Implant-supported full-arch restorations using an external spherical implant connection. A case series

Riabilitazione totale implanto-supportata usando impianti a connessione esterna sferica. Serie di casi

Received on 14 December 2022
Accepted on 9 January 2024

***Corresponding author**
Stefano Vania
stefano.vania@hotmail.it

Stefano Vania[1*]
Andrea Paratelli[2]
Eriberto Bressan[3]
Alberto Pispero[4]

[1]Freelancer in Milan, University of Padua
[2]Freelancer in Ferrara
[3]Department of Neurosciences, School of Dentistry, University of Padova, Italy
[4]Department of Biomedical, Surgical and Dental Sciences, University of Milan, Italy

ABSTRACT

OBJECTIVES

Full-arch rehabilitation has always represented the most challenging work both from the surgical and from the prosthetic aspect. One of the challenges in the treatment of full-arch implant supported rehabilitation is the implant alignment and therefore the prosthetic framework passivation.

MATERIALS AND METHODS

Two cases of atrophic edentulous mandible and maxilla has been treated with implant-supported full-arch rehabilitation. A novel implant design (Bionica Orbit®), characterized by a spherical external connection that allow a 360° abutment rotation with an axial correction of 30° has been used. Bionica Orbit® implant has been selected because they are born to facilitate the prosthetic framework passivation and the correction of implants disparallelism. Intramucosal spherical connection allows to place a single abutment, named LEM, from 0° to 30° axial inclination on 360° of revolution combined with mini, narrow and traditional body.

RESULTS

Two full-arch mandible and maxillary rehabilitation has been successfully treated with only one unscrew event on the provisional framework over the follow up.

DISCUSSION

This case series reports two cases of complete edentulism treatment in medically compromised patients presenting resorbed jaws. Such patients present a notable challenge for the clinician and atraumatic measures should be implied to reduce post-operative discomfort. Procedures such as maxillary sinus lifting, and guided bone regeneration often become necessary for achieving the implant rehabilitation of edentulous patients. The number of visits, the duration and the complexity of the surgeries significantly increase when bone graft procedures are adopted.

In these two full-arch rehabilitation cases of atrophic mandible and maxilla the main goal was to rehabilitate patients with fixed prosthodontics avoiding complex regenerative procedures.

For the two clinical scenarios reported in this article, the upper arch and lower arch rehabilitations were approached in different ways. The choice of inserting six instead of four implants for the upper removable rehabilitation was driven by the reduced horizontal dimension of the alveolar ridge that forced the clinician to opt for smaller implant diameters, avoiding bone graft surgery. The premaxilla region was intentionally avoided since the available amount of bone was considered insufficient. To reduce the risk of mechanical complications in narrow diameter implants, the thickness of the material in the

Doi: 10.19256/d.cadmos.02.2024.09

implant neck area is a determining factor.
The implant system implied in this case presented an external spherical connection where the abutment screw did not engage the implant body, but it was mostly confined to the spherical head of the fixture, thus allowing greater titanium thickness in the implant neck. Moving the implant-abutment connection the farther away from the crestal bone as a safety measure is often achieved by either implying tissue-level implants or by the interposition of a mesostructure between the implant and the prosthetic framework.
The implant system used for the rehabilitations described in this paper shared both advantages of a tissue-level connection and an adjustable abutment acting as mesostructure.

CONCLUSIONS
Within the limitations of this clinical report, using rotational abutments over external spherical implant connections seems a valuable solution for complete-arch fixed and removable rehabilitations. The system simplifies the prosthetic workflow and allows intraoral alignment of the abutment reducing the incidence of prosthetic framework misfit. The surgical protocol could benefit from the use of narrow implant diameters, possible due to such implant connection.

CLINICAL SIGNIFICANCE
This eternal spherical connection implant system can improve the full-arch rehabilitation allowing to minimize the surgical trauma avoiding regenerative procedures when possible and correcting in a second stage the prosthetic axis thanks to a very flexible connection and to an intraoral parallelizing device.

KEY WORDS
- Full-arch rehabilitation
- Overdenture
- Tilted implants
- Toronto bridge
- External connection

RIASSUNTO

OBIETTIVI
La riabilitazione completa delle arcate dentarie ha sempre rappresentato il lavoro più impegnativo sia dal punto di vista chirurgico che protesico. Una delle sfide nel trattamento della riabilitazione full-arch implanto-supportata è l'allineamento degli impianti e quindi la passivazione della struttura protesica.

