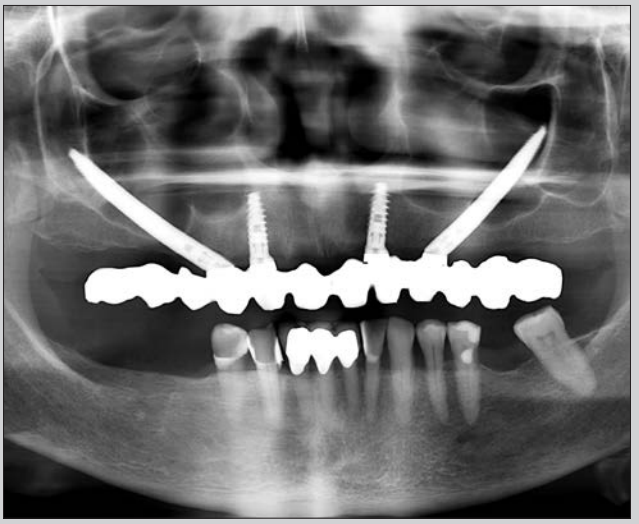
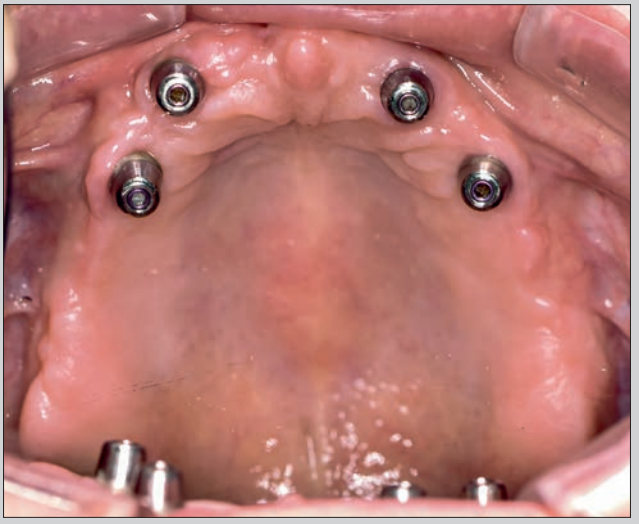
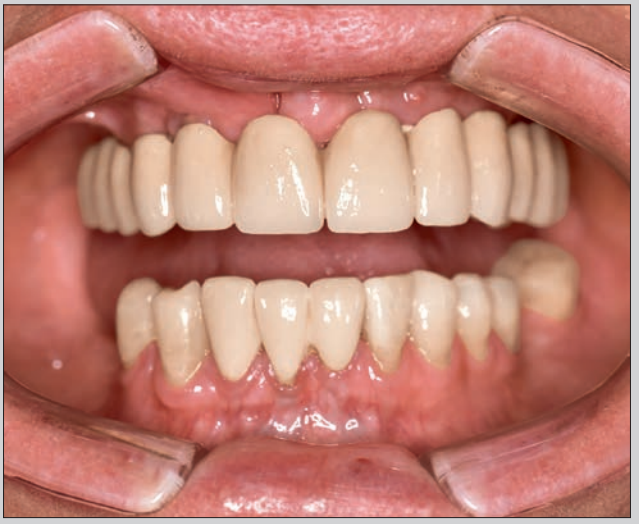
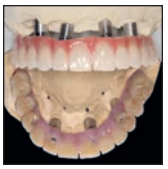






Finding Better Ways to Perform Graftless Full Rehabilitation of a Compromised Maxilla: New Platform-Switched Zygomatic Implants Placed Extra-Sinus Improve Prosthetic Restoration—A Preliminary Study of 25 Cases and 85 Implants



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Standard treatment for full rehabilitation of compromised maxillae with regular implants includes sinus elevation grafting, a minimum of two to three surgeries, and a minimum treatment time of 9 to 15 months. Zygomatic implants are a viable alternative. However, prosthetic restorations have been compromised due to abutments emerging on the palate. The purpose of this study was to find ways that abutments will emerge on the ridge (occlusal surface). The presented results show it can be done if zygomatic implants are placed in the sinus wall (extra-sinus) and use an internal, conical connection with platform-switching and 45-degree abutments. Thus, marginal tissue prognosis and primary stability may also be improved by adding coronal threads to an implant design. These improvements, if confirmed in longer follow-ups and further studies, may encourage more graftless rehabilitations of severely compromised maxillae, reducing the number of surgeries and overall treatment time. Int J Periodontics Restorative Dent 2022;42:35–41. doi: 10.11607/prd.5378

