tions and four prosthetic complications that were successfully solved. The low incidence of complications could be related to the high motivation of the patients included in this retrospective study. Moreover, the reinforcement of oral hygiene instructions was constantly delivered to each patient at each professional hygiene session. Biological complications can occur in every implant-based rehabilitation, from a single tooth gap to complete arches. The need for bone augmentation procedures could increase the risk of early complications such as graft failures, membrane exposure, and infections of graft sites, adding a variable to the surgical phase. Moreover, late complications could also be reported after several years because of the stability of the regenerated bone over time [11]. These unfaithful events could determine a longer "time-to-teeth" for the patients, enhancing pain, discomfort, and the overall rehabilitation time [42]. Complications such as chipping or screw loosening could be frequent events with complete-arch implant-supported prostheses [6,19,20]. However, due to a lack of data in the literature, no other study investigated complete-arch rehabilitations supported by NDIs. The prosthetic complications reported in the current literature are only related to single-tooth replacements. In order to reduce technical and/or biological complications, the prosthetic manufacturing had to be carefully made to obtain long-term survival and success. In addition, constant maintenance sessions, including professional hygiene sessions, occlusion checks, and radiographic checks of the implant status, and the use of nightguards are mandatory to decrease the risk of complications. In addition, some biomechanical aspects have to be analyzed. NDIs in vitro showed a higher possibility of fracture in load tests. Türker et al. [29] reported in a finite element analysis that the coronal part of the implant is the most likely to receive high stress in maximum intercuspation. In this sense, the peri-implant bone on the most coronal part of the implant could be overstressed if the clenching of the jaws was observed while the patient was sleeping, which may lead to loss of osseointegration [28]. Osseointegration was quantified by calculating the bone to implant contact (BIC) and the bone area fraction occupancy (BAFO). These indexes are considered essential for implant stability and indications of successful osseointegration. Jimbo et al. [32] demonstrated that when the implant diameter increased, the histomorphometry values of BIC and BAFO inversely decreased. In these terms, standard and wide implants showed significantly lower values compared with narrow implants in a longer healing period without occlusal loading. However, it must be pointed out that increasing the diameter of the implants increases their ability to withstand bending and torsional forces and loading [33]. It seems that the overload on NDIs could be significantly reduced if they are splinted together compared to NDIs replacing a single-tooth gap. In the present study, only NDIs were positioned to perform complete-arch rehabilitations on four dental implants and fixed prostheses with titanium frameworks and acrylic teeth. The overload on the implants could have been reduced in the study sample because of the light load of the definitive prosthesis, in combination with several occlusal checks and the use of nightguards. The use of metal-based and ceramic heavy frameworks may increase the risk of overload, which may negatively influence the crestal parts of the dental implants. More RCTs are needed to improve the scientific data on complete-arch restorations supported only by NDIs. As a matter of fact, clinical investigations should focus on the differences between NDIs placed in native bone and standard-diameter implants placed in augmented bone in order to clarify and better understand the possibilities of NDIs.

5. Conclusions

The results of this retrospective study including patients treated with complete-arch restorations with screw-retained fixed prostheses supported by four NDIs showed encouraging results, and this protocol appears to be a possible alternative when extensive bone augmentation procedures are needed to place standard dental implants.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data from the present study can be obtained upon reasonable request from the corresponding author.

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Figure 5. Interim prosthesis after implant placement.

Occlusion was verified with 40 µm articulating paper to avoid heavy contacts in order to uniformly distribute in centric occlusion and light lateral contacts. Patients were recalled 7 days after the surgery and every 15 days to check the occlusal contacts for the first 3 months. Moreover, maxillary occlusal nightguards were delivered to every patient to minimize the parafunction stress on the implants. They were designed to be applied only on the occlusal part of the prostheses and were realized from acrylic resin discs (Erkodent, Pfalzgrafenweile, Germany). The interim prostheses were not removed for at least 6 weeks from the immediate loading. At the end of the healing period, panoramic radiographs were taken, and the prostheses removed to check the implant stability. If an implant showed mobility, pain, or suppuration, it was removed, recorded as a failure, and replaced after 3 months. The SRA screws were torqued to 35 Ncm, and if the implants showed an absence of mobility, pain, and suppuration, they were considered osseointegrated and ready for the final prosthetic part of the protocol. A definitive plaster impression was taken to obtain a master cast of the patient. The definitive prosthesis workflow followed the principles of the removable complete denture. The main difference was that the definitive prostheses had a titanium framework with an acrylic resin denture base material and denture teeth and was screwed to the implants. The frameworks were digitally designed with titanium retentive pins for each tooth and were milled at a specialized milling center (Createch Medical Milling Center, Createch Medical S.L., Mendaro, Spain). Moreover, they had cantilevers to support the first molars. The cantilever length was determined following the prosthetic plan of the rehabilitation in combination with the final distal implant position including only the first molar (Figures 6 and 7).