MATERIALI E METODI
Due casi di edentulia totale con atrofia mandibolare e mascellare sono stati trattati con riabilitazione full-arch supportata da impianti. È stata utilizzata una nuova sistematica implantare (Bionica Orbit®), caratterizzata da una connessione esterna sferica che consente una rotazione del moncone di 360° con una correzione assiale di 30°. Gli impianti Bionica Orbit® sono stati selezionati perché nati per facilitare la passivazione del manufatto protesico e la correzione del disparallelismo implantare. La connessione sferica intramucosa consente di posizionare un singolo moncone, denominato LEM, con inclinazione assiale da 0° a 30° su 360° di rotazione in combinazione con corpo mini, stretto e tradizionale.

RISULTATI
Le due riabilitazioni mandibolari e mascellari dell'arcata completa sono state trattate con successo con un solo evento di svitamento sulla struttura provvisoria durante il periodo di follow-up.

DISCUSSIONE
Questa serie di casi riporta il trattamento di due pazienti con edentulia totale, atrofia marcata dei mascellari e compromissione medica generale. Tali pazienti rappresentano una sfida notevole per il medico e dovrebbero essere previste misure atraumatiche per ridurre il disagio postoperatorio. Procedure come il rialzo del seno mascellare e la rigenerazione ossea guidata spesso diventano necessarie per ottenere la riabilitazione implantare di pazienti edentuli. Il numero di visite, la durata e la complessità degli interventi chirurgici aumentano notevolmente quando si adottano procedure di innesto osseo. In questi due casi di riabilitazione full-arch di mandibola e mascella atrofica l'obiettivo principale era quello di riabilitare i pazienti con protesi fissa evitando complesse procedure rigenerative.
Per i due scenari clinici riportati in questo articolo le riabilitazioni dell'arcata superiore e dell'arcata inferiore sono state affrontate in modi differenti. La scelta di inserire sei invece di quattro impianti per la riabilitazione rimovibile superiore è stata dettata dalla ridotta dimensione orizzontale della cresta alveolare che ha costretto il clinico a optare per diametri implantari più piccoli, evitando l'intervento di innesto osseo. La regione premascellare è stata intenzionalmente evitata poiché la quantità di osso disponibile era considerata insufficiente. Per ridurre il rischio di complicanze meccaniche negli impianti di piccolo diametro lo spessore del materiale nella zona del collo dell'impianto è un fattore determinante.
Il sistema implantare previsto in questo caso presentava una connessione sferica esterna dove la vite del moncone non impegnava il corpo dell'impianto, ma era per lo più confinata alla testa sferica del corpo implantare, consentendo così un maggiore spessore di titanio nel collo dell'impianto. L'allontanamento della connessione impianto-abutment dall'os-

so crestale come misura di sicurezza è spesso ottenuto o implicando impianti tissue-level o mediante l'interposizione di una struttura intermedia tra l'impianto e la struttura protesica.
Il sistema implantare utilizzato per le riabilitazioni descritte in questo lavoro condivideva sia i vantaggi di una connessione a livello tissutale sia un moncone regolabile che fungeva da struttura intermedia per la correzione assiale.

CONCLUSIONI
Entro i limiti di questo studio clinico, l'utilizzo di abutment rotazionali su connessioni implantari sferiche esterne sembra una soluzione valida sia per le riabilitazioni complete delle arcate dentarie sia fisse che rimovibili. Il sistema semplifica il flusso di lavoro protesico e consente l'allineamento intra-orale dei monconi riducendo l'incidenza della mancata passività della struttura protesica. Il protocollo chirurgico potrebbe trarre vantaggio dall'uso di diametri implantari stretti, possibile grazie a tale connessione implantare.

SIGNIFICATO CLINICO
Questo sistema implantare caratterizzato da una connessione sferica esterna può facilitare la riabilitazione delle arcate complete, consentendo di ridurre al minimo il trauma chirurgico, evitando procedure rigenerative quando possibile e correggendo in una seconda fase l'asse protesico grazie a una connessione molto flessibile e a un dispositivo di parallelizzazione intra-orale.

PAROLE CHIAVE
- Riabilitazione full-arch
- Protesi totale rimovibile implanto-supportata
- Impianti inclinati
- Protesi Toronto
- Connessione esterna

1. INTRODUCTION

Although the percentage of completely edentulous patient in the working population is in steep decline, there is still a significant rate of edentulism in the elderly population[1].

For these patients, implant-supported complete-arch fixed rehabilitation or implant-supported complete-arch removable prostheses may offer improved chewing function, esthetics and contribute to a consistently improved quality of life[1].

As a consequence of edentulism, maxillary bones become affected by disuse atrophy, which eventually leads to alveolar and basal bone resorption[2,3]. Patients with severely resorbed jaws often complain about denture instability. In many situations their rehabilitation by means of implant-supported prostheses poses both surgical and prosthetic challenges for the clinician[4].

