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Technical procedure

Metal free, full arch, fixed prosthesis for edentulous mandible rehabilitation on four implants

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ABSTRACT

Purpose: The goal of this work is to describe an implant-prosthetic protocol for rehabilitation of edentulous mandible, by using a fixed prosthesis made of fiber-reinforced composite material (FRC). The protocol contemplates a minimal invasive surgery and ensures predictable and safe results, with good aesthetic and performance combined to cost savings.

Methods: FRC material is used to build the substructure of a prosthetic framework supported by four short implants (5 mm long and 4 mm wide). The prosthesis substructure is made of Trinia immersed in a matrix of epoxy resin (FRC). It is supplied in milling blocks (pre-cured) for the CAD/CAM (computer-aided design/computer-aided manufacturing) technique.

Implants are placed in lower edentulous jaw in position of first molar and canine, each side. Four month after, a resin bar is build based on a stone model, denture teeth are placed and the occlusion is checked. The resin bar and the stone model with milled abutments are scanned and a FRC bar is achieved with the CAD/CAM technique. The teeth are mounted to the substructure trough denture resin. Temporary cementation of framework is achieved on the abutments connected to the implants.

Conclusion: A protocol for a fixed mandibular implant-prosthetic rehabilitation is described. The protocol contemplates a minimal invasive surgery and ensures predictable and safe results, with good aesthetic and performance combined to cost savings. In addition, this technique allows performing basic surgery also in presence of atrophy.

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1. Introduction

Replacing dental tissues is one of the primary goal of dentistry. Continuous research for dental materials able to reproduce teeth is carried on. Although metal ceramic restoration is still the gold standard in prosthetic dentistry [1,2], in the last few years the interest was focused on composite materials [3–6]. Many studies have been conducted [7–12] to evaluate the performance of fixed partial dentures made of composite material, which offer several advantages over traditional metal-ceramic systems, including: improved aesthetics, a biomechanical behavior more akin to natural dentition (biomorphism) and the possibility of repairing or modifying denture chairside [11,13]. The main alternatives to the metals

are pressed ceramic, zirconia ceramics and fiber-reinforced polymer (FRP) materials. Given the limited applications of pressed ceramic [14,15] and the frequent "chipping" of porcelain layered on zirconia ceramics, research interest has turned toward fiber-reinforced polymer (FRP) [16–19].

Fiber-reinforced composite material (FRC) materials have been shown to achieve better functional-esthetical result and a good bio-tolerability [20–24]. In this study, we describe an implant-prosthetic protocol for rehabilitation of edentulous mandible, by using a fixed prosthesis made of FRC. The protocol contemplates a minimal invasive surgery and ensures predictable and safe results, with good aesthetic and performance combined to cost savings.

2. Materials and methods

2.1. Indications to the technique

This procedure is indicated in all cases of edentulous mandible needing a fixed rehabilitation [25–27]. Particularly, the technique

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is indicated to patients with a mandibular complete denture who complain for discomfort or poor esthetic results.

2.2. Patient selection

Patients with mobile prosthesis in the lower jaw were recruited, based on clinical and radiographic examinations.

2.3. Surgical procedure

Patients receive four short implants (Bicon LLC, Boston, MA, USA), 4 mm in diameter and 5 mm in height to support the fixed prosthesis. The implant is characterized by a plateau design, a crestal module with pure locking taper connection, sloping shoulder, abutment hemispheric profile and calcium phosphate based treatment. The implants and abutments of the system are made from Ti-6Al-4V alloy.

Implants are inserted in lower edentulous jaw in position of first molar and canine, each side, trough small surgical access. Four months after the first surgical stage, the implants are uncovered and healing abutments are placed.

2.4. Prosthetic procedure

The prosthesis substructure is made of Trinia (Bicon LLC) made up of interlaced multidirectional, multilayered fiberglass, immersed in a matrix of epoxy resin (FRC). It is supplied in milling blocks (pre-cured) for the CAD/CAM (computer-aided design/computer-aided manufacturing) technique.

After 15 days of healing, the abutments are removed and related transfers with their copings are connected to the fixtures (Fig. 1). An implant-level transfer impression is recorded in silicone material. The bite is recorded with articulation wax.

The stone model reproducing the position of the implants in the oral cavity is mounted in an articulator with the antagonist. Appropriate abutments are selected and milled parallel to one another with a 2–4° axis (Fig. 2). The model with the milled abutments is used to fabricate a light cured resin bar, and then used to set up denture teeth for an intra-oral confirmation.

Once the denture set-up has been clinically approved, a facial occlusal silicone mask is formed over the denture wax set-up. Denture teeth are removed from the resin bar and glued to the silicone mask with a cyanoacrylate glue. The stone model with the milled abutments and the resin bar are sprayed separately and digitally scanned (DS Scan, EGS).

