World Journal of Oral and Maxillofacial Surgery

Research Article
Published: 03 Feb, 2022

Full Zirconia Fixed Implant-Retained Restorations Manufactured (CAD/CAM) From Monolithic Zirconium Dioxide: 5-Year Prospective Clinical Study

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Abstract

Purpose: To evaluate the survival of implants, the success of prosthetics of implant-supported reconstructions based on monolithic zirconium dioxide, functioning up to 5 years.

Patients and Methods: In this study 42 patients were participated referred in need of full arch implant-supported reconstructions in maxilla, mandible or both. All patients underwent a thorough clinical examination according to a generally accepted scheme. After the diagnostic workup was completed, a treatment plan was developed by using a cone beam computed tomography and software system. Using surgical guides 21 patients' dental implants were installed.

Postoperative clinical and radiological monitoring was regularly conducted, and criteria for the success of implantation and success of prosthetics of implant-supported reconstructions were evaluated.

376 implants (6 to 8 dental implants in the edentulous arches) were installed for monolithic zirconia full arch reconstructions.

Prosthodontic treatment was performed 3 to 6 months after implants healing time. Digital technologies were included in the work flow with the laboratory scanning of the master casts and CAD/CAM manufacturing software. The monolithic zirconia block were milled using CAD/CAM software according to the manufacturer's specifications and then a monolithic zirconia restorations sintering.

Outcome measures were: Implant success; prosthesis success; complications and marginal bone levels.

Results: No intra-operative or immediate post-operative complications were noted. During a 3-year observation fracture of the monolithic zirconia or any other mechanical complications of prostheses, no registered, screws fractured in 3 prosthesis was observed over the 3-year study period.

Conclusion: Our studies have shown good aesthetic, functional and mechanical properties of monolithic zirconia restorations and fewer complications.

Keywords: Monolithic zirconium dioxide; Computer assisted manufacturing (CAD/CAM) technology; Implant-supported full-arch restorations

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Received Date: *09 Jan 2022*

Accepted Date*: 19 Jan 2022*

Published Date*: 03 Feb 2022*

Citation:

Gagik H, Gegham T, Khachtryan L, Vanyan N, Matevosyan D. Full Zirconia Fixed Implant-Retained Restorations Manufactured (CAD/CAM) From Monolithic Zirconium Dioxide: 5-Year Prospective Clinical Study. World J Oral Maxillofac Surg. 2022; 5(1): 1044.

Introduction

The traditional method of manufacturing crowns and other orthopedic structures is gradually inferior to digital. The era of Computer-Assisted Design/Computer Assisted Manufacturing (CAD/CAM) technology has brought a variety of digital prosthesis manufacturing techniques. For this purpose, scanners are used that make it possible to obtain a digital impression of the oral cavity, programs that model future orthopedic structures, milling laboratory that produce them, and special materials for manufacturing according to such algorithms. Now a day's implant-supported full-arch restorations show good success results [1-2].

For such restorations, various materials were used, such as metal-acrylic and metal-ceramic. However, the complication of metal-acrylic and metal-ceramic restorations associated with fractured or chipping prompted the search for other materials [3,4]. There is a lot of research where it was shown good mechanical, biological, and chemical properties of zirconium dioxide [4,5].

Today, zirconia dental restorations CAD/CAM technologies are the most modern way to restore teeth. Restorations are obtained as accurate, safe and natural as possible.

Zirconium oxide has gained popularity as reducing material also in oral implantology due to its biocompatibility and aesthetic appearance [6].

A new branch of research was the use of monolithic zirconium for the manufacture of implant restoration. However, there are publications where reported veneering ceramic chipping the zirconium substructure [7]. CAD/CAM manufactured, full arch monolithic zirconium oxide implant restorations provide available alternative for rehabilitating edentulous patients [8,9].

Use of the monolithic zirconium substructure reduces avoids chips [3,10].

