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Clinical Reliability of Complete-Arch Fixed Prostheses Supported by Narrow-Diameter Implants to Support Complete-Arch Restorations

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Abstract: The aim of this study was to evaluate the clinical application of fixed screw-retained complete-arch rehabilitations supported by four narrow-diameter implants (NDIs). The records of patients treated with complete-arch prostheses screwed onto four NDIs treated with an immediate loading protocol between 2010 and 2020 with at least 1 year of follow-up after the positioning of the definitive restoration were reviewed. The implants were placed according to the final prosthetic design and were immediately loaded. The interim prostheses were replaced after the healing period by definitive acrylic resin titanium-supported prostheses. Patients were followed to evaluate treatment success, the implant survival rate (ISR), and the prosthetic survival rate (PSR). A total of 121 NDIs were positioned in 30 patients to restore 30 complete arches (18 maxilla and 12 mandible). One implant did not achieve osseointegration, resulting in an overall ISR of 99.2%. No prosthetic or implant failures occurred during the 1 to 11 years of follow-up. Three biological and four prosthetic complications occurred, resulting in a treatment rehabilitation survival of 94.1% and a PSR of 86.7%. Despite the limitations of the present retrospective study, such as the use of one single type of dental implant and patients treated in a single rehabilitation center, complete-arch rehabilitation with fixed prostheses supported by four NDIs seems to be a reliable treatment in the medium to long term.

Keywords: narrow-diameter implants; immediate loading; complete arch; fixed prostheses

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1. Introduction

Before the arrival of dental implants, removable dentures were the only possibility to rehabilitate complete edentulous patients [1]. From the first years of the 21st century, tilting dental implants up to 30° distally in the distal parts of the jaws to avoid contact with the maxillary sinus or the inferior alveolar canals in atrophic jaws, avoiding bone augmentation procedures, became a well-documented and reliable treatment option. Malo et al. developed the "All-on-4" concept to restore edentulous jaws with two implants positioned axial in the anterior zone and two tilted in the posterior zone of both jaws [2]. The idea was to place the implants in a geometric manner that was as regular and symmetric as possible to make the interimplant position as large as possible, reducing the distal cantilever lengths of prostheses with 12 teeth [3–6].

However, patients that were edentate for a long time or the presence of terminal dentitions may increase the need for horizontal and/or vertical augmentation of the alveolar bones in both jaws [2,7,8]. Moreover, trauma, malformation, neoplasms, the use of removable prostheses, and periodontal disease may increase the reduction in bone width [9–11].

Different types of vertical and horizontal augmentation techniques were proposed to overcome these dimensional changes, such as maxillary sinus elevation and/or vertical ridge augmentation in combination with contour augmentation [12–14]. However, these

procedures should be performed only by expert clinicians to minimize possible intraoperative complications and postoperative morbidity. The combination of several augmentation procedures with dental implant placement may influence the overall surgery outcomes, such as early graft or membrane exposure [15–20]. Narrow-diameter dental implants (NDIs) were introduced to reduce or eliminate the need for horizontal bone augmentation procedures, reducing the implant diameter in the most coronal part [21–24]. NDIs can be classified in three categories according to the ITI consensus report [25]:

1. Implants < 2.5 mm Ø ("Mini-implants");
2. Implants 2.5 mm to <3.3 mm Ø;
3. Implants 3.3 mm to 3.5 mm Ø.

In certain clinical scenarios, NDIs provide prosthetic flexibility in patients with a reduced mesiodistal width or reduced bone thickness. Moreover, NDIs can be used for single-tooth rehabilitations, such as lateral incisors in the upper jaw or incisors in the lower jaw [26–29]. However, reducing the implant diameter may increase the risk of implant or component fracture in patients with heavy chewing function or parafunction. NDIs positioned to replace missing teeth in the posterior zone are still not well investigated in the literature. In these cases, it is mandatory to use caution in patients with parafunctional habits and malocclusion. As a matter of fact, for NDIs in the anterior zone there are different biomechanical forces that can overload the implants compared to the posterior zone [25,28,30–33].

The aim of this retrospective study was to evaluate the clinical survival of fixed screw-retained complete-arch rehabilitations supported by four NDIs.

