Prosthetic rehabilitation in the maxilla with fixed Implant-supported ceramic prosthesis – conventional technic x CAD/CAM: case report

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Abstract: Dental implants are widely recognized as a viable treatment for patients with totally edentulous jaw and/or maxilla. Implant-supported fixed prostheses are an predictable treatment option with proven durability, when their infrastructure is adapted and feature passivity to the implant/abutment system. The preparation of these infrastructures can be performed using the lost wax technique or by the digital scanning and milling system known as CAD/CAM. On these infrastructures various coating materials can be applied, such as acrylic resins, acrylic prefabricated teeth and ceramics, conventionally applied or using the CAD/CAM system. The purpose of this article is, by means of reporting two clinical cases, to compare two techniques for creating implant-supported ceramic prosthesis: the conventional technique with metal infrastructure made by the lost wax method and glazing ceramic, and the digital milling technique, with infrastructure and teeth in monolithic CAD/CAM zirconia. **Keywords:** Dental implants. Mouth rehabilitation. Ceramics.

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» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

INTRODUCTION

Dental implants are widely acknowledged as a feasible treatment option[1,2,3] both for replacing missing teeth as well as for supporting extensive prosthetic oral rehabilitations, restabilising not only function, aesthetics and phonetics but also resoring patients' self-steem.[4] Fixed implant-supported prostheses are proven to be a predictable and durable treatment option for fully edentulous patients, with prosthesis success and survival rates ranging from 72,2% to 100%.[5]

Nonetheless, in order to increase longevity and predictability of the fixed implant-supported prosthesis it is paramount that a passive fitting is generated between the prosthesis and the abutment components.[6,7] A passive implant/abutment fitting minimizes both biological and mechanical occurrences.[8] According to Bränemark, an infrastrucuture can be defined as passive when the gap between the structure and the abutment is equal to or less than 10µm.[9] Anything wider than that could lead to misfittings that contribute to accelerate marginal bone loss around implants through the years.[10]

Many materials combinations can be used to manufacture fixed implant-supported prosthesis: metal infrastructure under acrylic resin, metal infrastructure under composite resin and metal infrastructure under ceramics. The manufacturing process may be the conventional one, through the lost wax technique, or through the digital scanning and milling method, known as CAD/CAM system. On top of these infrastructures, different materials may be applied such as acrylic resin, pre-fabricated acrylic teeth, conventionally glazed or CAD/CAM system ceramics. However, complications such as cracks, dislodged acrylic teeth, difficulty to conceal the underlying metal structure, wearing of antagonist teeth, ceramic chipping, fitting problems and time consuming repairs have led dental professionals to seek for other material options. As a result of that, zirconia has been one of the options proposed to manufacture fixed implant-supported prostheses' infrastructures.[11]

The advantages of manufacturing infrastructures through the lost wax technique includes the possibility of aesthetic optimization due to the possibility of casting the material applied over the metal, and also the expertise that conventional labs have developed in reproducing this technique. Among the drawbacks, one can highlight the adaptation problems resulting from material shrinkage, for it is rather common to have structures being cut, repositioned and welded, leaving welding spots on the structure that are considered fragile.[3,12]

The CAD/CAM digital milling system has the following advantages: accurate fitting, manufacturing process less sensitive to human error, biocompatibility (case of titanium structures associated to ceramics), longer cantilevers (case of zirconia infrastructures) and no welding spots. Its disadvantages include ceramics' low bonding strength to titanium, and the high cost involved in both the acquisition and operation of a CAD/CAM system.[3,7] The monolithic zirconia infrastructure manufacturing process, which in other words means milling a ceramic block, reduces the possibility of fractures and avoids ceramic chipping. Advantages such as high strength, minimum occlusal adjustments and accuracy in the abutment fitting are also worth mentioning.[11]

This paper aims at comparing, through 2 clinical case-reports, the manufacturing techniques of ceramic fixed implant-supported prosthesis: the conventional technique, with metal infrastructure cast through the lost wax method, covered with glazed ceramics, and the digital milling technique, with zirconia infrastructure milled through the CAD/CAM technology.

