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Zygomatic implants placement in conjunction with maxillary sinus augmentation without bone grafting: Prosthetic and surgical consideration in immediate loading with the BARI technique

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ABSTRACT

Aim Zygomatic implants are mainly indicated for the rehabilitation of extremely atrophic maxilla when bone augmentation should be avoided. One disadvantage of zygomatic implants, which typically pass through the sinus, is initial or late bone resorption around the implant neck, which can result in oro-antral communications followed by possible sinusitis. To decrease the risk of sinus infection, a modified technique was developed to preserve the integrity of the sinus membrane and to regenerate bone around zygomatic implants through an extended sinus augmentation approach without bone grafting.

Case report This case report describes the treatment of a 53-year-old female patient who was completely edentulous in the upper and lower jaws and was wearing a complete removable denture. The patient's chief complaint was related to the removable prostheses and she asked for a fixed rehabilitation. The patient was treated with zygomatic implants in the upper atrophic maxilla and with 4 intra-foraminal implantw in the mandible with the immediate loading procedure according to the BARI Technique.

Conclusion This approach permitted to deliver two fixed, screw-retained, implant-supported fixed prostheses to the patient.

KEYWORDS Immediate loading; Maxillary sinus augmentation; Zygomatic implants.

INTRODUCTION

The implant-supported rehabilitation of upper and lower edentulous jaws has been extensively documented with excellent outcomes and long-term follow up (1-4). Those treatments can be applied on ideal anatomical conditions and permit to deliver to the patient screw-retained or cemented fixed complete prostheses. In cases of severe atrophy in the maxilla the treatment plan often includes additional surgical procedures in order to augment the bone volume and to allow a proper implant insertion. Several procedures have been proposed such autologous bone block grafts harvested intra and extraorally, inlay-onlay grafting procedures or interpositional grafts in combination with Le Fort I osteotomy (1, 5-13). In the most challenging cases the association of Le Fort I osteotomy and iliac crest grafts has shown predictable results, although it is considered to be a highly demanding technique for the patient because of its invasiveness (7, 14, 15).

An alternative procedure is the use of zygomatic implants. In 1999 Per-Ingvar Brånemark and colleagues introduced the zygoma implant concept (16) and widely documented it in several studies (17-23). The main advantages of this approach are as follows.

1. Donor site morbidity is reduced or avoided altogether.
2. Treatment time can be remarkably reduced or eliminated entirely in cases of immediate loading.
3. Bone graft survival and consolidation are not considered.
4. The total number of implants to support the prosthesis is reduced.
5. The treatment is more affordable and less invasive than alternative treatments.

Totally edentulous patients often require complex prosthetic procedures in order to fabricate a valid

FIG. 1A

FIG. 1B

FIG. 2A

FIG. 2B

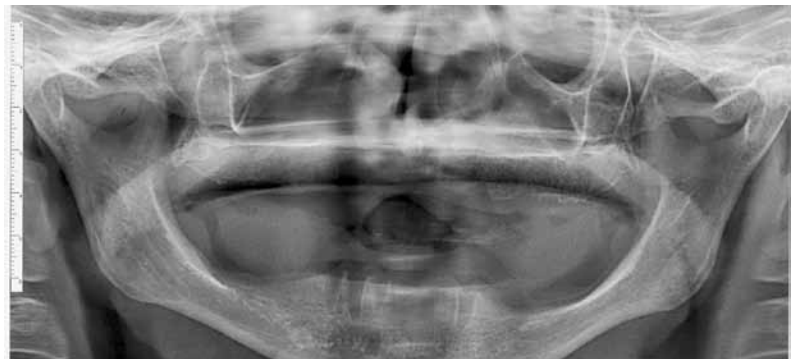

FIG. 3

FIG. 1A, 1B Insufficient labial support in front and lateral view. FIG. 2A, 2B Intraoral view of the upper and lower jaw. FIG. 3 Pre-operative OPG.

rehabilitation from both the functional and the aesthetic points of view. The use of interim provisional dentures before implant placement could be useful in order to determine the correct intermaxillary relationships (24). The BARI technique permits to transfer the informations obtained during the diagnostic phase to the final restoration (25).

The aim of this paper is to report a case of edentulous maxilla and mandible with severely resorbed maxilla and posterior mandible. The patient was treated with zygomatic implants in the upper atrophic maxilla and with four intra-foraminal implants in the mandible with the immediate loading procedure according to the BARI Technique (25). The zygomatic implants were placed in conjunction with maxillary sinus augmentation without bone grafting; this modified technique was developed to preserve the integrity of the sinus membrane and to regenerate bone around zygomatic implants using an extended sinus augmentation approach without bone grafting.

This approach permitted to deliver two fixed, screw-retained, implant-supported fixed prostheses to the patient.

CASE REPORT

The patient presented to the Multidisciplinary Department of Medical and Dental Specialties, Oral and Maxillofacial Surgery Unit, AOU, University of Campania (Naples, Italy). The principles outlined in the Declaration of Helsinki have been followed (26). The patient signed the informed consent form. At the moment of the first visit she was 53 years old and in good general health without any disease that could affect treatment.

The patient was completely edentulous in the upper and lower jaws and was wearing a complete removable denture. Her chief complaint was related to the removable prostheses and she asked for a fixed rehabilitation (Fig. 1A, AB).