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Successful, immediate, full rehabilitation of one or both dental arches is probably one of the most rewarding experiences for both dental professionals and their patients, who regain lost function and esthetics in one surgical visit. Full rehabilitation of a severely resorbed maxilla with regular implants requires bone grafting to the maxillary sinus. However, the graftless All-on-4 concept has been suggested[1–3] and reported in the literature, for both arches, in patients who would otherwise require posterior bone grafting (vertical and horizontal ridge augmentation in the mandible and sinus elevation in the maxilla).[4–6] The concept is based on placing inclined implants in the available remaining bone[7,8] (Fig 1), which increases the implant's length and surface for anchorage and osseointegration and creates advantageous implant spacing for prosthetic load distribution.[9]

Although placing four implants in the mandible has a high predictability, their longevity is more challenged in the maxilla due to softer bone. In such cases, zygomatic implants offer a more viable alternative via firm anchorage in zygomatic bone. Zygomatic implants may shorten the treatment time in the severely resorbed maxilla, even to 1 day. However, they compromise prosthetics because of abutments emerging on the palate. The present

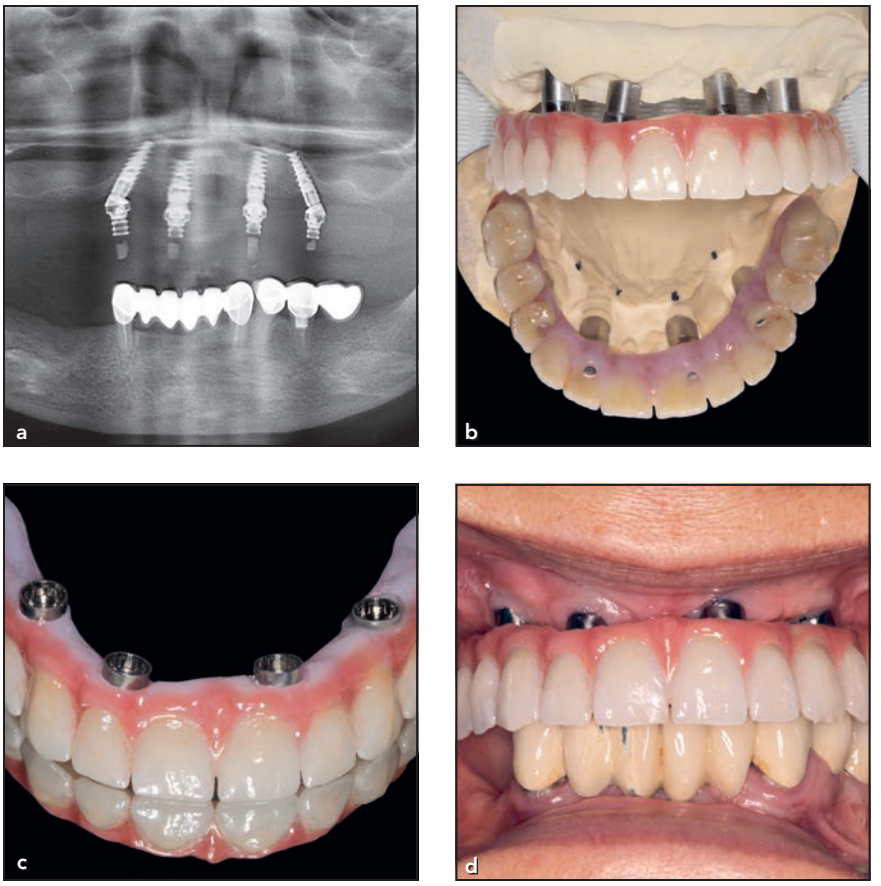

Fig 1 *All-on-4 prosthetic reconstruction on regular implants.* (a) *OPG of four regular implants in the maxilla. In the mandible, there is a partial denture on natural teeth.* (b) *Prosthetic model with a zirconium-oxide denture.* (c) *Prosthetic denture from the level of the muli-unit abutment.* (d) *All-on-4 on regular implants supporting the denture in the patient's mouth.*

authors report an extra-sinus insertion technique with a new zygomatic implant design that can overcome these prosthetic inconveniences.