CASE REPORT

CASE 1

40 year-old, white, female, first came to the office for a rehabilitation therapy under the complaint of constant gingival bleeding and anterior missing teeth.

A thorough history was taken and a clinical examination was done during which long probing depths around all teeth, great attachment losses and generalized tooth mobility were detected (Fig 1). X-ray exam revealed great bone loss. The following lab tests were requested: blood count, coagulogram and fasting glycaemia.

Figure 1: Patient's preop conditions.

Following to the complete collection of the clinical data set and a full periogram, that revealed that the lab results were within normal range and that all upper teeth were irreversibly involved, the planning was done for a fixed implant-supported full denture with metal infrastructure and ceramic coverage, anchored by titanium fixtures.

Treatment Description

An initial alginate impression was taken and the stone cast sent to the lab for the manufacturing of an immediate full denture, respecting the pre-existing vertical dimension and with denture teeth colours matching the natural ones.

All teeth were extracted. Eight Titamax Cone Morse (Neodent) implants were placed in the maxillae in the corresponding position to the following elements: 11, 21, 13, 23, 14, 24, 16 and 26. Patient returned the next day to try and wear an immediate conventional Full Denture as to restore patient's aesthetics and phonetics, followed by phonetic tests during the healing period. The temporary denture was relined twice with Resina Soft Provisório (TDV).

After the healing period, an anatomical alginate impression was taken, and the stone model obtained was used as template for the manufacturing of a customized opened acrylic impression tray proper for impressions of implant connections. After assessing the thickness of mucosal tissue, mini-pillars were connected over the morse taper implants and their respective healing screws. The impression transfers were adapted over each mini-pillar and splinted with an 0,7mm orthodontic wire and Pattern (GC America) acrylic resin as to avoid distortions during the impression with the Precise (Dentsply) SVP material.

After 10 days the Ni-Cr alloy metallic infrastructure was checked for passive and free fitting (Fig 2). Once there were clinical and radiographic evidence that the metal bar was passive, lab went on with the Creation CC (Oraltech) feldspathic ceramic glazing over the metal alloy (Fig 3). Three occlusal adjustments were done, leaving very light centric relation contacts in the cantilever areas and adjusting the canine guide for posterior disocclusion.

Once the pieces were incorporated to patient's mouth, stability was checked and the necessary occlusal adjustments were done. Screw orifices were closed with light cured composite resin. The patient was educated on proper hygiene methods to clean the prostheses and about the need for professional maintenance to be done at every six months (Fig 4).

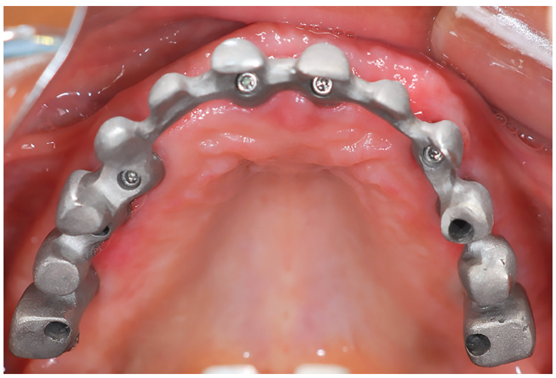

Figure 2: Conventionally manufactured metallic infrastructure being tried on.

Figure 3: Feldspathic ceramic being layered over metallic infrastructure.

Figure 4: Patient wearing fixed implant-suported prosthesis with metallic infrastructure overlaid with feldspathic ceramic

CASE 2

A 63 year-old female patient came to the clinic looking for rehabilitation treatment. Main complaint: fractured implant supported acrylic prosthesis. At the clinical examination, a full acrylic denture supported by 6 individualized cemented abutments over Straumann WN Standard Plus implants on the corresponding area to elements: 17, 15, 13, 22, 25 and 27. Implant on the area of 22 was diagnosed as non-osseointegrated.