The diagnostic phase started with facial analysis according to Arnett, in order to evaluate facial and lip support of the prosthesis, upper lip length and position, maxillo-mandibular relation (Angle's <class), tooth display at rest and during smile (27,28). Phonetic tests were also carried out (29-32) (Fig. 2A, 2B).

Intra-oral examination with careful evaluation of the relationship between the arches in the sagittal, vertical and transverse dimension was performed. Radiographs (panoramic and lateral x-rays) were also performed (Fig. 3). These analyses showed a severe atrophy in the maxilla and in the posterior mandible. The patient's prostheses were incongruous because of the loss of vertical dimension, probably because of the wear occurred during the years. The tooth display in the maxillary arch was insufficient.

The initial treatment plan included the fabrication of two new provisional, removable, complete maxillary and mandibular prostheses according to the diagnostic removable rehabilitation approach (24). The aim was to modify the occlusal and inter-arch relationships in order


FIG. 4A

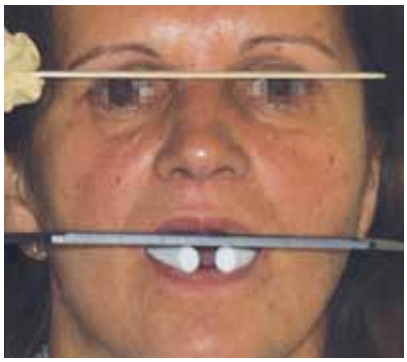
FIG. 4B


FIG. 4C


FIG. 4D


FIG. 4E


FIG. 4F


FIG. 4G


FIG. 4H


FIG. 4I


FIG. 4L


FIG. 4M


FIG. 4N

FIG. 4A-4C
VD detecting.

FIG. 4D-4G
Lip support and final complete denture.

FIG. 4H-4L
Complete dentures in front and lateral view.

FIG. 4M-4N
smile exposure before and after prosthodontic treatment.

to achieve improved aesthetics and function, modifying the length and the inclination of maxillary and mandibular incisors, the occlusal plane and the position of the first lower molar. The use of these interim removable dentures also allowed the soft and hard tissues management.

The provisional prostheses were used not only to provide the patient with acceptable function and aesthetics until the delivery of the definitive prostheses, but also had a "diagnostic" function and could be modified several times until a satisfactory aesthetic and functional result could be obtained with balanced inter-arch relationship. All the phonetic, aesthetic and functional parameters were assessed again with the diagnostic protheses before implant placement. Then the definitive prosthesis could be the copy of the provisional, but with a different and more durable material.

Initial alginate impressions were taken and individualized impression trays were built with a self curing resin (SR Ivolan). The flanges of the customized impression trays were functionalized with a polyether material usually used for fixed prostheses impression, but also appropriate

FIG. 5 X-ray stent.

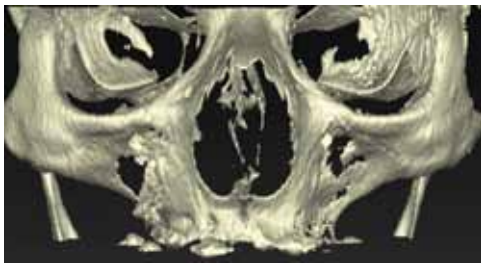

FIG. 6A

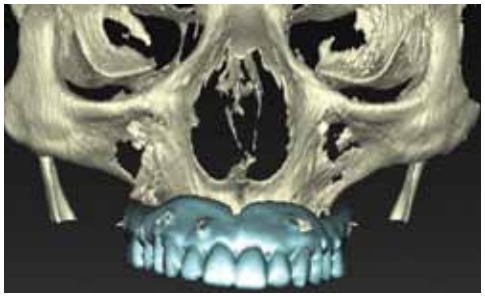

FIG. 6B

FIG. 6A,6B CB CT 3D configuration of the upper jaw

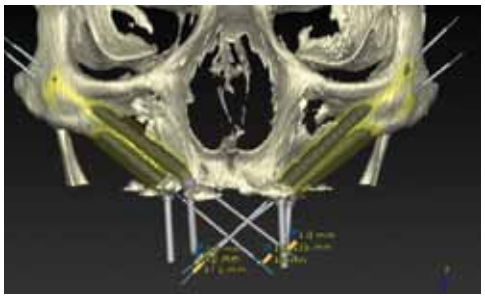

FIG. 6C

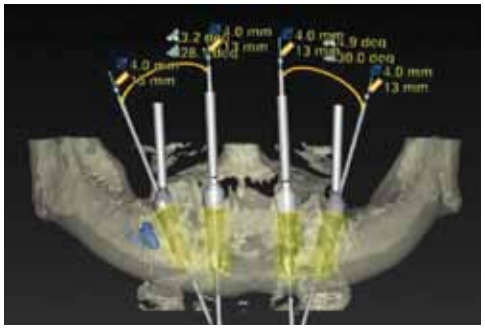

FIG. 6D

FIG. 6C,6D CB CT 3D, treatment plan configuration of the upper and lower jaw.