Different techniques have been proposed for the atrophic patient's treatment, such as tilted implants, sinus floor elevation, vertical or horizontal bone augmentation, narrow implants, short implants, alveolar nerve transposition[5-8]. Bone augmentation requires less conservative surgical approaches, in elderly or systemically compromised patients different options should be considered before taking a reconstructive path. A treatment approach using tilted implants has been recommended to both reduce prosthetic cantilevers and additional surgical interventions. Tilted implants have shown no significant differences in terms of survival rate and marginal bone loss compared with axially positioned implants[9].

Mini implants present a reduced diameter (less than 3 mm), while narrow/conventional diameter implants typically have a diameter greater than 3 mm[10]. Therefore, the use of mini implants to rehabilitate such patients allows the use of less-complex surgical techniques since the reduced diameter of the implant permits its placement in areas within the residual alveolar bone. These implants are associated with high survival rates, favorable marginal bone stability, and less post-operative discomfort[11]. Mini implants should be considered for retaining overdenture prosthesis is as well as pillars in fixed dental prostheses, as an alternative treatment when standard implants placement is not possible.

Regarding the type of implant-supported complete-arch dental prostheses, supported fixed solutions offer better stability, chewing function, self-confidence and overall quality of life[12]. However, in presence of factors such as patient's ability to perform oral hygiene successfully, dento-skeletal discrepancies, or low economical availability, implant-supported complete-arch removable prostheses should be considered[1,13].

One of the challenges in the treatment of full-arch implant supported rehabilitation is the implant alignment and therefore the prosthetic framework passivation. Mesostructures are valuable solutions for misaligned or tilted implants' emergence parallelization. However, pre-fabricated mesostructures allow to correct the prosthetic axis with limited choices of positions and degrees between 7° and 45° depending on implant system.

The present clinical report describes the rationale and the clinical usage of an intramucosal spherical connection which allows to place a single abutment LEM from 0° to 30° on 360° of revolution combined with mini, narrow and traditional body for the rehabilitation of two edentulous patients.

This case report was designed and carried out according to the CARE statement[14]. Prior to the surgeries, treatment alternatives were presented by the clinician and, finally, an informed consent was given by the patient.

2. MATERIALS AND METHODS

Clinical case 1

A 77 years-old male patient reported to the dental office with edentulous upper arch. Upon collecting anamnestic information, he was classified as ASA III patient[15] and information about previous dental history was gathered. The patient underwent upper teeth extraction 12 months prior to the dental visit, and he's been wearing a complete-arch removable denture since. The patient's chief complaint was related to denture instability, which led to social discomfort during speech and chewing. The lower arch presented both tooth-supported and implant-supported fixed restorations.

Radiographic examination showed peri-implant bone loss for all three implants in the lower arch. Non-surgical periodontal therapy was carried out prior to implant surgery, and he was given appropriate oral hygiene instructions. A cone beam computed tomography was obtained for the upper arch and a six implant-supported overdenture prosthesis was planned with the aim of providing improved stability and function.

The surgery was performed with the patient under local anesthesia with 4% articaine and 1:100,000 adrenaline. Crestal incision was made on the alveolar ridge, on both sides a full-thickness flap was reflected. Six tissue-level implants with an external spherical connection (Bionica Orbit®, Vicenza, Italy) were inserted in upper lateral incisors/canine region, second premolar region and second molar region for both right and left sides (**figg. 1-4**).

The implants dimensions were 3.2x10 mm in right premolar, lateral incisors and left molar regions, while 3.2x11.5 mm and 3.7x8 mm in the left premolar and left molar regions respectively. An insertion torque between 35 N/cm and 50 N/cm was achieved for all implants which indicated good primary stability. Peek cover screws with 0 mm height were secured to the implants in order to allow the patient to wear after 15 days the upper removable complete denture appropriately reconfigured (**fig. 5**).