After a thorough history was taken, clinical and radiographic exams requested and examined, a treatment planning was elaborated.

Treatment Description

The non-osseointegrated implant was removed and a new one was placed on the region of element 22. Incorporation of a temporary implant supported fixed prosthesis in acrylic resin was manufactured through the CAD/CAM technology for aesthetic tests. The permanent fixed implant-supported full denture was manufactured in monolithic zirconia.

Implant of element 22 was removed and a new implant was placed in the area with new mini-pillars. Next to that, the Precise (Dentsply) condensation silicone impression material was used to reproduce the position of implants in this new configuration, so that an immediate temporary prosthesis could be adapted sparing the new 22 implant, that rested for two months for proper osteointegration.

The old and fractured prosthesis was duplicated as to maintain its vertical dimension in order to manufacture the customized acrylic impression tray. After 60 days a new impression was taken with the Virtual (Ivoclar) addition silicone with the acrylic impression tray, positioning the transfers over the mini pillars, and splinting them with orthodontic wire and Pattern (GC America), with transfers being hold to the tray. The model obtained was scanned by the CAD/CAM system as to have the temporary acrylic fixed implant-supported full denture could be designed by the Zirconzahn Modelier (Zirconzahn) software. The A2 colour Temp Premium 95H16 (Zirconzhan) acrylic resin block was milled with the 2 L PMMA Premium (Zirconzhan) bur, to be delivered to mouth 2 days after impression. Phonetic and aesthetic tests were carried out in order to optimize the permanent prosthesis manufacturing process.

After patient spent 1 month comfortably wearing the CAD/CAM temporary prosthesis, the model was again scanned and a permanent fixed implant-supported full denture was designed and milled in monolithic zirconia by the CAD/CAM (Zirconzahn) system (Fig 5).

The Prettau Zirkon 95H25 (Zircozahn) zirconia block was milled by 2L, 1L, 1,5 XL and 0,6 size zirconia specific burs, during an approximately 5 hours and 13 minutes long milling process with an automated bur exchanging metal head. After the milling, a fine finishing was done by removing the connectors and refining the sulci and embrasures areas, as well as specific staining to Prettau (Fig 6) zirconia. The stabilizing bar was kept up to the end of the sintering, after which the material was sent to the oven (Zirkonofen 600) for a 12-hour cycle, during which the prosthesis is slowly cooled as to avoid thermal shock. Past this stage, the stabilizing bar is removed with burs and diamond disks and finished with silicone stones (Fig 7). This piece was tested on the mouth for passive fitting to

Figure 5: CAD/CAM system design and milling process of the zirconia.

Figure 6: Prosthesis fine finishing.