for this purpose (Impregum, 3m Espe) (33).
Baseplates with wax registration material were built and the face bow recorded in order to mount the maxillary cast on the articulator. The intermaxillary relations were established and recorded according to the phonetic, aesthetic and functional tests and the lower arch coupled with the upper one (29-31,34) (Fig. 4A-N).
After two months a radiopaque acrylic resin copy of the prosthesis was fabricated and used to perform a 3D radiographic evaluation with a software designed for surgical navigation (Nobel Clinician, Nobel Biocare, Sweden) (Fig. 5). The double scan protocol was used for radiographic acquisition of the patient and denture data, then superimposed using the radiopaque spheres embedded in the prosthesis' replica for reference. This step of the treatment allows to determine the position of the implants that should be the best possible according to the prosthetic project, and allows to evaluate the amount of available bone in the planned implant sites. The CT scan showed a severe atrophy of the jaws, especially of the maxilla. Since the patient expressed her desire to receive a fixed prosthesis, two options were evaluated for the maxillary arch: extensive bone grafting and subsequent implants placement or zygomatic implants that could avoid the need of bone grafting. The patient and the dental team together chose the zygomatic implants option because of the reduced treatment time and the relatively low morbidity if compared with extraoral grafting.
The treatment plan included also a fixed prosthesis in the mandible supported by four implants placed in the interforaminal area (Fig. 6A-6D).

Surgical procedure

Surgery in the maxilla started with a mid-crestal incision and the elevation of a full thickness muco-periosteal flap. Access to the maxillary sinuses was performed by means of osteotomies of the lateral wall of the sinuses. A careful elevation from the floor and medial dislocation of the sinus membrane were performed with appropriate instruments to allow a conservative approach (Fig. 7A-7B). Once that both sinuses were identified and preserved, the osteotomies for zygomatic implants were performed. The surgical template was used in each surgical step so as to verify the consistency of implant site preparations with the prosthetic project. The lateral window and the subsequent elevation from the floor and medial dislocation of the sinus membrane were extended to the superolateral aspect of the maxilla of the planned implant sites in the zygomatic bone. This prolonged lateral window was helpful during surgery for determining the orientation of implants within the zygoma and the maxillary sinus. After the sinus membrane was elevated and adequately dislocated, initial access into the zygomatic bone was obtained with a round bur. Depending on the quantity and quality of existing bone, the optimal positions for the implants in the regions of the second premolar and the first molar were defined. The angulations of the implants were checked to

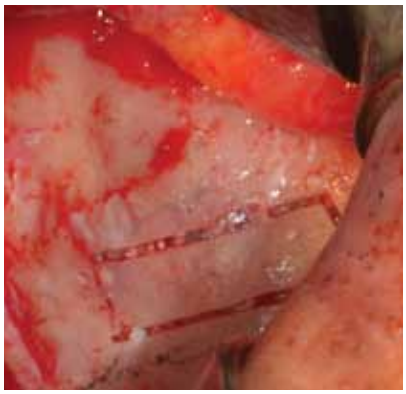

FIG. 7A Lateral bone window osteotomy using piezosurgery.

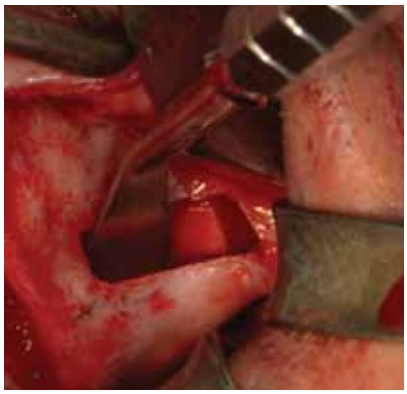

FIG. 7B Conservative elevation from the floor and medial dislocation of the sinus membrane.

FIG. 8 Zygoma implants placement on left side.

confirm that they fit within the provisional prosthesis. The exact position of the tip of the implant in the zygomatic arch was marked with a round bur after the sinus window had been prepared. Subsequently, different drills with increasing diameters were used to prepare the sites for the insertion of the zygomatic implants (Nobel Biocare). The precise implant lengths were determined by the use of a special depth gauge. The exact positions of the Branemark System Zygoma TiUnite (Nobel Biocare) were: site 1.5, 1.3, 2.3 and 2.6. All the implants were 4 mm of diameter (Fig. 8). The lengths were 4.75 mm in region of 1.3 and 2.3; 4.25 mm in region of 1.5 and 2.6. The angular (17°) Multi Unit Abutments (3 mm height) were placed on the implants. At the end of the surgical session, prosthetic procedures for immediate loading were performed (Fig. 9A).

Prosthetic procedure

The master models, already mounted on the articulator, were excavated using the one-model technique (34). Then, two plates with three occlusal stops were built from the master model in order to record the implant position. These plates were to be stabilized by the closure of the patient against three occlusal stops (without interfering with the prosthetic components) according to the BARI technique (25) (Fig. 9B-9C).

After the placement of 4 zygomatic implants (Nobel Biocare) and angulated multi-unit abutments, impression transfers were screwed on the implants. An acrylic resin (Pattern Resin, GC America) was used to connect the transfers to the previously realized plates (Fig. 9D-9F). A new set of impression transfers was then placed on the implants and connected among them, thus creating a "verification jig".

Implant analogues were connected to the transfer embedded in the plates. The plates then allowed repositioning of the analogues in the excavated master models, already mounted in the articulator as previously described. The analogues were blocked into the casts with IV grade plaster stone (Fujirock EP, GC Europe, Leuven BE). When the stone was set, the plates were removed. The second set of transfer connected with resin was used to

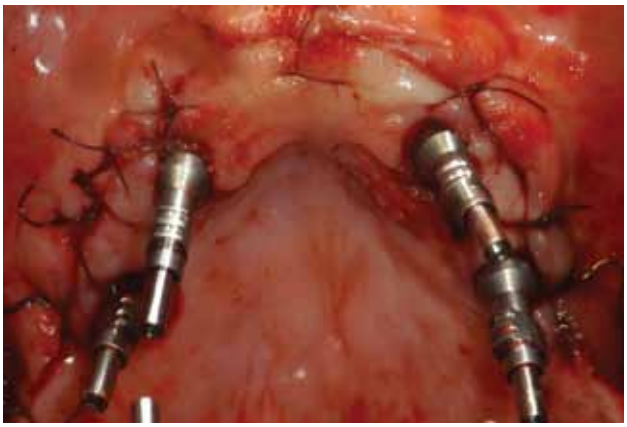

FIG. 9A Impressin coping on MUA.