On the day of definitive prosthesis placement, new maxillary acrylic resin occlusal nightguards were delivered to each patient and screw access openings were restored with a provisional material (Fermit, Ivoclar Vivadent, Naturno, Bolzano, Italy). The patients were recalled every 4 months for professional oral hygiene and peri-implant parameter recording (BoP and PS) and every 12 months for annual radiographic and clinical examinations, following the EAO guidelines [35] (Figure 8).

Figure 6. Definitive prosthesis with cantilevers after 7 years of use.

Figure 7. Occlusal view of definitive prosthesis after 7 years of use.

Figure 8. Panoramic radiograph after 7 years of use in maxillary-implant-supported rehabilitation. In the mandible, the same treatment was performed with standard-diameter implants. One previously placed implant had fractured and was left in the subgingival region. It was not included in the rehabilitation treatment.

2.2. Follow-Up Protocol

Each patient was enrolled in a specific maintenance protocol. Every 4 months, one expert dental hygienist performed a professional hygiene session. A clinical check of the implant and the prosthesis was performed annually. An independent operator who was not involved in the study performed panoramic radiographs to assess the radiographic peri-implant bone quality in accordance with the European Association for Osseointegration (EAO) guidelines. Implant success and survival were assessed according to the criteria accepted at the International Congress of Oral Implantologists Consensus Conference for Implant Success [36]. Biological (i.e., mucositis and peri-implantitis) as well as technical complications (i.e., screw loosening, acrylic veneering fractures, and tooth detachment) were also recorded at each planned visit. Moreover, peri-implant values were recorded at the four sites/implants by one experienced dental hygienist.

2.3. Outcomes

2.3.1. Rehabilitation Treatment Survival

The rehabilitation treatment was survival in the absence of biologic or prosthetic complications after definitive prosthesis delivery.

2.3.2. Implant Survival Rate

The implants were recorded as successfully integrated implants after clinical and radiographic examinations in accordance with the criteria of Albrektsson [37]. A "surviving implant" was an implant in the absence of biologic complications, without bleeding and/or suppuration on probing, with an absence of pain, mobility, or suppuration when the peri-implant mucosa was pressed. Moreover, the combination of one of the previous clinical signs with radiographic bone loss of more than 2 mm were the criteria to be used for the diagnosis of peri-implantitis [38,39].

2.3.3. Prosthetic Survival Rate

Definitive prosthesis survival was defined as an absence of technical complications. A "surviving prosthesis" was a prosthetic reconstruction that was stable and in good function [1].

2.3.4. Soft Tissue Parameters

Soft tissue values were assessed at the implant–SRA interfaces at each follow-up visit using a periodontal probe (Hu-Friedy PGF-GFS, Hu-Friedy), following the protocol previously published by the authors of [40].

2.4. Statistical Analysis

The data of the involved patients were anonymized and imported into a master spreadsheet. A descriptive analysis was performed using means and standard deviations. The implant was used as the unit in the statistical analysis.

3. Results

The results from 30 patients of both genders (13 men and 17 women, mean age: 69.2, ranging from 54 to 87 years) were collected and analyzed (Table 1).

Table 1. Main characteristics of included patients (mean age in years).

Characteristics of Included Patients	
Number of patients (female, male)	30 (17, 13)
Mean age (range)	69.2 (54–87)
Smokers (five cigarettes per day)	3
Maxilla	18
Mandible	12

A total of 30 complete arches (18 maxilla and 12 mandible) were restored using four NDIs that were loaded immediately to support screw-retained fixed prostheses. In total, 121 NDIs were positioned, and 120 were reviewed at least 1 year after definitive prosthesis positioning (Table 2).

Table 2. Life table analysis at the implant level (n = implants placed per year; follow-up in years).

Baseline Implant Positioning	n	Follow-Up
2010	8	11
2011	8	10
2012	8	9
2013	12	8
2014	16	7
2015	12	6
2016	16	5
2017	16	4
2018	4	3
2019	4	2
2020	16	1

In total, 40 implants (33.3%) were positioned flapless, while 80 implants (66.7%) were positioned with flaps, and 68 implants were positioned in healed sites (56.7%), while 52 implants were positioned in postextraction sockets (43.3%). Two types of NDIs were used: 70 Ø3.3 mm Narrow Crossfit® Bone Level implants (BL NC, Straumann) and 50 Ø3.3 Narrow Crossfit Bone Level Tapered implants (BLT NC, Straumann). The implants lengths were 14 mm (50.8%), 12 mm (45%), and 10 mm (4.2%) (Table 3).

Table 3. Characteristics of positioned implants.