After implants placement, flaps were sutured, and the patient was prescribed

Fig. 1 Case 1. Pre-operative upper arch

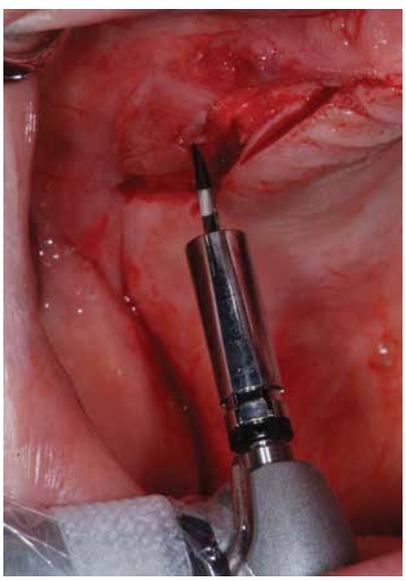

Fig. 2 First drill insertion with dept stops system

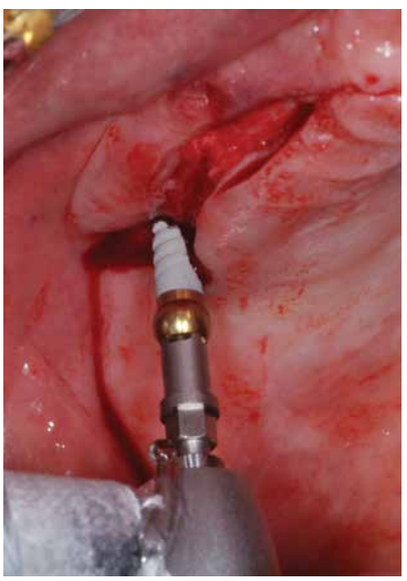

Fig. 3 Spherical external implant connection 1.6 position

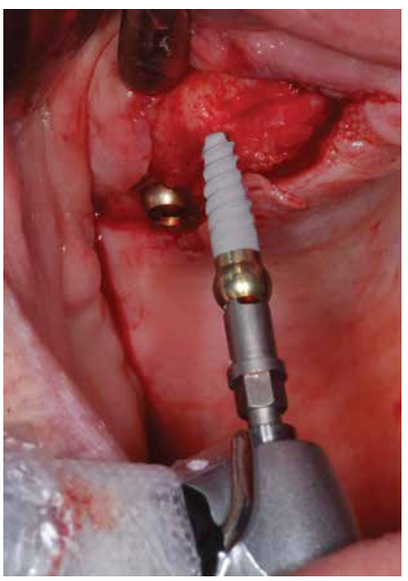

Fig. 4 1.3. Bionica Orbit® implant positioning

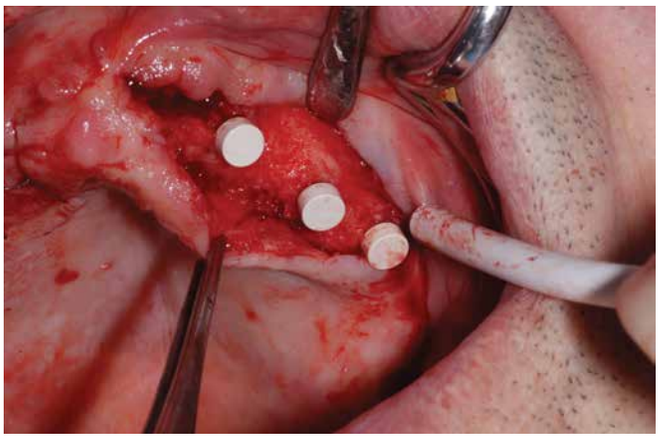

Fig. 5 PEEK healing caps

Fig. 6 Three months post-surgical orthopanoramic X-ray before implant connection

Fig. 7 Two week post-surgery

Fig. 8 Oriented Bionica Orbit® abutment

Fig. 9 Intra-oral parallelizing device

with amoxicillin 1 gr/12 h for 5 days and ibuprofen 400 mg in case of discomfort. The patient was recalled after 5 days for evaluation and sutures were removed on the 10th day. A panoramic radiograph was obtained on the day of the implant-abutment connection (**fig. 6**). The patient's upper removable complete denture was adapted in order to avoid pressure spots over the implant cover screws. After 12 weeks the patient was recalled (**fig. 7**), implant cover screws were removed and six 3.6 mm height screw retained overdenture abutments (Bionica Orbit®) were placed with the aid of a dedicated parallelism device (**figg. 8, 9**). Vertical dimension and centric relation of patient were recorded. A complete overdenture prosthesis was fabricated and relined over the overdenture abutments with retentive caps. Occlusal adjustments were made, and maintenance instructions were delivered to the patient.

Clinical case 2

A 73 years-old, female, presenting edentulous maxillary and mandibular jaws reported to the dental clinic complaining about instability of the lower complete removable denture. She reported a history of bone marrow transplant as well as colon cancer and she was being treated for

severe anxiety and insomnia disturbs with zolpidem 5 mg/day and cholecalciferol for vitamin D deficiency. According to the American Society of Anesthesiologists classification, she was classified as ASA III patient. The patient underwent extraction of the remaining upper and lower teeth due to carious lesions approximately one year prior to the visit. She had been wearing removable upper and lower complete dentures.

Both clinical and radiographic examinations, despite the lower edentulous jaw presented a significant degree of horizontal contraction, showed adequate amount of alveolar bone for implant placement. According to the patient, the upper denture was evaluated stable and comfortable. An implant-retained removable complete denture was suggested for the lower arch modifying the existing one. As the mandible presented a U-shaped conformation, 4 implants had been planned.