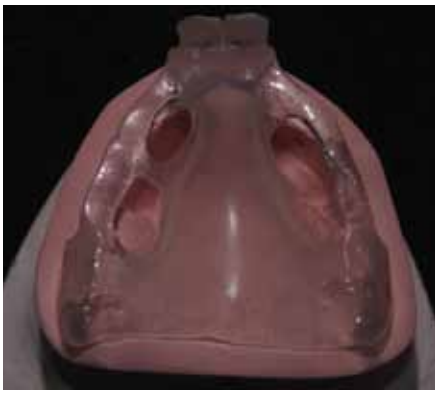

FIG. 9B Upper surgical and prosthetic stent in occlusal view.

FIG. 9C Surgical and prosthetic stent in CR in frontal view.

FIG. 9D An acrylic resin was used to connect the transfers to the previously realized plates; lateral view.

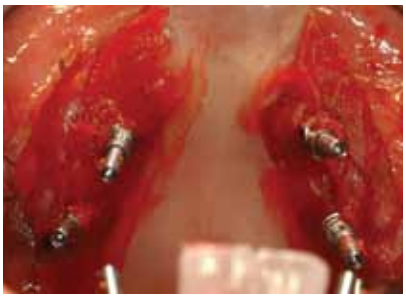

FIG. 9E An acrylic resin was used to connect the transfers to the previously realized plates; occlusal view.

FIG. 9F A new set of impression transfers was then placed on the implants and connected among them, thus creating a "verification jig.

FIG. 10A

FIG. 10B

FIG. 10C

FIG. 10A-10C Prosthesis delivered 2 days post-operatively.

FIG. 10D

FIG. 10E

FIG. 10F

FIG. 10D-10F Two months post-operatively. The pictures in the right show the radiographic control in PA and LL views.

check the position of the analogues and to avoid possible errors (Fig. 9F).
All information previously recorded regarding inter-arch relationships could be used for the implant-supported rehabilitation. The provisional diagnostic phase with the removable dentures was carefully performed and with a great effort to find the correct inter-arch relationship. With the described procedure no information was lost.

Immediate loading

At this point it was possible to deliver the restorations 2 days after surgery (immediate loading). Titanium abutments were used. A metallic framework was casted and luted to the abutments with anaerobic cement (Panavia SA Cement – Kuraray, Tokio, Japan). The second set of prosthesis was excavated and positioned onto the metallic framework in order to verify its passive fit. The framework and the prosthesis were connected with the resin for removable dentures and then the prosthesis extension was reduced removing parts of the flanges. Finally the prostheses were polished. At the end of this procedure the upper removable denture was transformed in an implant-supported, screw-retained fixed prosthesis. Two days after implant placement the prosthesis was delivered to the patient, tightening the screws at 10 N/mm. The care taken in the procedures of information transfer allowed to avoid major occlusal adjustment at the moment of delivery and to maintain the aesthetic and functional conditions already extensively tested for several weeks in the patient's mouth (Fig. 10A-10F).
Sutures were removed 11 days after surgery.
Two months later, four implants were placed in the lower arch in the interforaminal area, so as to respect the recommended ratio between the distal cantilever of the prosthesis and the length between the implants (36). The two distal implants were placed in a tilted position according to the All-on-four protocol (37). A crestal mucoperiosteal incision was performed with two releasing incisions at the distal ends of the crestal cut. A full thickness flap was raised and mental foramina


FIG. 11 Delivered of the lower jaw prostheses 2 days later post-op.


FIG. 12A 24 months later.


FIG. 12B 24 months later.

were isolated with special care in order to avoid any neuro-sensory damage. The knife-edge portion of the bone crest was removed with the aid of a relatively large bur mounted on a straight low-speed handpiece, under abundant irrigation. When a sufficient bone width in order to place regular sized implants was achieved, the bone was drilled at the center of the mandible so as to create a bed for positioning the surgical template. Implant site preparations were performed and four 13 mm long implants with 4 mm of diameter with external connection were placed (Nobel speedy, Nobel Biocare, Sweden). The two distal implants were distally tilted (Fig. 11).
Multi-unit abutments (30° of angulation and 3 mm of height) were connected to the implants in order to compensate the different implant inclinations. Impression were taken and a fixed hybrid prosthesis was delivered 24 hours after surgery, following the same prosthetic steps described for the upper arch.
Sutures were removed after 8 days. Follow-ups ensued at 30 and 60 days and a lateral radiograph was taken at the end of treatment (Fig. 12A-12C). The patient was enrolled into the maintenance program with professional hygiene session every 6 months.


FIG. 12C OPG 2 years after treatment.