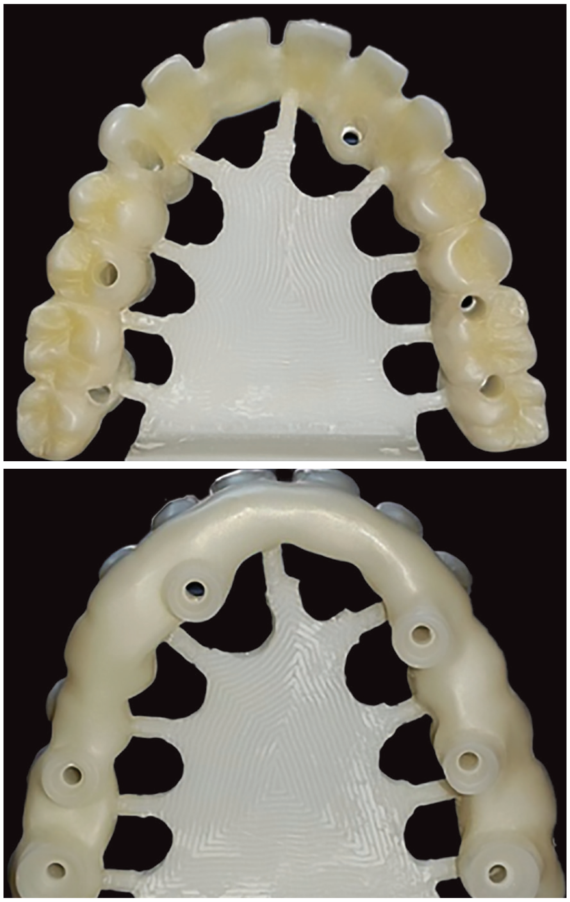

Figure 7: Fixed Implant-supported Full Prosthesis fully milled, before ceramic staining.

the underlying pillars, aesthetics and phonetics.

Having done the verification and obtained patient's approval, the work was sent back to the lab for zirconia finishing and staining (Fig 8). A Zirkon Ice (Zirkonzahn) ceramic mass layering was done on the buccal surface for the gingival characterization and some staining was also done on the lingual and occlusal surfaces.

The work was tested on the mouth to for aesthetic adjustments, after which the final glazing was applied. During the incorporation, some occlusal adjustments were needed (Fig 9). Pillar screws orifices were covered with composite resin and patient was oriented regarding the proper hygiene methods to clean the prostheses and about the need for professional maintenance to be done at every six months.

DISCUSSION

Infrastructure

When implants are successfully osseointegrated and adequately positioned, long-term clinical success substantially depends on achieving a passive fitting between implants and the prosthetic infrastructure (metal or zirconia).[7,8,13]

Figure 8: Try-on of CAD/CAM zirconia milled Fixed Implant-Supported Full Prosthesis already stained.

Figure 9: CAD/CAM monolithic zirconia milled Fixed Implant-Supported Full Prosthesis incorporated.

Misfitting between traditionally manufactured structures and implants was measured and an not only an average distortion of 100μm was found but also none of the structures were passively fit to the implants.[14] Results obtained with CAD/CAM infrastructures showed better adaptation if compared to the adaptation seen with the conventionally manufactured ones.[3,6,7,10,12] This misfitting, and subsequent lack of passiveness, may be measured by the vertical gap between the infrastructure and implant abutments and, despite none of the techniques are totally free from vertical gaps, the CAD/CAM manufactured infrastructures have shown significantly smaller gaps vis-à-vis to the ones traditionally produced.[13]

The use of CAD/CAM technology allows the use of either titanium or zirconia, as in the second clinical case, both presenting similar and/or more consistent and better results than the infrastructures cast in precious metals, with low corrosion risk in the oral environment.[6,13,15] As the aesthetic demands increased, there was a search for the zirconia CAD/CAM infrastructures that bear advantages like aesthetic appearance, biocompatibility, less plaque retention and better mechanical properties.[8] Zirconia and Titanium CAD/CAM milled structures present similar adaptation.[6,16]

The multi-staged manufacturing process of conventional infrastructures (impression, stone model pouring, waxing, casting, polishing, acrylic or ceramic overlaying application) leads to errors and discrepancies in the final adaptation. For this reason, the highly accurate CAD/CAM manufacturing technique may be accounted for eliminating many stages that could lead to errors and discrepancies.[6,8]

Misfittings may be avoided in the conventional setting through welding. However, this procedure is subject to many variables such as: resin curing shrinkage, weld manipulation, thermal expansion caused by the welding and the different melting points of metals used, all of which generate susceptible spots in the structure.[6]

Prosthesis Longevity

Longevity factors like implant survival, prosthesis survival and technical complications are observed.