The surgery was performed with the patient under local anesthesia with 3% mepivacaine without adrenaline. A crestal incision was performed on the intraforaminal portion of the alveolar ridge and a full-thickness flap was reflected. Two 2.7x10 mm tissue-level implants (Bionica Orbit®, Vicenza, Italy) were placed in the right and left canine regions. For the posterior region, two incisions were realized on the attached mucosa and full-thickness flaps were reflected, two 3.2x8 mm tissue-level implants were inserted in the premolar area (**figg. 10-17**). Primary closure was obtained for all three surgical sites (**fig. 18**). An insertion torque between 35 N/cm and 50 N/cm was achieved for all implants.

After surgery, the patient was prescribed with amoxicillin 1 gr/8 h for 6 days and ibuprofen 400 mg in case of discomfort. The patient was recalled after 5 days for evaluation and sutures were removed on the 10th day. Zero millimeters height peek cover screws were chosen for all implants in order to allow the patient to wear after 15 days the upper full denture appropriately reconfigured (**fig. 19**). A post-operative panoramic radiograph was obtained (**fig. 20**).

After 3 months the patient was recalled and mucotomy was performed to remove the soft tissue that overgrew on the implant cover screws. After healing, a zinc oxide eugenol impression of the lower arch had been taken using the lo-