Characteristics of Positioned Implants	
Number of implants	120
Failed implants	1
Types of implants	
Bone Level Narrow Crossfit	70
Bone Level Tapered Narrow Crossfit	50
Maxilla	72 (60%)
Mandible	48 (40%)
Postextractive	52 (43.3%)
Healed sites	68 (56.7%)
Free-hand surgery	48 (40%)
Static computer-guided surgery	72 (60%)
Flapless surgery	40 (33.3%)
Open-flap surgery	80 (66.7%)

All implants were inserted with insertion torque values of at least 35 Ncm. Twelve arches were treated using prosthetically driven free-hand surgery while the other eighteen arches were treated using fully guided template-driven static computer-guided surgery. In the opposite dentitions, 11 patients presented with natural teeth and fixed restorations, 10 patients had removable dentures, 7 patients had implants supporting complete-arch fixed prostheses, and 2 had natural dentitions. No dropouts occurred during the follow-up period, and no deviations occurred from the original protocol. No prosthetic complications occurred to the interim prosthesis during the healing period. One implant did not achieve osseointegration during the healing period, resulting in an implant survival rate of 99.2%. The failed implant (BLT NC 12 mm) was placed in a healed site, removed at the osseointegration check after the healing period, and replaced via a computer-guided surgery procedure after a healing period of 3 months. After the healing period, a total of 30 definitive prostheses with cantilevers were positioned. No prosthetic or implant failures

(i.e., framework fracture, abutment fracture, or screw fracture) occurred during the entire observation period. BoP was recorded for three implants (2.5%), and plaque was detected around seven implants (5.8%). No mucositis or peri-implantitis were recorded at the last follow-up visits. Three biological and four prosthetic complications occurred, resulting in a treatment rehabilitation success of 94.1%. Three implants showed mucositis in two patients after 4 and 6 years of use. The patients skipped two professional maintenance sessions. The implants were debrided, chlorhexidine was prescribed twice a day for 15 days, and the complications resolved [41]. Four prosthetic complications occurred in three patients, resulting in a prosthetic survival rate of 86.7%. Two patients had chipping of acrylic resin veneers, and one patient had chipping and screw loosening on two implants after 5 and 8 years of use, respectively. The patients did not wear the nightguards for 6 months. The prostheses were repaired and screwed to 15 Ncm to the SRAs, and the patients were encouraged to wear the nightguards.

4. Discussion

The aim of this study was to analyze the clinical outcomes of complete arch restored with complete-arch prostheses that were screwed onto four NDIs and loaded immediately. The main limitations of this study were the lack of a control group and its retrospective nature. Nevertheless, 120 NDIs were positioned, restoring 30 complete arches. Only one implant did not achieve osteointegration after the healing period, and it was successfully replaced, resulting in an ISR of 99.2% after an observation period ranging from one to eleven years. Several studies investigated the clinical performance of NDIs [22–24]. Two systematic reviews by Gonzalez-Valls et al. [10] and Valente et al. [11] reported that the clinical outcomes of NDIs can be comparable to the standard dental implant outcomes, especially when significative bone augmentation procedures are needed to place standard implants. The meta-analysis showed an overall NDI ISR of 97.80% over 3.5 years of follow up, while the ISR for implants placed with horizontal bone augmentation procedures reported an overall ISR of 97.22% after 3.22 years of follow-up [11]. In recent years, NDIs were investigated in clinical scenarios of partially edentulous patients when supporting fixed prostheses in the aesthetic and posterior zones [9,15,25], providing high ISR values and a low incidence of biologic and/or prosthetic complications. Moreover, NDIs may be useful when wide bone augmentation procedures are required, such as after trauma, malformation, neoplasms, the use of removable prostheses, and periodontal disease. Reconstructive surgeries are always related to greater morbidity, leading to multiple surgeries and higher economic costs for the patients. In complete edentulous patients, NDIs were mostly used to support two-implant mandibular overdentures, providing encouraging clinical results in terms of ISR, marginal bone loss (MBL), and patient satisfaction [16–18,26]. The main limitation of this treatment option is the hybrid support of the prostheses. The mandibular overdenture can be attached to two implants and can have a mucosa support. In this sense, the comfort for the patients could decrease because of the load on the posterior region of the mucosa in the mandible. For fixed prostheses, four implants are considered to be the minimum number to give support and to reduce overload. One study conducted by Coskunses [27] reported clinical data of 67 NDIs supporting fixed complete-arch prostheses in combination with standard dental implants, with a maximum of 2 years of follow-up. In these terms, the present study reported clinical data of 30 complete arches from 1 to 11 years of use restored with complete-arch prostheses screwed onto four NDIs. Complete-arch restorations with four implants could be considered a valid treatment option in the medium to long term. As a matter of fact, the last systematic review with a meta-analysis by Valente et al. [11] indicated that "NDIs do not seem suitable for 'all-on-four' rehabilitations due to the increased load stress during occlusal function". The present study goes the opposite way and shows favorable results for the all-on-four technique with NDIs. The incidence of implant–prosthetic failures and biological and/or prosthetic complications were mostly related to smoking and/or the frequency of maintenance sessions [1,3–5]. In the present study, the overall treatment success was 94.1% due to three biological complica-