Predictability of only four regular implants was discussed in the literature,[10–12] with major concerns about occlusion and nonaxial bending forces on angled implants that might cause marginal bone loss, abutment screw loosening, or broken abutment screws, implants, or prostheses.[13–15] None of these were reported in a significant number during 5 years of follow-ups.[16–18]

Materials and Methods

The present authors' practice specializes in immediate rehabilitation on four implants (All-on-4). Regular implants are utilized the most; however, in patients with little bone in the anterior region or in heavy smokers,[19] extra-sinus placement of zygomatic implants is done.

Standard zygomatic implants (NobelZygoma, Nobel Biocare) with an external hex were placed at the bone level, positioning the abutments palatally. Internal hex implants (Zygomatic, Noris Medical; and Z1, iRES) allowed for subcrestal placement and therefore deeper positioning of the 45-degree angulated abutments, which emerge on top of the alveolar crest, as desired prosthetically. When the implant-abutment connection is modified,[20,21] mesial zygomatic implants are placed on the occlusal surface at a canine or first premolar, and distal zygomatic implants are placed at the first molar (Fig 2).

The mesial implant (Fig 3, top implant) goes through a small window at the bottom of the zygomatic bone in the anterior sinus wall, while the distal implant (Fig 3, bottom implant) runs outside the sinus to the body of zygomatic bone, where the zygomatic arch emerges.

This allows for the same prosthetic protocol as regular and short implants (Fig 1). The most frequently used zygomatic implant lengths are 52 mm (mesial) and 35 mm (distal) (Fig 4).[22,23] The torque of the distal implant should not exceed 60 Ncm to prevent breaking the zygomatic arch (Fig 5).

The zygomatic implants used in the present study were Nobel Biocare, Noris Medical, and the new implants designed by the authors (Z1) and manufactured by iRES. To prevent gingival recession around zygomatic implants (Z1), a buccal fat pad flap (BFPF) was also performed.

The study group included 64 patients (age range: 33 to 81 years) who were either edentulous or had hopeless teeth in a resorbed maxilla. Patient data was taken from existing medical records. All patients were fully rehabilitated without sinus