Fig. 10 Case 2. Pre-operative mucosal healing after teeth extractions

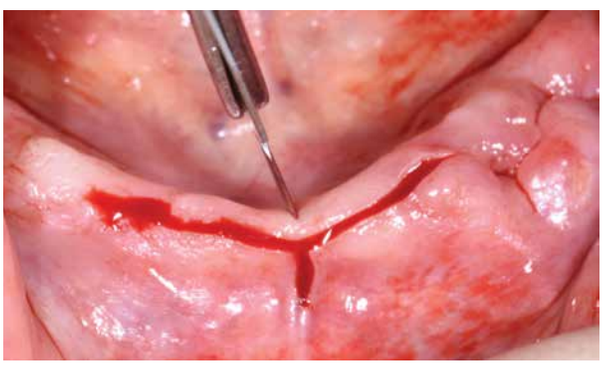

Fig. 11 Crestal and midline incisions

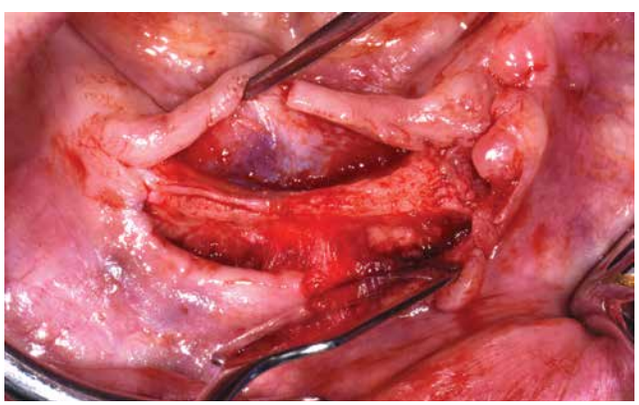

Fig. 12 Lower arch intra-foramina flap elevation

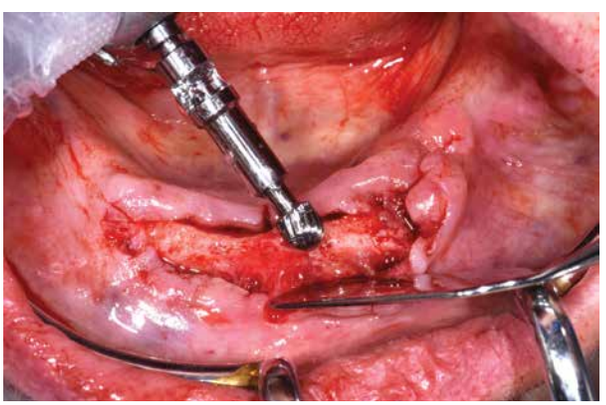

Fig. 13 Crestal correction with rotating burs

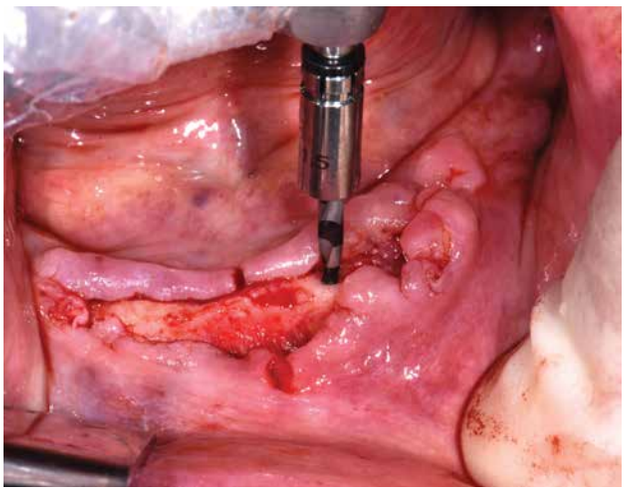

Fig. 14 Implant preparation with depth control device

Fig. 15 Bionica Orbit® implant system carrier

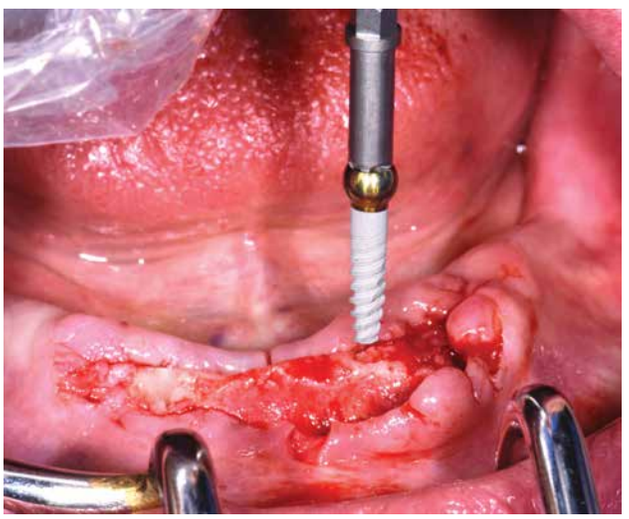

Fig. 16 Bionica Orbit® implant insertion

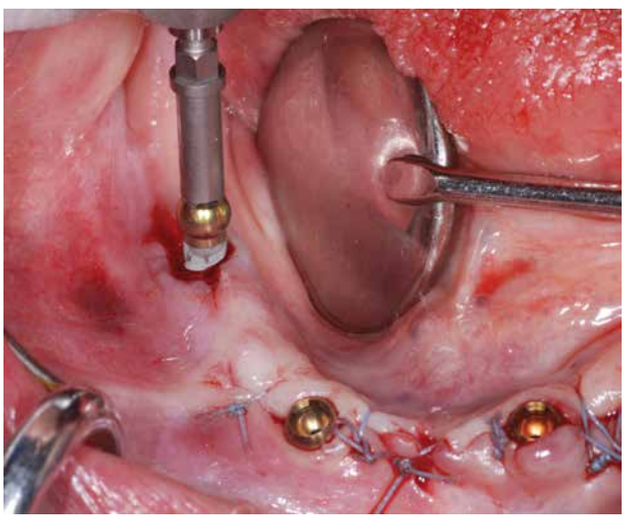

Fig. 17 Implant insertion position 4.5

Fig. 18 Post-surgery sutures

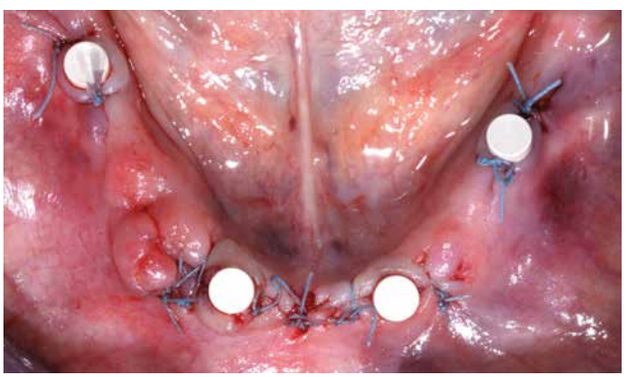

Fig. 19 PEEK healing cap in position

Fig. 20 Three months post-surgical orthopanoramic X-ray before implant connection

wer prosthesis as impression tray, recording the implants position and the soft tissue architecture. After 1 day the lab returned the denture appropriately modified to avoid interferences with the LEM equator abutments and providing correct soft tissue support. Four 3.6 mm height equator LEM abutments were placed with the aid of the parallelism device in order to ensure a correct insertion pathway for the prosthesis (**figg. 21, 22**).

The prosthodontist reconfigured the lower denture with acrylic resin including the cap attachment of the equator devices in the prosthesis. Yellow retentive caps were positioned. After checking retention and occlusal interferences, the prosthesis was delivered to the patient and hygiene instructions were provided (**fig. 23**).

3. DISCUSSION

This case series reports two cases of complete edentulism treatment in medically compromised patients presenting resorbed jaws. Such patients present a notable challenge for the clinician and atraumatic measures should be implied to reduce post-operative discomfort. Procedures such as maxillary sinus lifting, and guided bone regeneration often become necessary for achieving the implant rehabilitation of edentulous patients[16].