DISCUSSION

Zygomatic implants could be an excellent solution for the rehabilitation of patients with severe maxillary atrophy. This treatment option can reduce the complexity of the treatment and certainly shortens treatment time.
Traditionally, extremely atrophic maxillae, when standard implants cannot be inserted because of severe bone resorption, have been treated with dentures or fixed prostheses supported by implants placed in augmented bone.
Dentures are associated with different morbid (stomatitis, traumatic ulcers, and irritation-induced hyperplasia) and psychological alterations (depression), as well as social problems (38, 39).
Grafting procedures, including maxillary sinus augmentation, onlay bone graft, and apposition graft with or without Le Fort I osteotomy, were commonly used, showing success rates between 60% and 90% (40-47). However, the need for a multi-staged approach, the increased risks of potential intraoral and/or extraoral complications, high level of bone resorption after bone graft, and increased operating time as well as costs, has induced clinicians to seek alternative treatment options for these patients. For these reasons, the development of treatment alternatives is welcomed by patients, especially when immediate implants function is possible (48, 49).
The relationship between zygomatic implants and maxillary sinus is still controversial; the most common complication is maxillary sinusitis, appearing in 8 of 15 studies published in the literature, with a frequency of 1.85% to 18.42% (50-56). The highest percentage of sinusitis was presented by Kahnberg et al. (55), whose series included 14% of patients with prior sinus disease.
Zygomatic implants are mainly indicated for the rehabilitation of severely atrophic maxilla when bone augmentation should be avoided. One drawback of zygomatic implants, as they pass through the sinus, is initial or late bone resorption around the implant neck, which can result in oro-antral communications followed by possible sinusitis. To decrease the risk of sinus infection, a modified technique was developed to preserve the integrity of the sinus membrane and to regenerate bone around zygomatic implants using an extended sinus augmentation approach without bone grafting. For these reasons the authors preserved the Schneider's membrane during surgery for zygomatic implant placement.
Edentulous subjects lack occlusal reference and thus a

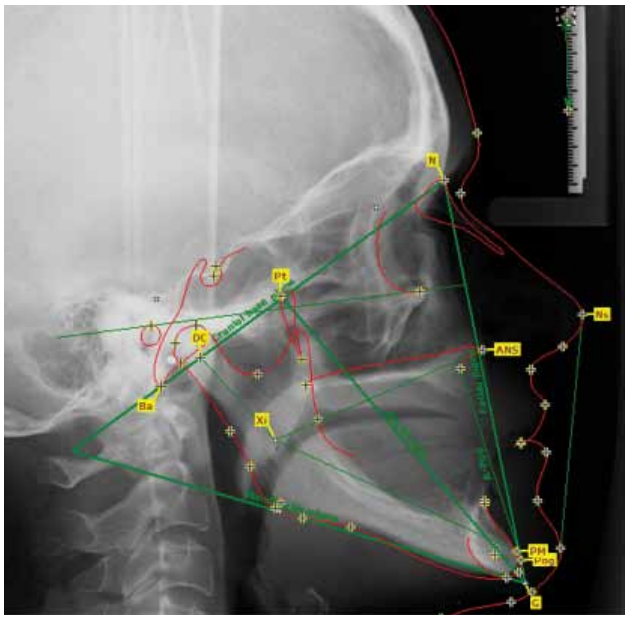

FIG. 13A Cephalometric analysis before surgery.

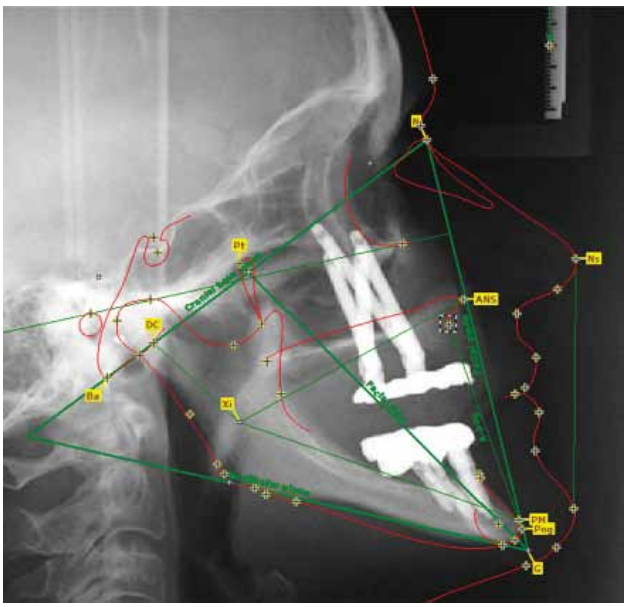

FIG. 14A Cephalometric analysis 2 years after treatment.

results	norm value	value
SNA	80..89°	73°
SNB	75..82°	75°
ANB	2..4°	-2°
SND	76..77°	75°
II	130..150°	
SN-OcP	14°	
SN-GoGn	30°	39°
Max1-NA	22°	
Max1-SN	108°	
Mand1-NB	25°	
1u-NA	4mm	
1l-NB	4mm	
Pog-NB		16mm
Holdaway ratio	0..2mm	
S-L	51mm	95mm
S-E	22mm	33mm

results	norm value	value
NBaPtG	90±3°	95°
NPogPOr	90±3°	94°
MeGoPOr	23±6°	24°
ANSXPM	47±4°	48°
DCXPM	31±4°	23°
A-NPog	-1±2mm	-11mm
1l-APog	1±2mm	
Mand1-APog	22±4°	
6uPTV	21±3mm	
Li-NsPog'	-4±2mm	-13mm
MeGoNPog	68±4°	62°