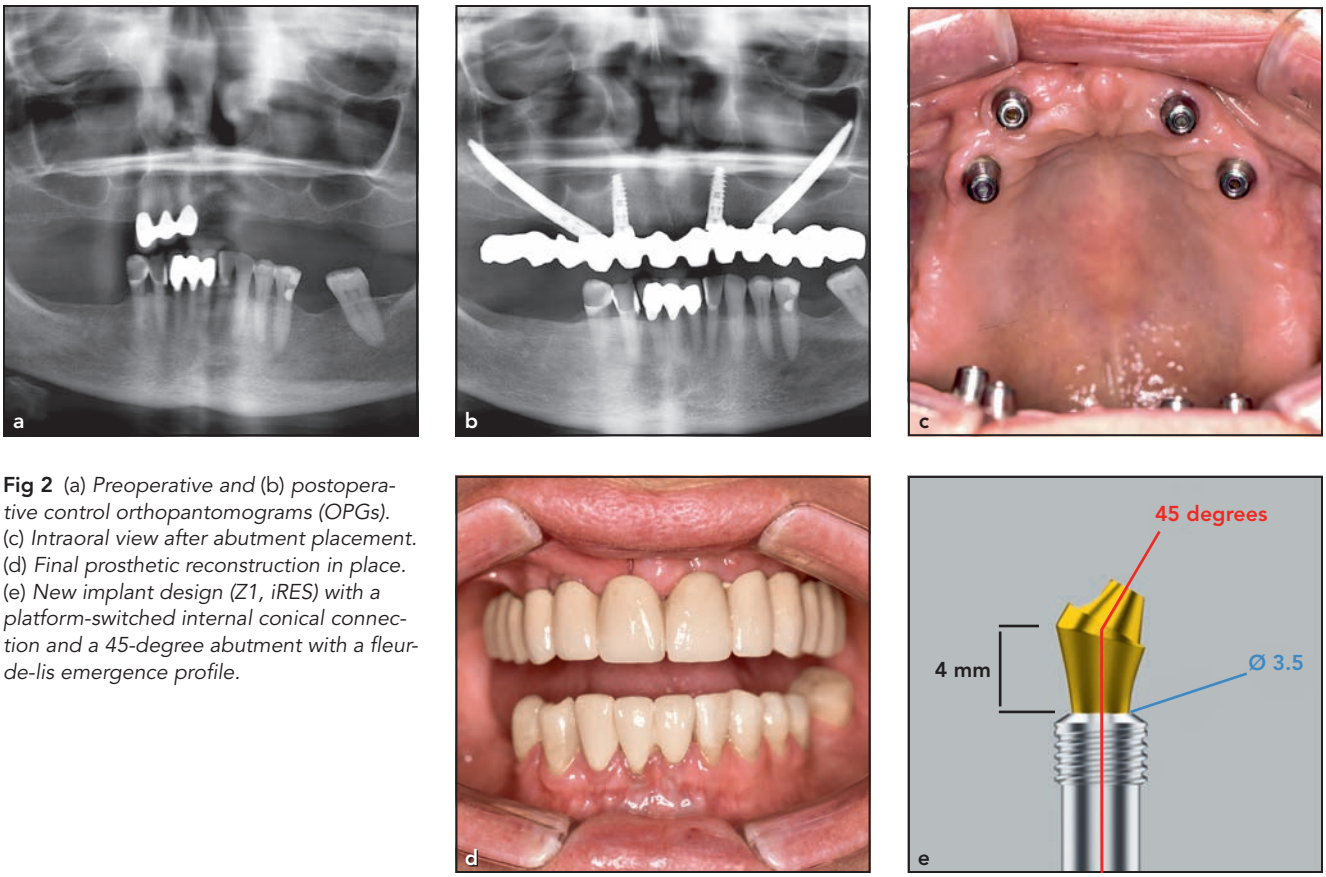

Fig 2 (a) *Preoperative and* (b) *postoperative control orthopantomograms (OPGs).* (c) *Intraoral view after abutment placement.* (d) *Final prosthetic reconstruction in place.* (e) *New implant design (Z1, iRES) with a platform-switched internal conical connection and a 45-degree abutment with a fleur-de-lis emergence profile.*

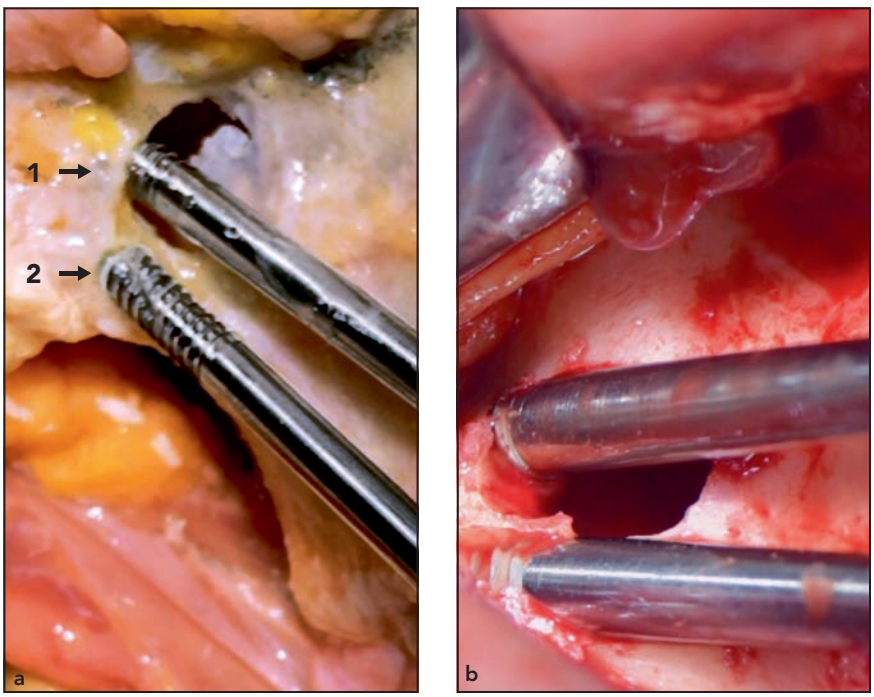

Fig 3 (a) *Proper positioning of zygomatic implants, placed extra-sinus in a cadaver: 1 = mesial zygomatic implant positioned intracortically; 2 = distal zygomatic implant positioned at the base of the zygomatic arch.* (b) *Two implants with the same positions during surgery.*