The number of visits, the duration and the complexity of the surgeries significantly increase when bone graft procedures are adopted[17], factor that becomes of paramount importance when treating medically compromised patients. The frequency of patients that undergo implant treatment needing bone graft surgery was reported being 50.3%, with higher prevalence in the upper premaxilla and in the lower intraforaminal areas. To decrease the surgical trauma and avoid the need for bone augmentation, techniques such as decreasing the number of implants have proven successful[18].

For the two clinical scenarios reported in this article, the upper arch and lower arch rehabilitations were approached in different ways. The choice of inserting six instead of four implants for the upper removable rehabilitation was driven by the reduced horizontal dimension of the alveolar ridge that forced the clinician to opt for smaller implant diameters, avoiding bone graft surgery. The premaxilla region was intentionally avoided since the available amount of bone was considered insufficient.

On the other hand, the lower removable rehabilitation required implant-support in

Fig. 21 LEM abutment orientated with intra-oral parallelizing device

Fig. 22 LEM abutment orientated with intra-oral parallelizing device: front view

Fig. 23 Implant supported removable complete denture

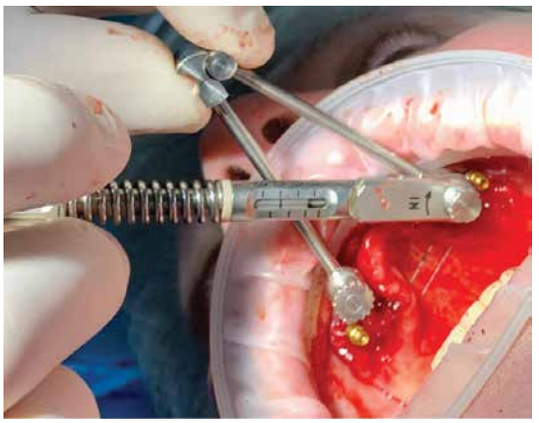

Fig. 24 Intra-oral parallelizing device

Fig. 25 Implant section. Full frame body and spherical tissue-level connection

the intra-foraminal area to ensure proper retention for the overdenture. To overcome the narrow horizontal ridge in that area, 2.7 mm diameter implants were chosen. Survival rates for narrow diameter implants have been described by Schiegnitz et al.[19] as more alarming than for standard diameter implants, however only 4 studies were included in their meta-analysis and the authors agreed that their long-term biological and mechanical behavior still needs to be investigated. To reduce the risk of mechanical complications in narrow diameter implants, the thickness of the material in the implant neck area is a determining factor. The implant system implied in this case presented an external spherical connection where the abutment screw did not engage the implant body, but it was mostly confined to the spherical head of the fixture, thus allowing greater titanium thickness in the implant neck (**figg. 24, 25**).

Moving the implant-abutment connection farther away from the crestal bone as a safety measure is often achieved by either implying tissue-level implants or by the interposition of a mesostructure between the implant and the prosthetic framework[20]. The implant system used for the rehabilitations described in this paper shared both advantages of a tissue-level connection and an adjustable abutment acting as mesostructure.

From a prosthetic standpoint, the advantages offered by the trilobate head in the fixture, tightened into the abutment once it was parallelized, resolved the need for stocking different measurements of angulated abutments. Nevertheless, whenever possible, choosing the one-abutment-one-time technique should be preferred as a more favorable marginal bone behavior is expected by avoiding repeated removal of the abutment[21]. Connecting and parallelizing prosthetic abutments on the day of the surgery with the aid of dedicated devices (**fig. 26**) could benefit the stability of the crestal bone as well as reduce the overall duration of the treatment.

Concerning numbers have been reported for the occurrence of mechanical complications in implant-supported complete-arch rehabilitations, and more frequently in overdentures than in fixed restorations. The long-term *in vivo* behavior of the implant connection described in this report has yet to be investigated, however, the rationale to recommend its use could be supported by biological and surgical advantages that may ease the treatment outcome, especially in cases where minimally invasive approaches are necessary.

Fig. 26 Orientable LEM abutment: 0° to 30° axial correction on a 360° rotation

4. CONCLUSIONS

Within the limitations of this clinical report, using rotational abutments over external spherical implant connections seems a valuable solution for complete-arch fixed and removable rehabilitations. The system simplifies the prosthetic workflow and allows intra-oral alignment of the abutment reducing the incidence of prosthetic framework misfit.

The surgical protocol could benefit from the use of narrow implant diameters, possible due to such implant connection. Long-term observations are needed to validate this implant design. ■

CONFLICT OF INTEREST

The authors confirm that are no known conflicts of interest associated with this publication.

FUNDING FOR THE STUDY

The authors did not have significant financial support for this work that could have influenced its outcome.

INFORMED CONSENT

For the publication of the case, including photos, the consent of the patient was obtained.

