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Digital Workflow–Assisted All-On-Four® Rehabilitation of Severely Resorbed Maxillary and Mandibular Arches: A Case Report

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Abstract:
Background: *Rehabilitation of severely resorbed edentulous arches is challenging because of inadequate bone volume, poor denture stability, and compromised function. The All-on-Four® concept provides an alternative approach for fixed full-arch rehabilitation by strategically positioning four implants to maximize available bone and reduce the need for extensive augmentation. Digital technologies such as cone-beam computed tomography (CBCT), virtual planning, and computer-guided surgery can further facilitate prosthetically driven implant placement.*
Case Presentation: *A completely edentulous patient with inadequate stability of conventional complete dentures was rehabilitated using a digitally planned and guided All-on-Four® approach. CBCT data were integrated with virtual prosthetic planning, and surgical guides were fabricated for guided implant placement. Four implants were placed in each arch, followed by delayed loading and definitive screw-retained porcelain-fused-to-metal prostheses.*
Conclusion: *Satisfactory function, prosthetic stability, and esthetics were achieved. This case demonstrates the clinical application of a digital workflow combined with the All-on-Four® concept for fixed rehabilitation of severely resorbed edentulous arches.*
Key Words: *All-on-Four®; guided implant surgery; edentulous arch; tilted implants; fixed implant-supported prosthesis.*

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I. INTRODUCTION

Complete dentures remain a conventional treatment modality for complete edentulism; however, rehabilitation of edentulous arches can be challenging because of residual ridge resorption, compromised denture stability, and functional limitations, particularly in the mandible. These factors may negatively affect retention, stability, masticatory efficiency, and quality of life.[1] Dental implants have significantly improved the predictability of rehabilitation for completely edentulous patients, while advances in digital dentistry have further enhanced the accuracy of implant placement.

Completely edentulous arches can be rehabilitated using implant-retained overdentures or fixed full-arch implant-supported prostheses. Although overdentures offer advantages such as lower cost, fewer implants, and ease of maintenance, fixed prostheses provide improved masticatory function, reduced food entrapment, and psychological benefits associated with fixed teeth. However, limitations such as reduced bite force compared with fixed prostheses, the need for replacement of retentive components, and potential psychological dissatisfaction in patients who prefer a fixed restoration may influence treatment selection.[2]

Fixed full-arch implant-supported prostheses are preferred by many patients because of the advantages they offer over removable prostheses. These include higher bite forces, reduced food entrapment, and psychological benefits associated with fixed teeth.[2] Pjetursson et al. reported implant and prosthetic survival rates of 95.6% and 95.4%, respectively, for full-arch fixed implant-supported prostheses over a 5-year period.[3]

The All-on-X concept has evolved as an alternative approach for full-arch implant rehabilitation. The All-on-Four® concept, introduced by Paulo Maló in the 1990s, utilizes two anterior axial implants and two posterior tilted implants to maximize the use of available bone, increase the anteroposterior spread, and reduce distal cantilever length. This approach can facilitate fixed rehabilitation while reducing the need for extensive

bone augmentation in appropriately selected patients with advanced ridge resorption.[4] Adequate primary stability, available bone volume, appropriate implant angulation, and prosthetically favorable implant positioning are important for predictable outcomes. Computer-guided surgery can further facilitate accurate, prosthetically driven implant placement.[5,6] Maló et al. reported implant and prosthetic survival rates of 93% and 98.8%, respectively, over an 18-year follow-up period.[7]

This clinical report describes the rehabilitation of severely resorbed edentulous maxillary and mandibular arches using a digitally planned and guided All-on-Four® approach with delayed loading and definitive screw-retained porcelain-fused-to-metal prostheses.

II. CASE PRESENTATION

A 45-year-old woman in good general health reported difficulty in mastication and dissatisfaction with her existing complete dentures, particularly because of inadequate denture stability. Extraoral examination revealed facial symmetry, adequate mouth opening, and no clinically significant temporomandibular joint abnormalities. (Fig-1) Intraoral examination revealed complete edentulism in both arches, with healthy oral mucosa and no evidence of inflammation or other pathological changes. (Fig-2)

Preoperative extraoral view (Fig-1)
Preoperative intraoral view (Fig-2)

Clinical and Laboratory Procedures
Denture Preparation and Digital Planning

The existing maxillary and mandibular complete dentures were relined with an elastomeric material to ensure intimate adaptation to the underlying mucosa . (Fig. 5) Zirconia radiographic markers were attached to the polished surfaces of the dentures in the canine and molar regions bilaterally (Fig. 6). Cone-beam computed tomography (CBCT) was acquired with the dentures positioned intraorally. The dentures were subsequently scanned using an intraoral scanner, and the denture scan data were merged with the CBCT data to facilitate prosthetically driven three-dimensional treatment planning. The integrated digital data were transferred to the laboratory for surgical guide fabrication.

Processed denture relined with elastomer (Fig-5)
Zirconia radiographic markers placed on the dentures for CBCT (Fig-6)

Treatment Planning

A guided All-on-Four® implant placement protocol was planned for both the maxillary and mandibular arches. Four implants were planned for each arch, comprising two anterior axial implants and two posterior tilted implants, to optimize the available bone and increase the anteroposterior spread.

Surgical Phase
Surgical Guide Placement

Under local anesthesia, the surgical guides were positioned and secured to the residual alveolar ridges using anchor pins to ensure accurate transfer of the digitally planned implant positions (Fig. 10).