FIG. 13B, 13C Preoperative Steiner and Ricketts cephalometric parameters.

results	norm value	value
SNA	80..89°	74°
SNB	75..82°	76°
ANB	2..4°	-2°
SND	76..77°	78°
II	130..150°	
SN-OcP	14°	
SN-GoGn	30°	36°
Max1-NA	22°	
Max1-SN	108°	
Mand1-NB	25°	
1u-NA	4mm	
1l-NB	4mm	
Pog-NB		16mm
Holdaway ratio	0..2mm	
S-L	51mm	106mm
S-E	22mm	29mm

results	norm value	value
NBaPtG	90±3°	99°
NPogPOr	90±3°	91°
MeGoPOr	23±6°	25°
ANSXPM	47±4°	48°
DCXPM	31±4°	23°
A-NPog	-1±2mm	-11mm
1l-APog	1±2mm	
Mand1-APog	22±4°	
6uPTV	21±3mm	
Li-NsPog'	-4±2mm	-16mm
MeGoNPog	68±4°	63°

FIG. 14B, 14C Postoperative Steiner and Ricketts cephalometric parameters.

correct recording of intermaxillary relations and a correct evaluation of the vertical dimension should be carried out by means of phonetic, aesthetic and functional tests (29-31). In the present case, the cephalometric study showed a slight increase in the parameters evaluating the vertical dimension when comparing the initial and the final situation. These changes in the cephalometric parameters were expected as a consequence of the increase of the prosthetic height (Fig. 13-16).

The case reported required an extended diagnostic phase with removable prostheses (diagnostic prostheses) that could be modified several times until a correct mandibular position, with pleasant aesthetics and comfortable phonetics, could be found.

It is clear that the whole process was time-consuming and therefore it was important for the authors to keep information acquired so as to deliver the final restoration with no delays and without repeating part of the work alredy done. This is the reason why the authors used this information transfer technique, originally developed for standard osseointegrated implants, for zygomatic

FIG. 15A

FIG. 15B

FIG. 15C

FIG. 15D

FIG. 15A, 15D Clinical front view. Up: Preoperative vertical dimension in the patient in static and dynamic phase. Below: Postoperative vertical dimension in the patient in static and dynamic phase.


FIG. 16A


FIG. 16B


FIG. 16C


FIG. 16D

FIG. 16A, 16D Lateral and oblique view of the face. Left: Preoperative; Right: Postoperative.

ones. Through this approach, after diagnosis was performed, all the informations could be maintained and a definitive implant-supported restoration could be manufactured based on the diagnostic denture. The use of these diagnostic dentures to record the facebow and to mount the models on the articulator as well as the use of resin plates to transfer the implant position into the excavated models, guarantee that inter-maxillary relationships are not lost. When the implant analogues are embebbed in the master models and the inter-maxillary registration is maintained, it is easier for the clinician and the technician to achieve the work with precision and rapidity.

CONCLUSION

The present paper describes a possible approach to the rehabilitation of totally edentulous patients with extremely resorbed alveolar crests. This approach mainly consist of the following characteristics.

- The use of diagnostic prostheses before implant placement, which could be modified several times until the treatment objective is reached.
- The use of zygomatic implants, that are a suitable alternative for implant placement in cases with severe posterior maxillary atrophy, and the proposed lifting of Schneider's membrane of the maxillary sinus from the floor as well as the medial dislocation to place zygomatic implants may decrease the risk of biologic complications, in contrast with traditional zygomatic implant placement.
- The BARI technique allows a simplified transfer of information from the diagnostic dentures to the fixed implant-supported rehabilitation.