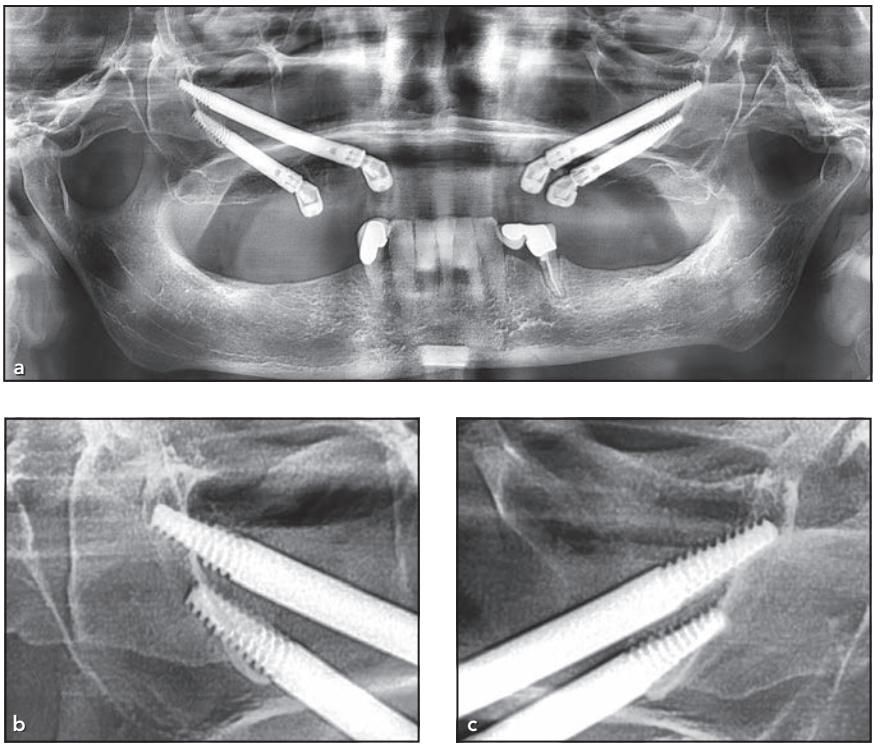

Fig 4 (a) *Postoperative OPG scans demonstrating proper positioning of zygomatic implants with extra-sinus placement, with closer views of the* (b) *right and* (c) *left sides.*

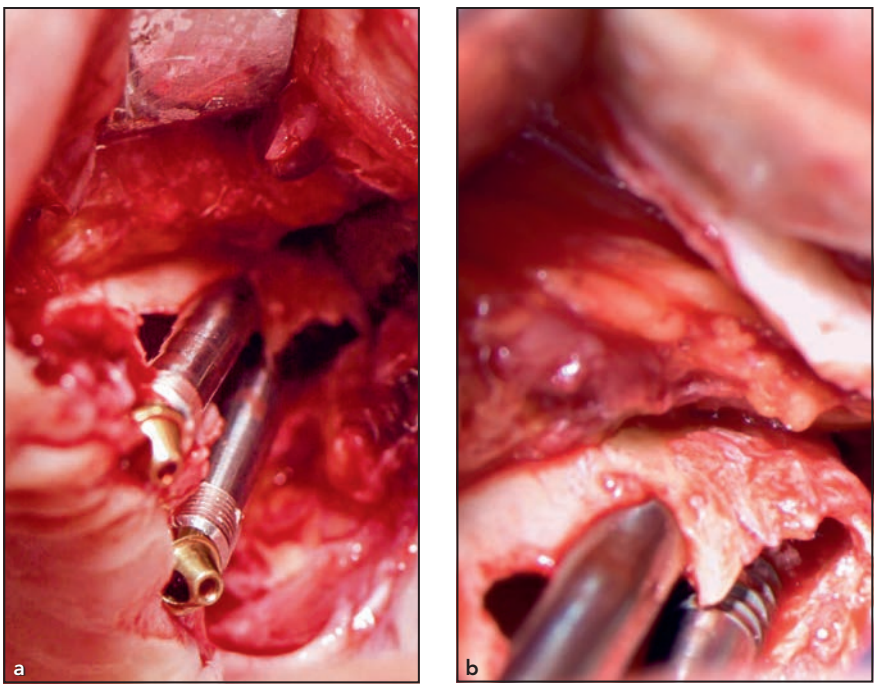

Fig 5 (a) *Correct positioning of a mesial zygomatic implant (top implant) and correct positioning of a distal zygomatic implant (bottom implant) after breaking the zygomatic arch when the insertion torque was greater than 60 Ncm.* (b) *Enhanced view.*