Surgical Guide stabilized with anchor pins (Fig-10)
Implant Placement

Four implants were placed in the maxilla and four in the mandible (Fig. 11,12). In each arch, two anterior implants were placed axially, while the two posterior implants were tilted approximately 30° to optimize the available bone and maximize the anteroposterior spread. As adequate primary stability was not achieved, a delayed loading protocol was planned.

Implant placement (Fig-11,12)
Healing Phase

Healing abutments were connected, and a postoperative panoramic radiograph was obtained to confirm implant positioning. (Fig.13) The existing maxillary and mandibular dentures were adjusted and relined for use during the osseointegration period.

OPG- Postoperative panoramic radiograph following implant placement (Fig-13)

Prosthetic Phase
Prosthetic Options Considered
The available full-arch prosthetic options included:

- CAD/CAM-milled zirconia framework with individual ceramic crowns;
- CAD/CAM-milled titanium framework with acrylic or ceramic veneering;
- porcelain-fused-to-metal (PFM) prosthesis supported by a metal framework; and
- Malo Bridge.[7,8]

Definitive Prosthetic Design

A screw-retained PFM prosthesis supported by a Co-Cr framework was selected for both arches because it provided an appropriate balance of strength, rigidity, esthetics, and cost-effectiveness.

Implant-Level Impression

Following the osseointegration period, implant-level open-tray impressions were made using splinted impression copings (Figs. 14). The impression copings were splinted to minimize movement during impression making and improve the accuracy of the definitive working casts.

Open tray implant level impression (Fig-14)

Verification Jig Trial

A verification jig was tried intraorally to assess the accuracy and passive fit of the implant positions (Fig. 15).

Verification of Jig trail (Fig-15)

Resin Framework Trial

A resin framework trial was performed to evaluate tooth position, occlusion, esthetics, phonetics, and vertical dimension of occlusion (VDO) (Fig. 16).

Resin framework trail (Fig-16)

Definitive Prosthesis Fabrication

Following satisfactory clinical evaluation of the framework and resin trials, the definitive screw-retained PFM prostheses supported by Co-Cr frameworks were fabricated for both the maxillary and mandibular arches.

Prosthesis Delivery

The definitive prostheses were secured using prosthetic screws tightened to the manufacturer's recommended torque. The screw-access channels were sealed with composite resin to maintain retrievability while providing an acceptable esthetic outcome. (Fig. 17).

Definitive screw retained PFM prosthesis (Fig-17)

Postoperative Evaluation

A postoperative orthopantomogram (OPG) was obtained to evaluate the implant and prosthetic positioning and to confirm satisfactory rehabilitation (Fig. 18).

Postoperative panoramic radiograph with definitive prostheses (Fig-18)

(Fig-18)

Clinical Outcome

Following prosthetic rehabilitation, the patient demonstrated satisfactory function, prosthetic stability, and esthetics. The patient reported improvement in masticatory efficiency, comfort, and overall satisfaction.

III. DISCUSSION

Rehabilitation of severely resorbed edentulous arches is challenging because conventional complete dentures may provide inadequate stability, retention, and masticatory function. Although implant-supported prostheses offer improved treatment options, limited bone volume and anatomical restrictions may necessitate additional procedures such as bone augmentation or nerve transposition.[1]

The All-on-Four® concept provides an alternative approach for fixed full-arch rehabilitation using two anterior axial and two posterior tilted implants. This configuration maximizes the use of available bone, increases the anteroposterior (A-P) spread, and reduces the distal cantilever length.[4] Krekmanov et al. reported improved prosthetic support with tilted implants,[9] while Bevilacqua et al. demonstrated favorable biomechanical behavior with tilted implants compared with vertically positioned implants associated with longer cantilevers.[10]

Although immediate loading is frequently used with the All-on-Four® concept, delayed loading was selected in the present case because adequate primary stability was not achieved at implant placement. The existing dentures were therefore adjusted and relined for use during the osseointegration period. Digital planning and guided surgery facilitated prosthetically driven implant positioning and appropriate distribution of the implants within the available bone.[8]

Adequate A-P spread and controlled cantilever length are important considerations in full-arch implant rehabilitation. Favorable implant distribution and appropriate occlusal design may help reduce unfavorable biomechanical loading of the prosthesis. The long-term clinical performance of the All-on-Four® concept has been supported by favorable implant and prosthetic survival rates. Soto-Peñaloza et al. reported implant survival rates ranging from 93% to 100% and prosthetic survival rates above 95%,[13] while Maló et al. reported implant and prosthetic survival rates of 93% and 98.8%, respectively, over an 18-year follow-up period.[12]

A screw-retained porcelain-fused-to-metal (PFM) prosthesis supported by a Co-Cr framework was selected for both arches because of its strength, rigidity, esthetic potential, and retrievability. Implant-level restoration also allowed direct connection of the prosthesis to the implants, simplifying the prosthetic workflow in the present case. The combination of digital planning, guided implant placement, delayed loading, and definitive metal-ceramic prostheses provided satisfactory functional and esthetic rehabilitation in this patient.

IV. CONCLUSION

The guided All-on-Four® concept provided a viable treatment option for the rehabilitation of severely resorbed maxillary and mandibular edentulous arches in the present case. Digital planning and guided surgery facilitated prosthetically driven implant placement, while delayed loading was selected because adequate primary stability was not achieved at implant placement. The definitive screw-retained metal-ceramic prostheses provided satisfactory functional stability and esthetics. Careful patient selection, prosthetically driven planning, appropriate implant positioning, and regular maintenance are essential for successful full-arch implant rehabilitation.

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