2. Materials and Methods

The analysis was conducted in a retrospective manner that included all patients treated with a single operative protocol in a single dental office between 2010 and 2020. The patients included in the analysis needed to be followed up for a minimum of 1 year after the positioning of the definitive restoration. The study was conducted in accordance with the Helsinki Declaration of 1964 and the revision in 2013 for ethical principles regarding human experimentation and with the written informed consent of the patients. The study was approved by the institutional review board of Sapienza University of Rome with protocol number 0000212 and was registered with protocol number ISRCTN16104700 (date: 10/02/2022). The study was conducted following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (http://www.strobe-statement.org (accessed on 20 December 2022)) [34]. The medical status of the patients was documented. The patients included in the retrospective study were treated if they were in good health and did not need any bone augmentation procedures to place four implants with minimum dimensions of 3.3 mm of diameter and 10 mm of length. Patients were not treated if they did not have suitable bones for such measures of implants, had diseases, or smoked. All patients gave their written informed consent for immediate implant loading.

2.1. Clinical Protocol

Each treated patient received a comprehensive evaluation of function and esthetic in order to re-establish correct tooth positions. Patients were included in this treatment protocol if they were fully edentulous or partially edentulous with terminal dentitions in one or both jaws. Moreover, the periodontal status was screened, and only patients with plaque scores (PS) < 25% and bleeding on probing (BoP) < 20% could receive the treatment. For edentulous patients, brand-new removable dentures were fabricated and worn by patients to re-establish function, aesthetic, and correct tooth positions until the patients felt comfortable with the new disposition. For terminal dentition patients, partial dentures were fabricated if stable teeth were present, otherwise extractions were performed and immediate dentures were fabricated. Diagnoses were made clinically and radiographically with preoperative panoramic radiographs and CBCT scans with radiographic templates

in place. Radiographic templates were made from duplications of the interim prostheses (Figures 1–3).

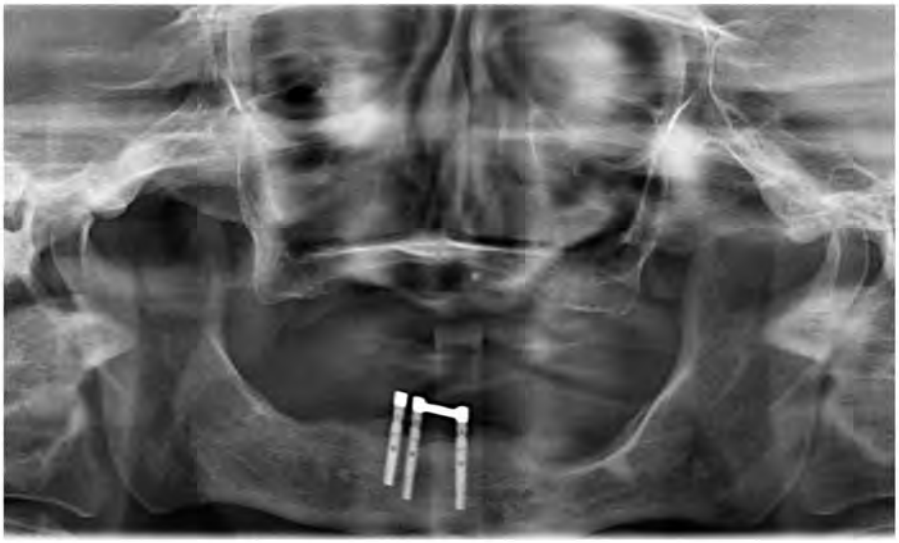

Figure 1. Preoperative panoramic radiograph with complete edentulism in the maxilla and failing implants in the mandible.

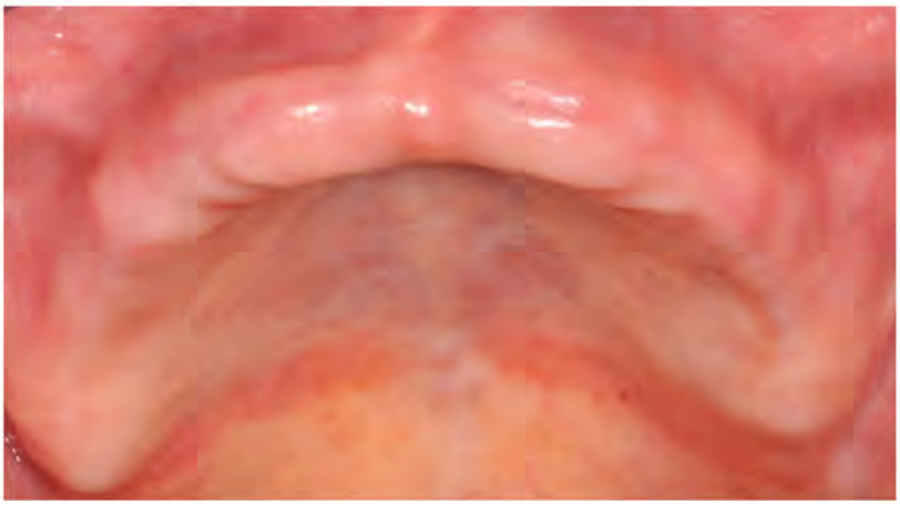

Figure 2. Clinical view of an edentulous maxilla before treatment.