REFERENCES

1. Adell R, Lekholm U, Gröndahl K, Bränemark PI, Lindstrom J, Jacobsson M. Reconstruction of severely resorbed edentulous maxillae using osseointegrated fixtures in immediate autogenous bone grafts. International Journal of Oral and Maxillofacial Implants 1990;5:233–246.
2. Snauwaert K, Duyck J, van Steenberghe D, Quirynen M, Naert I. Time dependent failure rate and marginal bone loss of implant supported prostheses: a 15-year follow-up study. Clin Oral Investig 2000; 4:13-20.
3. Ortorp A, Jemt T. Clinical experiences of computer numeric control-milled titanium frameworks supported by implants in the edentulous jaw: a 5-year prospective study. Clin Implant Dent Relat Res 2004; 6:199-209.
4. Astrand P, Ahlqvist J, Gunne J, Nilson H. Implant treatment of patients with edentulous jaws: a 20-year follow-up. Clin Implant Dent Relat Res 2008; 10:207-17.
5. Moura LB, Carvalho PH, Xavier CB, Post LK, Torriani MA, Santagata M, Chagas Júnior OLAutogenous non-vascularized bone graft in segmental mandibular reconstruction: a systematic review. Int J Oral Maxillofac Surg 2016; 45:1388-1394.
6. D'Amato S, Tartaro G, Itro A, Nastri L, Santagata M. Block versus particulate/titanium mesh for ridge augmentation for mandibular lateral incisor defects: clinical and histologic analysis. Int J Periodontics Restorative Dent 2015; 35:1-8.
7. Chiapasco M, Brusati R, Ronchi P. Le Fort I osteotomy with interpositional bone grafts and delayed oral implants for the rehabilitation of extremely atrophied maxillae: a 1–9-year clinical follow-up study on humans. Clinical Oral Implants Research 2007; 18: 74–85.
8. Cordaro L, Torsello F, Accorsi Ribeiro C, Liberatore M, Mirisola di Torresanto V. Inlay–onlay grafting for three-dimensional reconstruction of the posterior atrophic maxilla with mandibular bone. Int J Oral Maxillofac Surg 2010 ; 39: 350–357.
9. Santagata M, Tozzi U, Tartaro G, Santillo V, Giovanni C, Lamart E, Itro A, Colella G, D'Amato S. Maxillary sinus augmentation with autologous and heterologous bone graft: a clinical and radiographic report of immediate and delayed implant placement. J Maxillofac Oral Surg 2014; 13(4):401-8.
10. Venezia P, Torsello F, Cavalcanti R, D'Amato S. Retrospective analysis of 26 complete-arch implant-supported monolithic zirconia prostheses with feldspathic porcelain veneering limited to the facial surface. J Prosthet Dent 2015 ; 114(4):506-12.
11. D'Amato S, Sgaramella N, Vanore L, Piombino P, Orabona GD, Santagata M. Piezoelectric bone surgery in the treatment of an osteoma associated with an impacted inferior third molar: a case report. Clin Cases Miner Bone Metab 2014 ; 11(1):73-6.
12. Santagata M, Guariniello L, D'amato S, Tozzi U, Rauso R, Tartaro G. Augmentation of atrophic posterior maxilla by short implants and osteotome technique. Stomatologia 2012; 14(3):85-8.
13. Itro A, Lupo G, Marra A, Carotenuto A, Cocozza E, Filipi M, D'Amato S. The piezoelectric osteotomy technique compared to the one with rotary instruments in the surgery of included third molars. A clinical study. Minerva Stomatol 2012; 61(6):247-53.
14. Keller EE, Van Roekel NB, Desjardins RP, Tolman DE. Prostheticsurgical reconstruction of the severely resorbed maxilla with iliac bone grafting and tissue integrated prostheses. Int J Oral Maxillofacial Implants 1987; 2:155–165.
15. Cawood JI, Stoelinga PJW, Brouns JJA. Reconstruction of the severely resorbed (Class VI) maxilla. A two-step procedure. Int J Oral and Maxillofacial Surgery 1994; 23:219-225.
16. Higuchi KW The zygomaticus fixture: an alternative approach for implant anchorage in the posterior maxilla. Ann R Australas Coll Dent Surg 2000; 15:28-33.
17. Davó R. Zygomatic implants placed with a two-stage procedure: a 5-year retrospective study. Eur J Oral Implantol 2009; 2:115-24.
18. Davó R Malevez C, Pons O. Immediately loaded zygomatic implants: a 5-year prospective study. Eur J Oral Implantol 2013; 6:39-47.
19. Aparicio C, Manresa C, Francisco K, Claros P, Alández J, González-Martín O, Albrektsson T. Zygomatic implants: indications, techniques and outcomes, and the zygomatic success code. Periodontol 2000 2014; 66:41-58.
20. Aparicio C, Manresa C, Francisco K, Ouazzani W, Claros P, Potau JM, Aparicio A. The long-term use of zygomatic implants: a 10-year clinical and radiographicmreport. Clin Implant Dent Relat Res 2014 ; 16:447-59.
21. Bedrossian E. Rehabilitation of the edentulous maxilla with the zygoma concept: a 7-year prospective study. Int J Oral Maxillofac Implants 2010 ; 25:1213-21.
22. Aparicio C, Ouazzani W, Aparicio A, Fortes V, Muela R, Pascual A, Codesal M, Barluenga N, Franch M. Immediate/Early loading of zygomatic implants: clinical experiences after 2 to 5 years of follow-up. Clin Implant Dent Relat Res 2010; 12:77-82.
23. Davó R, Malevez C, Rojas J, Rodríguez J, Regolf J. Clinical outcome of 42 patients treated with 81 immediately loaded zygomatic implants: a 12- to 42-month retrospective study. Eur J Oral Implantol 2008 ;1:141-50.
24. Venezia P, Lacasella P. Post-extractive and diagnostic removable rehabilitation: a