The compressive strength of zirconia is superior to tensile strength. Therefore, this material is not recommended for the use of cantilever prostheses in order to prevent its fracture. CAD/CAM technologies have advanced significantly and this has allowed laboratories to make monolithic restorations, avoiding the need for subsequent layering of feldspar ceramics [11,12].

The manufacturing process of zirconium fixed bridge structures is carried out under the control of a computer program. Implant impression is made; a model is made that is scanned using a 3D scanner, processed by a special program (CAD), which models the image of the future.

Implant supported restorations and transfers it to milling equipment machine (CAM), which automatically cuts the ultra precise construction of the future restorations from a solid block of zirconium dioxide. Further, by firing in a special furnace, the frame is given the strength of the metal.

Sintering occurs at a temperature of about one and a half thousand degrees it is thanks to it that zircon gets its phenomenal strength. The sintering process guarantees the accuracy of the landing frame up to 20 microns.

The final touch of restorations manufacturing, is the enamel coloring in the corresponding shade, grinding and the restoration acquires a natural shine. Thanks to this technology, the finished restorations perfectly fit the patient’s implants, taking into account their smallest individual characteristics.

There is evidence of short-term positive results; however, the amount of research needed remains insufficient to draw final and reasoned conclusions.

The purpose of the study was to evaluate the survival of implants, the success of prosthetics of implant-supported reconstructions based on monolithic zirconium dioxide, functioning up to 3 years.

Patients and Methods

The 42 patients (19 females and 23 males, range: 38-64) were participated in this study referred in need of full arch implant-supported reconstructions in maxilla, mandible or both. The 21 of these patients required maxillary and mandibular full arch reconstruction, and 7 involved only the maxillary arch. In 4 patient's natural teeth and a complete denture. A total of 53 edentulous arches were restored: 29 maxillary and 24 mandibular arches. All patients underwent a thorough clinical examination according to a generally accepted scheme. After the diagnostic workup was completed, a treatment plan was developed by using a cone beam computed tomography and software system. Dental implants of 21 patients were installed the edentulous arches using surgical guides. Postoperative therapy included antibacterial, anti-inflammatory drugs.

Postoperative clinical and radiological monitoring was regularly conducted, and criteria for the success of implantation and success of prosthetics of implant-supported reconstructions were evaluated.

The 376 implants (6 to 8 dental implants in the edentulous arches) were installed for monolithic zirconia full arch reconstructions. Prior to the start of the prosthetics phase, patients wore temporary full dentures.

The prosthetic indication was made according to each patient clinical condition in order to achieve the highest function and esthetic.

Prosthodontic treatment was performed 3 to 6 months after implants healing time. The impression procedure is initiated 2 weeks after the implant uncover. The prosthetic phases started with impression open tray or optical impression with an intraoral scanner.

The open tray impression is made using polyvinyl siloxane impression materials. All healing abutments were removed and open tray impression copings were inserted. Impression copings were splinted with pattern resin. Vinyl polysiloxane material was used for bite registration.

After casting the master, the received master casts were scanned. Files obtained as a result of scanning were imported into prosthetic CAD, where the virtual waxing of the restoration was carried out. All arch restorations were designed without veneering porcelain.

The virtual waxing of the restoration transformed temporary acrylic prosthesis and after trying to ensure adequate fit, function and esthetics were temporarily fixed on the implants for 1 to 2 week. After some minor adjustments, the restoration was milled in a monolithic zirconia block and were sintered in the oven. The final full arch prostheses were clinically verified in the oral cavity and after occlusal adjustments last working step was enamel coloring in the corresponding shade and grinding.

After the approval and consent of the patients with the shape and shade of the final restorations, they were fixed. Of the 54 full arches, 26 were implant supported screw-retained, and 28 full arches were implant supported cement-retained. Occlusal screws were torqued following manufacturer’s instructions. Cement-retained fixed prostheses were cemented with temporary cement. Prior to the final cementation, the inner surface of each crown was treated according to the manufacturers’ recommendations.

Outcome measures were: prosthesis success; implant success; complications and marginal bone levels. Postsurgical change in marginal bone levels was assess by digital X-ray were taken immediately (base line for comparison) and 1, 3 years post operatively.