Figure 3. Radiographic template with radiopaque landmarks made from a duplicate of the denture.

From 2010 to 2015, implants were positioned free-hand using the radiographic templates to prepare implant recipient sites; from 2016 to the conclusion of the report, fully computer-guided surgery with static templates was used to place the implants. Platform-switched implants with round apexes (Bone Level Implant, Straumann, Straumann AG, Basel, Switzerland) or tapered apexes (Bone Level Tapered Implant, Straumann) with a narrow neck diameter of 3.3 mm were used in the treated patients. A specific drill set was used to prepare each implant recipient site (Surgical Kit, Straumann). The sequence of the drills was carefully respected in order to underprepare the implant recipient site, enhancing primary stability. The first drill was a needle drill that had to create a hole in the cortical zone. Then, the pilot drill (2.2 Ø mm) was used to create a pathway in the hole made by the needle drill. These two drills were used under copious irrigation at 800 rpm. The last drill was the 2.8 Ø mm drill, which followed the pilot drill pathway. The drill was used without irrigation at 40 rpm in order to recover bone chips along the drill. Then, the profile drill (3.3 Ø mm) was used only in the crestal zone to reduce stress on the cortical zone during implant positioning. The flaps were limited to the implant recipient zone and were not overextended in order to reduce the invasiveness. The insertion torque was confirmed with a torque wrench (Straumann AG). After implant placement, angulated or straight screw-retained abutments (SRA, Straumann) were positioned to enhance the parallelism between the tilted and vertical implants with titanium copings screwed onto them. The SRAs could correct the emergence profile from 0° to 30° with different gingival heights to create an appropriate transmucosal tunnel and an axial support for the occlusal load. Sutures were used if necessary and were made by polyglycolic acid (PGA). Chlorhexidine (0.1%) was recommended for patients twice daily for one week for plaque control. For pain control, the patients were prescribed analgesics. The sutures were removed 14 days after surgery. The interim prostheses based on the prosthetic plans were milled from blocks of polymethyl methacrylate (PMMA, dima Mill temp, Kulzer) and merged with a self-curing resin (Enamel Plus, Micerium) to the titanium copings. The correct position of the interim prosthesis was determined by occlusal contacts with the opposite dentition. The interim prostheses had no cantilevers and were screwed to 15 Ncm onto the SRAs (Figures 4 and 5).

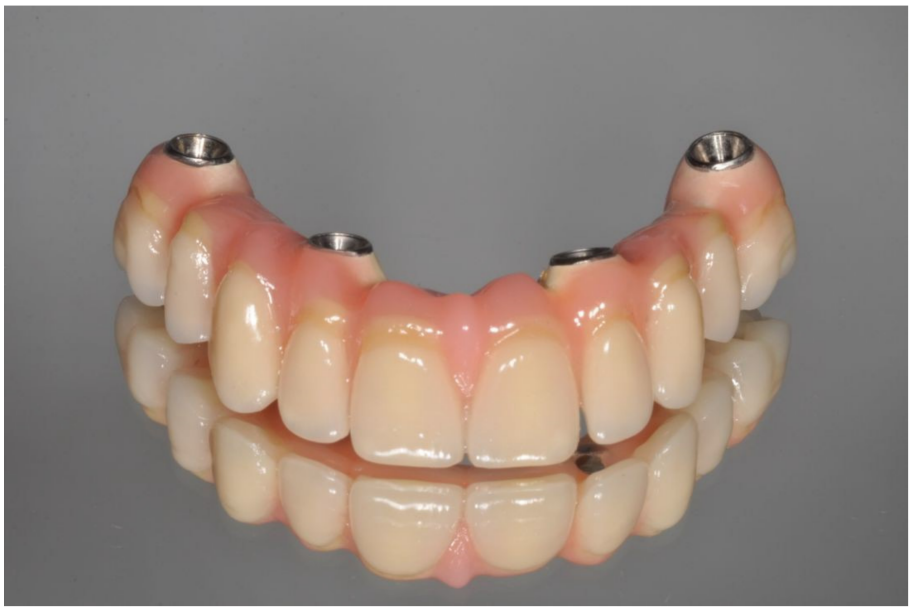

Figure 4. Interim prosthesis without cantilevers.