The fiber-resin bar is digitally designed (EXOCAD) on the computer, with a minimum thickness of 7.0 mm throughout, an abutment clearance of 30 microns for cement and a maximum
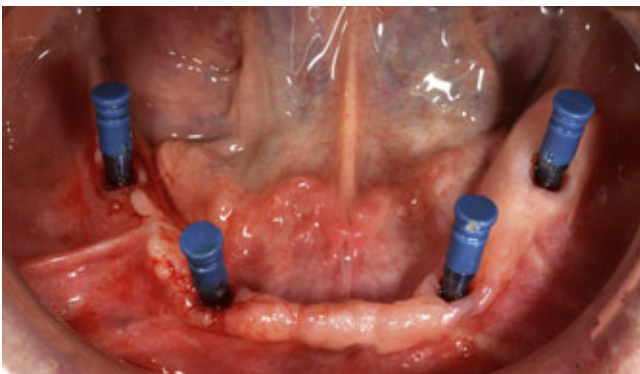

Fig. 2. Stone model with milled abutments. The parallel milling is necessary to achieve a passive fitting of prosthesis.

cantilever extension of 21.0 mm. The project is realized using a milling machine operating on five axes (Roland DWX-50). The machine uses diamond-hardened drills and works at 1 and 2 mm to 16,000 rpm for the roughing stage and up to 25,000 rpm in the finishing stage (Fig. 3).

After the milling, the bar is manually reduced and checked on the stone model with the abutments. Additionally, the sequence of insertion of the milled abutments is defined and the fitting is verified with the silicone mask. A denture resin is poured into the silicone mask to secure teeth to the bar. Final polymerization is achieved under hot water, with an air pressure of three bars. After polymerization, the prosthesis is removed from its silicone mask, and then finished and polished in a conventional manner.

The prosthesis itself is used to orient and place the abutments in the well of the implants following the pre-ordered sequence. The fitting of the framework is checked and the Morse taper connection is activated. Temporary cementation of framework is achieved (TempBond, Kerr). The occlusion is evaluated and adjusted (Figs. 4 and 5).

3. Difference from conventional methods

The first difference from conventional methods is that this procedure limits the indications for bone graft or regeneration, thus using the residual native bone. This is important because horizontal and vertical bone augmentation procedures are

Fig. 1. Implants with transferts and copings in position ready for impression. The implants are placed at the position of canine and first molar, each side.
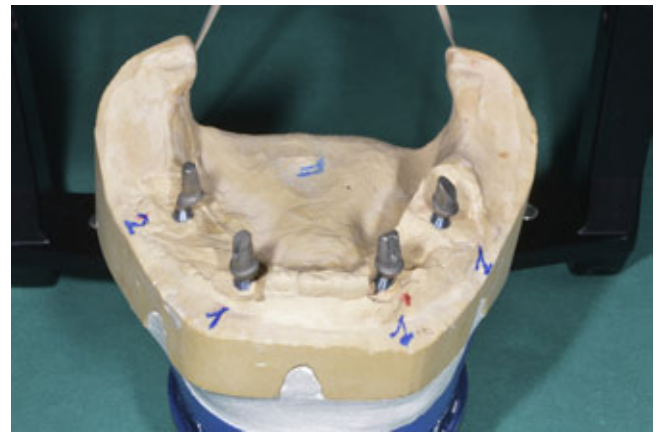

Fig. 3. Fiber-composit disk during milling process. After the digital design, the project is realized through a milling machine.

Fig. 4. Intra-oral view, framework is cemented to abutments.

subjected to variable efficacy [28], cause more stress to patients and have longer rehabilitation period.

In addition, the use of short implants in native bone limits the indication to tilted implants. As observed by some authors, stress distribution around implant angulated more than 35° can lead to fail [29–31].

The technique presented does not use the immediate load protocol because it is demonstrated that, to ensure a bone formation, it is necessary neo-angiogenesis [32] and cement line formation [33]. In order to immediately load an implant, a primary stability is required, with a bone compression that often may cause reabsorption and replacement with non-functional, avascular bone [34]. In addition, patients eligible for this protocol are often already denture wearers.

The second difference is related to the framework material. According to several authors, FRC allows better distribution of occlusal loads [35], while performance are comparable to other materials [7,24]. The FRC may absorb energy from the masticatory cycle, because of the lower flexural modulus of the material compared to metal alloys [35]. This effect becomes an advantage as it contributes to the maintenance of the peri-implant bone [35].

Another difference concerns bio-tolerability. The reference material (metal alloy) is used despite a lack of robust clinical tolerance studies [36]. Corrosion represents a concrete risk, as cobalt and nickel are released into the oral cavity [37–40], and long-term effects have not yet been fully discovered [1,37,41,42]. The use of a metal-free prosthesis may solve the problems related

Fig. 5. Radiographical evaluation, note the subcrestal position of implants, the metal-free substructure with denture theet in position. The opposite dentition in this patient was a complete removable denture.

to metal structures such as corrosion, toxicity, complexity of manufacture, economic cost and aesthetic limitations [4,37–40].

4. Effect or performance

This technique allows performing basic surgery also in presence of atrophy. The characteristics of the prosthesis allow the use of only four implants. The main advantages for the patient consist in reduced rehabilitation time, minor trauma, better bio-tolerability of prosthesis, good esthetic and minor treatment cost.

5. Conclusion

A protocol for a fixed mandibular implant-prosthetic rehabilitation is described. The protocol could also be useful to atrophic mandibles, ensuring secure, accurate, and safe implant placement with minimal invasiveness and providing a fixed FRC-denture-teeth prosthesis for a durable and cost effective rehabilitation. Moreover, the mechanical characteristics of Trinia, comparable to traditional materials, could make it a viable alternative to metal in the production of prosthetic structures.

Ethics

The work has been approved by the ethics committees and subjects gave informed consent to the work (protocol number of ethic approval is prot. 628/13" "rif.2791/13-06-2013).

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