grafting with both regular and zygomatic implants in different combinations of four or more implants per person. Total of 185 implants were placed in an All-on-4 solution: 100 regular implants (Nobel Biocare, Axis, Alpha Bio, Brånemark, Sterngold, Adin, AB, Thommen, and/or Noris Medical) and 85 zygomatic implants (Nobel Biocare, Noris Medical, or iRES) with extra-sinus placement. For the purpose of this study, only the 25 patients who received the 85 zygomatic implants were selected for comparison of the external hex zygomatic implants (Nobel Biocare) vs the internal connection zygomatic implants (Noris Medical and iRES).

The 85 zygomatic implants presented better survival rates than regular implants in the "All-on-4 or more" (five or six implants) treatment during the cumulative 180-month follow-up period.

The study group comprised adults who were edentulous or had hopeless teeth. All were rehabilitated with an All-on-4 treatment using regular (Group 1) or zygomatic implants (Group 2):

- Group 1 (n = 39):
  "All-on-4 or more" with regular implants
- Group 2 (n = 25 patients and 85 zygomatic implants):
  Group 2A = Nobel Biocare;
  Group 2B = Noris Medical;
  Group 2C = iRES

Tables 1 and 2 show the number of each implant type (by manufacturer) used in Groups 1 and 2, respectively.

All patients in Group 2 had a severely resorbed maxilla and did not have enough bone to place regular implants, so each patient received four iRES zygomatic implants (quad zygoma method).

Oncological patients, patients that underwent radiotherapy or were undergoing chemotherapy, and patients with uncontrolled diabetes were excluded from this study.

The study proposal was submitted to and accepted by the bioethical committee document (no. KE-0254/43/2019).

Table 1 Regular Implants Used in the Study

Regular implant type	Implants, n (%)	Failed implants, n (%)
Nobel Biocare	24 (24%)	0 (0%)
Axis	8 (8%)	0 (0%)
Alpha Bio	36 (36%)	14 (14%)
Brånemark	4 (4%)	0 (0%)
Sterngold	4 (4%)	0 (0%)
Adin	4 (4%)	2 (2%)
AB	4 (4%)	0 (0%)
Thommen	8 (8%)	0 (0%)
Noris Medical	8 (8%)	0 (0%)
Total	100 (100%)	16 (16%)

Each patient received "All-on-4 or more" treatment.

Results

Group 1: Regular Implants

Group 1 comprised 39 patients (age range: 43 to 76 years) who were edentulous or with hopeless teeth that were removed. The treatment was performed by three surgeons (P.A., M.K.P., and B.S.) in three different clinics from June 2012 until October 2018. Out of the total 100 regular implants placed in the maxilla, 16 were lost during the study period, representing a 16% implant failure rate. Those implants were used for "All-on-4 or more" with immediate loading (Table 1). None of the prostheses were broken.

The implants used were from different manufacturers (Table 1). The diagnostics included clinical dental and medical examinations (including ear, nose, and throat [ENT]) by the ENT specialist and radiologic examinations (orthopantomogram [OPG] and CBCT). The most frequently used sizes of mesial implants were 3.75 × 13 mm, 4.3 × 13 mm, and 4.2 × 13 mm, and the distal ones were 3.75 × 18 mm, 3.75 × 16 mm, 4.2 × 18 mm, and 4.2 × 16 mm.

The surgery was done under local anesthesia, and the implant positions were planned according to the All-on-4 protocol: two mesial implants (perpendicular) and two distal implants (angled). Sometimes, additional implants were placed.

Fixed prostheses were placed within the first 3 months in 36% of patients, and the remining patients received prostheses at 3 or 6 months postoperative. The prostheses were either porcelain, acrylic, or composite partial dentures.