new approach. Labline 2013; 3:17-29.
25. Venezia P, Lacasella P, Cordaro L, Torsello F, Cavalcanti R. The BARI technique: a new approach to immediate loading. Int J Esthet Dent 2015;10:428-43.
26. General Assembly of the World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. J Am Coll Dent 2014;81:14-8.
27. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part I. Am J Orthod Dentofacial Orthop 1993; 103:299–312.
28. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part II. Am J Orthod Dentofacial Orthop 1993; 103:395–411.
29. Silverman MM Accurate measurement of vertical dimension by phonetics and the closest speaking centric space. Part I. Dent Digest 1951; 57:261-265.
30. Pound E. (1966) Cross arch splinting vs. premature extractions. J Prosthet Dent 1966;16:1058-1068.
31. Pound E. Let /S/ be your guide. J Prosthet Dent 1977; 38:482-489.
32. Fradeani M. Phonetic Analysis: Appraising the dentolabial relationship during phonesis to determine ideal incisal length, adequate tooth position and correct vertical dimension of occlusion. Esthetic rehabilitation in fixed prosthodontics Volume 1: Esthetic analysis. Chicago: Quintessence Publishing Co, Inc; 2004.
33. Zollo A, Della Pietra A. La definizione dei bordi in protesi totale: due metodiche a confronto. Dental Dialogue 2003; 7:558-573.
34. Millet C, Jeannin C, Vincent B, Malquarti G. Report on the determination of occlusal vertical dimension and centric relation using swallowing in edentulous patients. J Oral Rehabil 2003;30:1118–1122.
35. Biscaro L, Becattelli A, Poggio PM, Soattin M, Rossini F. The one-model technique: a new method for immediate loading with fixed prostheses in edentulous or potentially edentulous jaws. Int J Periodontics Restorative Dent 2009; 29:307-13.
36. Mericske-Stern RD, Taylor TD, Belser U. Management of the edentulous patient. Clin Oral Implants Res 2000; 11(1):108–125.
37. Malo P, Rangert B, Nobre M. "All on Four" immediate – function concept with Branemark system implants for completely edentulous mandibles: a retrospective clinical study. Clin Implant Dent Relat Res 2003 ; 5:2-9.
38. Cooper LF. The current and future treatment of edentulism. J Prosthodont 2009; 18:116-122.
39. Berggren U, Haägglin C, Hallberg U, Hallberg L. Psychological and quality of life aspects of edentulousness and treatment with dental implants. In: Brånemark PI (ed). The osseointegration book: from calvarium to calcaneus. Berlin: Quintessence; 2005. p157-176.
40. Kahnberg K, Ekestubbe A, Grondahl K, Nilsson P, Hirsch J. Sinus lifting procedure. One-stage surgery with bone transplant and implants. Clin Oral Implants Res 2001;12:479-487.
41. Nystrom L, Ahlqvist J, Legrell PE, Kahnberg K. Bone graft remodelling and implant success rate in the treatment of the severely resorbed maxilla: a 5-year longitudinal study. Int J Oral Maxillofac Implants 2002 ;31:158-164.
42. Nyström E, Ahlqvist J, Gunne J, Kahnberg KE. 10-year followup on onlay bone grafts and implants in severely resorbed maxillae. Int J Oral Maxillofac Surg 2004 ; 33:258-262.
43. Nyström E, Nilson H, Gunne J, Lundgren S. Reconstruction of the atrophic maxilla with interpositional bone grafting/ Le Fort I osteotomy and endosteal implants: A 11–16 year follow-up. Int J Oral Maxillofac Surg 2009;38:1-6.
44. Jensen J, Sindet-Pedersen S, Oliver AJ. Varying treatment strategies for reconstruction of maxillary atrophy with implants: results in 98 patients. J Oral Maxillofac Surg 1994; 52:210-218.
45. Kahnberg KE, Nilsson P, Rasmusson L. Le Fort I osteotomy withinterpositional bone grafts and implants for rehabilitation of the severely resorbed maxilla: A 2-stage procedure. Int J Oral Maxillofac Implants 1999; 14:571-578.
46. Wallace SS, Froum SJ. Effect of maxillary sinus augmentation on the survival of endosseous dental implants. A systematic review. Ann Periodontol 2003; 8:328-343.
47. Esposito M, Grusovin MG, Rees J, Karasoulos D, Felice P, Alissa R, et al. Effectiveness of sinus lift procedures for dental implant rehabilitation: a Cochrane systematic review. Eur J Oral Implantol 2010; 3:7-26.
48. Duarte L, Filho H, Francischone C, Peredo L, Brånemark P. The establishment of a protocol for the total rehabilitation of atrophic maxillae employing four zygomatic fixtures in an immediate loading system: a 30-month clinical and radiographic follow-up. Clin Implant Dent Relat Res 2007 ; 9:186-196.
49. Stiévenart M, Malevez C. Rehabilitation of totally atrophied maxilla by means of four zygomatic implants and fixed prosthesis: a 6–40-month follow-up. Int J Oral Maxillofac Surg 2010 ; 39:358-363.
50. Malo P, Nobre Mde A, Lopes I. A new approach to rehabilitate the severely atrophie maxilla using extramaxillary anehored implants in immediate funetion: a pilot study. J Prosthet Dent 2008; l00:354-366.
51. Pi Urgell J, Revilla Gutiérrez V, Gay Escoda CG. (2008)Rehabilitation of atrophie maxilla: a review of 101 zygomatic implants. Med Oral Patol Oral Cir Bucal 2008; 1;13:E363-370.
52. Davo R, Malevez C, Rojas J. Immediate function in the atrophic maxilla using zygoma implants: a preliminary study. J Prosthet Dent 2007; 97:44-51.
53. Aparicio C, Ouazzani W, Garcia R, Arevalo X, Muela R, Fortes V. A prospective clinical study on titanium implants in the zygomatic arch for prosthetic rehabilitation of the atrophie edentulous maxilla with a follow-up of 6 months to 5 years. Clin Implant Dent Relat Res 2006; 8:l 14-122.
54. Becktor JP, Isaksson S, Abrahamsson P, Sennerby L. Evaluation of 31 zygomatic implants and 74 regular dental implants used in 16 patients for prosthetic reconstruction of the atrophie maxilla with cross-arch fixed bridges. Clin Implant Dent Relat Res 2005; 7:159-165.
55. Kahnberg KE, Henry PJ, Hirsch JM, et al. Clinical evaluation of the zygoma implant: 3-year follow-up at 16 clinics. J Oral Maxillofac Surg 2007; 65:2033-2038.
56. Peñarrocha M, García B, Martí E, Boronat A. Rehabilitation of severely atrophie maxillae with fixed implant-supported prostheses using zygomatic implants placed using the sinus slot technique: clinical report on a series of 21 patients. Int J Oral Maxillofac Implants 2007; 22:645-650.