence tomography (OCT), and transillumination, which has been in use for several years in order to detect caries.

The dentine core, including the dentin-enamel transition, is milled in dentin-colored zirconia which has been isostatically compressed with a pressure of 3000 bar. This pressure is necessary in order to achieve a 100% density with a minimal shrinkage during sintering which can never be achieved by 3D print-technology, which takes place at atmospheric pressure. The porcelain outer layer is applied by a centrifugation of a liquid suspension at 3000 rpm in a negative form of EOS on the zirconia dentine core. The centrifugal pressure ensures a good contact between the two materials and a 100% porcelain density, which with manual application is not feasible. Because of the direct contact between dentine-colored zirconia and the zirconia shines through the translucent porcelain layer; all the more as the porcelain layer is thinner. This creates the same color dynamics with color “from within” like in natural teeth [5]. Although the restorations, after firing, show nearly all their natural aesthetics, individualization (chalky stains, smoke lines, emphasizing fissures, etc.) on the basis of photos and scans, is indispensable. The contact points are checked using 3D printed models. Because, during baking, the very dense porcelain layer shrinks linearly perpendicular to the zirconium oxide surface, deviations from the designed outer surface remain negligible.

The aesthetic result can be described as excellent (Figure 3). The crowns and bridges exhibit light dynamics similar to that of natural teeth. This is probably caused by scattering of the light on the dentine core which leads to different effects in the incisal area (Figure 1). Because of the high translucency the presence of apatite crystals give the enamel an opal effect (blue absorption), in the incisal area, like it occurs in a natural tooth.



Figure 3: Four Primero anterior crowns with a layered histo-anatomic build-up.

Because with densely compressed zirconia it is much easier to mill sharp edges, than with the usual brittle, pre-sintered zirconia blocks, the copings and bridge substructures are not weakened by necessary grinding of the marginal edge after sintering. As a result, supra-gingival minimal invasive preparations, such as knife edge (extended bevel preparation) are possibly without the risk of the out-break of the marginal edge [6].

Discussion

The current procedure describes the production of durable layered restorations with an innovative, simple method on the basis of the copy of the histo-anatomic natural tooth structure. This makes the manufacture quick and predictably. The costs of the production process can be valued as large cost-saving compared the manual application of porcelain by a dental technician. The products exceed in their optical behavior even their natural model (Figure 3). Moreover, the production effort is considerably simplified in comparison with other known methods for layered restorations, such as manually firing, press-on technique and digital veneering by sintering a tooth colored glass cap onto a zirconia cap [7]. The latter technique makes it, when undercuts are present in the dentin core, impossible to fit the outer part on the zirconia cap. In the current method, the porcelain is pressed by the centrifugal force in the negative EOS-shape and, therefore, reaches all the undercut areas correctly.

Summary

The histo-anatomy of the tooth implies that the dentine core is the key to CAD/CAM generated anterior aesthetics. It is of the utmost importance in the generation of the individual 3D-tooth structure, including the outer surface (EOS), and the dentin-enamel junction (DET). This makes a new approach possible for the production of anterior teeth.

With the described method it has been proven that a bilaminar technique that simulates three-dimensional structures to the dentine and enamel, is suitable to achieve convincing aesthetic results. A very important factor for further development is the capture of the natural structure of a dentine core of adjacent teeth in the patient with intraoral digital acquisition devices.

Bibliography

1. Van der Zel JM. "Ceramic-fused-to-metal restorations with a new CAD/CAM system". *Quintessence International* 24.11 (1993): 769-778.
2. Bazos P and Magne P. "Bio-emulation: biomimetically emulating nature utilizing a histo-anatomic approach structural analysis". *European Journal of Esthetic Dentistry* 6.1 (2011): 8-19.
3. Korenhof CAW. "The enamel-dentine border: a new morphological factor in the study of the (human) molar pattern". *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* 64B (1961): 639-664.
4. Van der Zel JM. "Zahnformen mit binärer Innenstruktur". *Die Quintessenz der Zahntechnik* 39.7 (2013): 934-936.
5. Dozić A., et al. "The influence of porcelain layer thickness on the final shade of ceramic restorations". *Journal of Prosthetic Dentistry* 90.6 (2003): 563-570.
6. Dekker JWJM., et al. "Klinische evaluatie van CAD/CAM-kronen met een natuurlijke laagopbouw". *Nederlands Tijdschrift voor Tandheelkunde* 121 (2014): 101-105.
7. Beuer F., et al. "High-strength CAD/CAM-fabricated veneering material sintered to zirconia copings - a new fabrication mode for all-ceramic restorations". *Dental Materials* 25.1 (2009): 121-128.

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