Results

No postoperative complications have been reported. The 36

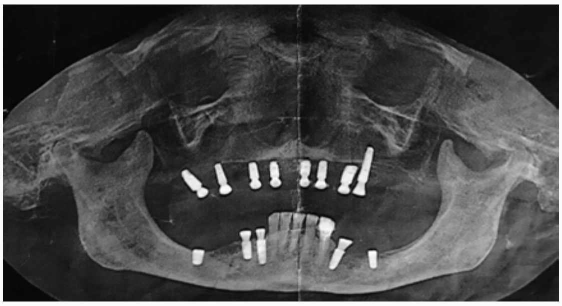

Figure 1: CT scan 5 month after surgery.

month follow-up period evaluation of CT scan revealed implants demonstrated to integrate normally. All of the patients presented with healthy soft tissue. Marginal bone loss data were recorded, mean Marginal Bone Loss (MBL) was 1.2 ± 0.25 mm. A total of 8 implant failures were recorded. After 3 implants show survival rates (97.6%).

During a 5-year observation fracture of the monolithic zirconium dioxide or any other mechanical complications of prostheses, no registered, screws fractured in 3 prosthesis was observed over the 3-year study period. Patients were satisfied with the aesthetic and functional outcome of the treatment.

The results showed that implant treatment is effective to improve patients' masticatory efficiency.

This case reports presents a combination of surgical and prosthetic solutions applied to a case of oral implant rehabilitation in patients with edentulism maxillae and partial edentulism in mandible.

Case Presentation

A 53 years old female patient, presented to clinic with edentulous maxilla and partial edentulous mandibula. Medical examination revealed that the patient presented good general health. The patient was subjected to radiological examination with Cone Beam Computed Tomography (CBCT). A treatment plan was defined that included: installation of 8 dental implants in the maxilla and 5 dental implants in mandibula. According to the protocol, the implants sites were prepared and implants were placed.

The loading of the implants was delayed, the patient was provided with a removable complete denture. The prosthetic phases started after 5 months healing period (Figure 1). Impression procedure started 2 weeks after opening the implant. The first impression from implant transfers was obtained using the open tray method with soft silicone. The laboratory made the 1st model, the resin pattern in implant transfers and sectioned. In the mouth, the resin pattern section was put together and then obtains the final impression. Vinyl polysiloxane material was used for bite registration. Master model was made by the laboratory with gypsum type IV and then, received master cast were scanned by CAD (3 Shape Dental System, Dentsply Sirona Japan). Files obtained as a result of scanning were imported into prosthetic CAD. Digital wax-up was used and a prototype of the restoration where designed (Figure 2). Milling machine was used to mill the prototype in temporary acrylic prosthesis which was then tested in the mouth and were temporarily fixed on the implants and teeth for 2 week.

With the approved design prototype a zirconia block (Cerconht, Dentsply Sirona K.K.) were machined with a CAM (Cercon brain, Dentsply Sirona K.K.). After zirconia sintering, the restoration was checked in the model and delivery to the clinic.

Provisional restorations were removed, zirconia restorations clinically verified in the oral cavity and after some minor adjustments occlusion and after patient approval the restorations were glazed. Zirconia restorations were cemented with temporary cement (Figure 3).

All the implants were stable and in good prosthetics function with no postoperative complications followed up for 3 years. So far, no further problem has occurred and the restoration has remained functional.

Discussion

Zirconium dioxide was introduced to dentistry in the 1970s because of its superior mechanical properties, and the favorable response to soft tissues [13,14]. Nowadays it´s one of the most used material in restorative dentistry and is a more esthetical material. Although zirconia frameworks veneered glass ceramic have been successful aesthetics, their most common disadvantage is chipping of the veneering ceramic [15]. There are clinical studies showing the effectiveness for monolithic zirconia compared with zirconia frames with ceramic veneering [16,17].