Table 2 Zygomatic Implants Used in the Study

Zygomatic implant type	Implants, n	Failed implants, n (%)
Nobel Biocare (2A)	39 (46%)	2 (2.4%)
Noris Medical (2B)	22 (26%)	0 (0%)
iRES (2C)	24 (28%)	1 (1.2%)
Total	85 (100%)	3 (3.6%)

Each patient received "All-on-4 or more" treatment.

Group 2: Zygomatic Implants

Group 2 comprised 25 patients (age range: 33 to 81 years) who received zygomatic implants, treated at the Periodontology Department of Medical University of Lublin. All patients were examined and enrolled in the study by one surgeon (P.A., M.K.P., or B.S.). Two patients were smokers. All patients were diagnosed with OPG, CBCT, and ENT examinations.

In total, 85 zygomatic implants were loaded and followed up through a cumulative 180 months. During the study period, 3 zygoma implants were lost, representing a 3.5% implant failure rate. None of the prostheses broke, representing a 100% prosthesis survival rate (Table 2), as in Group 1. The following zygomatic implant types were used: 46% Nobel Biocare (2A; n = 39), where all of the implant surface was rough (oxidized); 26% Noris Medical (2B; n = 22), where all implants were rough (SLA) only at the apex, which was anchored in the zygomatic bone; and 28% Z1 iRES (2C; n = 24), where all implants had a rough (SLA) surface at the apex and a machined body with a crestal thread and a conical platform-switched internal connection.

In addition, patients with zygomatic implants 2A (Nobel Biocare) and 2B (Noris Medical) were given regular implants to support the prostheses. New implants 2C (iRES) were placed alone (four implants per patient) without any additional regular implants (quad zygoma method).

Prosthetic rehabilitation with an immediate loading method was employed to 45% of zygomatic implant patients. Of these patients, Groups 2A, 2B, and 2C comprised 10%, 22%, and 68%, respectively, of the immediate loading protocols.

Discussion

Standard treatment with sinus elevation and regular implants takes 9 to 15 months and carries a risk of both graft and implant failure. Treating the edentulous maxilla with zygomatic implants requires the surgical skills of a maxillofacial surgeon. The original surgical protocol placed implants through the sinus, and abutments emerged on the palate. Additionally, the external hex flat connection of standard zygomatic implants may not favor soft tissue preservation of peri-implant bone and soft tissue.

The authors of the present study analyzed their own clinical material (unpublished) according to reported techniques and success rates and modified both the implants and technique to adjust zygomatic treatment to match the current standards for regular implants in regards to bone and soft tissue preservation and naturally emerging prosthetics. In the present study, the efficacy of immediate loading of regular and zygomatic implants is compared. Other researchers reported gum recession around zygomatic implants as the main complication. To prevent this, the present authors asked for implants with an internal, conical connection and platform-switching. To manage gum recession, the BFPF technique was used.[24–26]

The present results correlate with published data reporting a 95% success rate for zygomatic implants.[22,27]

Immediate loading was applied to both patient groups (regular and zygomatic implants), with the results corresponding to findings from another study on the All-on-4 treatment.[28]

Stability of the zygomatic implants is not at risk from peri-implantitis because the main anchorage is deep at the zygomatic bone body and not at the crystal bone, which is where peri-implantitis starts. Additionally, the machined surface on the coronal part of the new implant (Z1) should prevent the spread of peri-implantitis, which has been confirmed in other studies.[29,30]

Conclusions

New zygomatic implants with extrasinus placement may present a better, graftless option than regular implants in graftless full rehabilitation of compromised maxillae without compromising prosthetics. Short- and long-term stability of zygomatic implants are at less risk of peri-implantitis at the crest because their main anchorage is deep in the zygomatic bone. Adding a platform-switched, internal, conical connection and utilizing a machined surface coronally may better preserve marginal bone, as has been reported on regular implants.

Further follow-ups and studies are needed. Development of surgical guides may further facilitate the procedure to become a standard treatment of choice for full rehabilitation of compromised maxillae.

Acknowledgments

The authors declare no conflicts of interest.

Author contributions: P.A. contributed to the study concept/design, acquired funds, collected data, and drafted, critically revised, and approved the article; M.K.P., A.B., B.S., L.K., and W.P. analyzed and interpreted data, were involved in statistical analysis and critical revision of the article, and approved the article. J.W.M. contributed to the study concept/design, collected data, and drafted,

critically revised, and approved the article. W.T. analyzed data, edited the text, and helped with translation.

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