Implant survival under immediate loading differs in cases where the CAD/CAM fixed implant-supported full prosthesis is done by computer aided surgery and is manufactured during the virtual placement of implants, therefore, before implants themselves are placed, what adds complications and leads implant survival rates under conventionally manufactured prosthesis to be higher than the CAD/CAM ones.[17,18] For late loading protocols, both conventional and CAD/CAM structures present similar results, with implant survival rates ranging around 95%.[5,19,20] Carames 2015 has reported 100% survival in 156 implants used to anchor 26 CAD/CAM monolithic zirconia fixed implant-supported full prosthesis after a 2-year follow up.

Another key factor to implants survival is the marginal bone loss that happens along the years. Ortop 2012 did not report significant differences between the control group, with conventional infrastructures cast in gold, and the CAD/CAM titanium manufactured infrastructures after 10 years.

Results are also similar for prosthesis survival when comparing conventional technique to CAD/CAM full arch restoration.[5,19,20] In the conventionally manufactured prostheses the survival of the gold-acrylic protocols was 90,2% compared to a 96,8% survival in the metal-ceramic ones.[22] In an 18-year prospective study, Teigen 2012 reported that 42% of patients did not present technical or biological complications, whilst the other patients reported an average of 10 repairs, with a higher incidence for the gold-acrylic works. CAD/CAM fixed implant-supported full prosthesis infrastructure manufactured with zirconia have shown a 100% survival in a 5-year follow-up study.[23] Carames 2015 reported that there were no infrastructure fractures or mechanical complications such as loose screws in a series of 26 fixed implant-supported full prosthesis followed up for 2 years.

Contact with Gingival Tissues

Katsoulis, 2011 has compared gold cast overdenture structures, CAD/CAM milled titanium structures and CAD/CAM milled fixed implant-supported titanium prosthesis and reported the absence of gingival hyperplasia in the CAD/CAM structures against a 66% hyperplasia incidence on conventional gold cast structures what may be attributed to the light and homogeneous design of the CAD/CAM structures in contact with the mucosa, if compared to the gold conventionally cast structures, that were either too close to the gingiva in some points or presenting quite a few millimetres gaps in others. In another study with 16 patients, Papaspyridakos 2013 has rehabilitated with CAD/CAM fixed implant-supported full zirconia prosthesis and followed them up for 5 years, having found no gingival recession or inflammation in the implant/abutment interface in none of the 103 implants placed.

Technical Complications

With regards to technical complications, the conventionally manufactured fixed implant-supported full prostheses have shown similar results to the ones manufactured through the CAD/CAM system.[5,23] In both CAD/CAM and conventional techniques, the ceramic application adds complications since ceramics are naturally technique sensitive materials. In CAD/CAM full arch restorations with zirconia infrastructure and feldspathic ceramic layering those fractures are rather common (31,25%) given the low bond strength between the different ceramic materials23. Carames, 2015 reported a 96% clinical success rate on 26 fixed implant supported-full monolithic zirconia prosthesis, with one single prosthesis having suffered chipping of the ceramic layering after a 2 years follow up.

In the case of ceramic fractures due to usage, the repair by adding a new ceramic layer and burning the structure a second time may increase the chance of damaging the welding points (full arch restorations produced by the lost wax technique) and potentially damage the ceramics due to excessive burning cycles (both techniques), notwithstanding that the ceramic manufactured prosthesis are highly resistant if compared to the acrylic resin ones. One treatment option would be to manufacture the infrastructure with ceramic single crowns for separate cementation, occasionally allowing a much faster replacement of fractured crowns without removing the full piece, provided that all prosthetic data will be stored by the software.[1,3,7]

CONCLUSION

After reviewing the literature related to the clinical cases reported in this paper, one can conclude that the CAD/CAM manufactured infrastructure for fixed implant-supported full dentures provides not only better fitting to implants but also improved mechanical and biological features if compared to infrastructures manufactured through the conventional technique (lost wax). Nevertheless, the conventional technique is still widely used for economic reasons, since the CAD/CAM technique is presently associated with considerably higher costs.

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