Chipping of veneering ceramics are a frequent complication of zirconia-based restorations on implants [18,19]. These problems were solved with the use of CAD/CAM technology milling in one block monolithic zirconia for a full arch over implants [17]. In presented clinical study using digital techniques, maxillary and mandibular full arch were restored with CAD/CAM monolithic zirconia implant-supported full-arch restorations.

The results of study showed good mechanical properties, good biocompatibility, did not present any complications during the observation period. High transparency of zirconium-dioxide allows for monolithic restorations without the need for veneers and the risk of chipping.

Most authors are of the opinion that this treatment option should be treated with caution. Compared to other dental ceramics, zirconium is considered an opaque material and the transparency of zirconia depends on the thickness of zirconia. Reducing the thickness

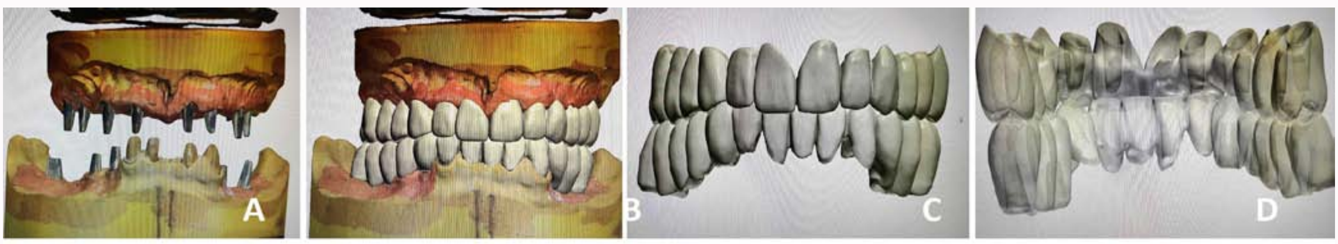

Figure 2: Implants scan model (A). Computer-aided design of restorations (B-D).

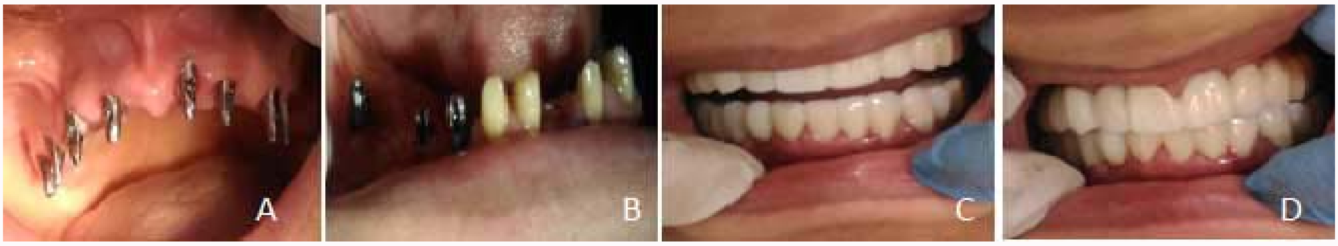

Figure 3: Intraoral view of abutments upper jaw (A), and lower jaw (B) before prosthetic reconstruction. Final intraoral frontal view after prosthetic rehabilitation with non-removable monolithic zirconia restorations (C,D).

of zirconia may increase transparency to restorations [17,20].

In this study, based on the clinical situation zirconium prostheses had a thickness of 0.8 mm to 1.5 mm and showed high esthetic and resistance to fractures. When choosing the method of fixing the restoration, must be considered that screw-retained implant restorations provide better retrievability and cement-retained implant restorations provide improved aesthetics and increased chances of achieving [21-23].

In this study we did not give preference to screw-retained or cement-retained fixation methods; the fixation method was chosen based on the clinical situation. Differences between cement and screw-retained restorations are not statistically significant.

Conclusion

The results confirm that fabrication of the monolithic zirconia restorations reduces breakage possibilities and avoids chipping. Our studies have shown good aesthetic and mechanical properties of monolithic zirconia restorations and fewer complications. This method is for professionals with extensive experience, as it requires long training and prior work experience.

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