REFERENCES

1. **Frauke Müller SB.** ITI Treatment Guide, Volume 9: Implant therapy in the geriatric patient. Quintessence Publishing, 2016 (312 p).
2. **Cardaropoli G, Araújo M, Lindhe J.** Dynamics of bone tissue formation in tooth extraction sites: an experimental study in dogs. J Clin Periodontol 2003;30(9):809-18.
3. **Cawood JI, Howell RA.** A classification of edentolous jaws. Int J Oral Maxillofac Surg 1988;17(13):232-6.
4. **Sanz M, Dahlin C, Apatzidou D, Artzi Z, Bozic D et al.** Biomaterials and regenerative technologies used in bone regeneration in the craniomaxillofacial region: Consensus report of group 2 of the 15th European Workshop on Periodontology on Bone Regeneration. J Clin Periodontol 2019;46(S21):82-91.
5. **Abayev B, Juodzbalys G.** Inferior alveolar nerve lateralization and transposition for dental implant placement. Part I: A systematic review of surgical techniques. J Oral Maxillofac Res 2015;6(1):1-13.
6. **Urban IA, Jovanovic SA, Lozada JL.** Vertical ridge augmentation using guided bone regeneration (GBR) in three clinical scenarios prior to implant placement: a retrospective study of 35 patients 12 to 72 months after loading. Int J Oral Maxillofac Implants 2009;24(3):502-10.
7. **Cucchi A, Chierico A, Fontana F, Mazzocco F, Cinquegrana C et al.** Statements and recommendations for guided bone regeneration: Consensus report of the Guided Bone Regeneration Symposium Held in Bologna, October 15 to 16, 2016. Implant Dent 2019;28(4):388-99.
8. **Del Fabbro, Massimo TT.** L'elevazione del seno mascellare stato dell'arte, alternative terapeutiche e revisione sistematica della letteratura. Riv Ital Stomatol 2004:6-19.
9. **Del Fabbro M, Bellini CM, Romeo D, Francetti L.** Tilted implants for the rehabilitation of edentulous jaws: a systematic review. Clin Implant Dent Relat Res 2012;14(4):612-21.
10. **Upendran A, Gupta N, Salisbury HG.** Dental mini-implants. StatPearls Publishing, 2021.
11. **Jung RE, Al-Nawas B, Araujo M, Avila-Ortiz G, Barter S et al.** Group 1 ITI Consensus report: The influence of implant length and design and medications on clinical and patient-reported outcomes. Clin Oral Implants Res 2018 Oct 1;29(Suppl 16):69-77.
12. **Wang Y, Bäumer D, Ozga A-K, Körner G, Bäumer A.** Patient satisfaction and oral health-related quality of life 10 years after implant placement. BMC Oral Health 2021 Jan;21(1):30.
13. **Tsigarida A, Chochlidakis K.** A comparison between fixed and removable mandibular implant-supported full-arch prostheses: an overview of systematic reviews. Int J Prosthodont 2021;34:s85-92.
14. **Riley DS, Barber MS, Kienle GS, Aronson JK, von Schoen-Angerer T et al.** CARE guidelines for case reports: explanation and elaboration document. J Clin Epidemiol 2017;89:218-35.
15. **Doyle DJ, Goyal A, Bansal P, Garmon EH.** American Society of Anesthesiologists Classification. In Treasure Island (FL), 2022.
16. **Benic GI, Hämmerle CHF.** Horizontal bone augmentation by means of guided bone regeneration. Periodontol 2000 2014 Oct;66(1):13-40.
17. **Almahrous G, David-Tchouda S, Sissoko A, Rancon N, Bosson J-L, Fortin T.** Patient-Reported Outcome Measures (PROMs) for two implant placement techniques in sinus region (bone graft *versus* computer-aided implant surgery): a randomized prospective trial. Int J Environ Res Public Health 2020 Apr;17(9):2990.
18. **Toia M, Stocchero M, Corrà E, Becktor JP, Wennerberg A, Cecchinato D.** Fixed full-arch maxillary prostheses supported by four *versus* six implants with a titanium CAD/CAM milled framework: 3-year multicentre RCT. Clin Oral Implants Res 2021 Jan;32(1):44-59.
19. **Schiegnitz E, Al-Nawas B.** Narrow-diameter implants: a systematic review and meta-analysis. Clin Oral Implants Res 2018;29(Suppl 16):21-40.
20. **Sasada Y, Cochran DL.** Implant-abutment connections: a review of biologic consequences and peri-implantitis implications. Int J Oral Maxillofac Implants 2017;32(6):1296-3021.
21. **Bressan E, Grusovin MG, D'Avenia F, Neumann K, Sbricoli L et al.** The influence of repeated abutment changes on peri-implant tissue stability: 3-year post-loading results from a multicentre randomised controlled trial. Eur J Oral Implantol 2017;10(4):373-90.