All-On-Four Treatment Concept in Dental Implants: A Review

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ABSTRACT

Background: The All-on-4 implant concept is a predictable graftless approach for full-arch rehabilitation in edentulous patients.

Aim: To review diagnosis, planning, prosthetic considerations, and materials used in All-on-4 rehabilitation.

Materials and Methods: A narrative review of literature focusing on prosthodontic aspects of All-on-4 therapy.

Results: Various prosthetic designs including hybrid prosthesis, metal–ceramic, milled titanium, and zirconia demonstrate reliable outcomes.

Conclusion: All-on-4 provides predictable functional and esthetic rehabilitation when proper prosthodontic principles are followed.

Keywords: All-on-4, implant prosthesis, full-arch rehabilitation, zirconia, hybrid prosthesis

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INTRODUCTION

Edentulism is a state associated with compromised esthetics, functional and psychological complications for the patient. Traditionally, the rehabilitation of completely edentulous patients relied primarily on conventional complete dentures. However, despite their widespread use, removable prostheses frequently fail to meet patient expectations due to compromised stability, reduced chewing efficiency, and difficulty in adaptation, particularly in cases of severe ridge resorption.

Implant-supported fixed prostheses have gained significant popularity owing to their high success rates, reduced maintenance requirements, and the psychological benefit of mimicking natural dentition.

One of the major challenges in implant dentistry remains the rehabilitation of patients with severely atrophic jaws. Advanced ridge resorption, particularly in the posterior maxilla and mandible, often necessitates complex adjunctive procedures such as sinus floor elevation, guided bone regeneration, ridge augmentation, nerve repositioning, or autogenous bone grafting. Although effective, these procedures are associated with increased treatment duration, cost, and morbidity, limiting their acceptability for many patients.

To address these limitations, modern oral rehabilitation strategies emphasize simplified implant protocols and immediate loading concepts. Within this paradigm, the All-on-4 treatment concept was introduced as a graftless solution for full-arch rehabilitation in atrophic jaws. By strategically placing four implants—two axial implants in the anterior region and two posterior implants tilted distally—this concept maximizes the use of available bone, avoids critical anatomical structures, reduces cantilever length, and enables immediate function. Consequently, the All-on-4 concept represents a significant advancement in the management of edentulism, offering predictable outcomes with reduced biological and financial burden.

RATIONALE OF ALL-ON-4 CONCEPT

The All-on-4 concept was developed to address the limitations of conventional full-arch implant protocols, particularly in patients with compromised bone volume. One of its primary advantages is the ability to avoid extensive bone grafting procedures by utilizing

available anterior bone and angulating posterior implants to bypass anatomical constraints such as the maxillary sinus and inferior alveolar nerve.

Immediate loading is another key feature of this approach, allowing patients to receive a fixed provisional prosthesis on the day of surgery. This immediate restoration of function and esthetics significantly enhances patient satisfaction and quality of life. From a biomechanical standpoint, the strategic angulation of posterior implants increases the anterior–posterior spread, reduces cantilever length, and promotes favorable load distribution, thereby minimizing mechanical complications.

Cost-effectiveness is an additional advantage of the All-on-4 protocol. By reducing the number of implants required and simplifying surgical and prosthetic procedures, overall treatment costs are lowered without compromising clinical outcomes. Long-term studies have consistently reported survival rates exceeding 95% for both maxillary and mandibular arches, further supporting the reliability of this concept.

Despite its advantages, the All-on-4 concept is not without limitations. It may not be suitable for patients with severe anterior bone defects requiring grafting, and meticulous prosthetic planning is essential to prevent biological and mechanical complications. Nevertheless, when appropriately indicated, the All-on-4 approach offers a predictable and efficient solution for full-arch rehabilitation.

Indications

1. Edentulous patients who need fixed implant-supported prosthesis – maxillary, mandibular or both.
2. Patients with partial maxillary/mandibular edentulism with only few intact natural teeth in the anterior region.
3. Patients with worn out dentition which needs extraction and replacement of all teeth.
4. Patients with periodontally compromised mobile teeth which need extraction and replacement.
5. Edentulous or partially edentulous patients with very limited subantral bone height in the posterior maxilla.
6. Edentulous or partially edentulous patients with very limited bone height above the mandibular canals in the posterior mandible.
7. Edentulous patients with maxillary sinus pathologies contraindicating the sinus grafting procedure.
8. Patients with adequate volume of healthy bone in the maxillary and mandibular anterior region to place implants.
9. Implant overdenture cases with severe ridge resorption – tilting posterior implants give more support to the denture and prevent soft tissue abrasion and further bone loss in the posterior region.

Contraindications

1. Patients with inadequate bone volume in the max illary and mandibular anterior region to place implants.
2. Anterior wall of the sinus is located far anterior to the usual position, contraindicating tilting of the posterior implants to reach the second premolar or first molar position.

DIAGNOSIS AND TREATMENT PLANNING IN THE ALL-ON-4 CONCEPT

Accurate diagnosis and meticulous treatment planning are fundamental to the long-term success of the All-on-4 treatment concept. Errors at the diagnostic stage may compromise esthetics, biomechanics, implant survival, and patient satisfaction.

1. Patient Evaluation and Case Selection

The diagnostic process begins with a thorough medical and dental history to identify systemic conditions that may influence healing and implant survival. Conditions such as uncontrolled diabetes mellitus, osteoporosis, smoking, immunosuppression, and parafunctional habits must be carefully evaluated, as they may affect osseointegration and long-term outcomes. Psychological assessment and evaluation of patient expectations are equally important, as All-on-4 therapy involves irreversible procedures such as tooth extraction and alveolar bone reduction.

2. Clinical Examination

A comprehensive intraoral and extraoral examination is essential. Extraoral assessment includes evaluation of facial symmetry, lip support, smile line, and phonetics. High smile lines demand careful planning to prevent visibility of the prosthesis–tissue junction, whereas low smile lines are more forgiving esthetically.

Intraorally, the clinician must assess:

- Soft tissue quality and quantity
- Ridge morphology and degree of resorption
- Interarch space
- Occlusal vertical dimension
- Jaw relationships and centric relation
- Tongue position and functional envelope

The amount of available prosthetic space plays a critical role in determining the type of definitive prosthesis, particularly when deciding between hybrid prostheses and monolithic zirconia restorations.

3. Diagnostic Imaging and Radiographic Assessment

Radiographic evaluation is indispensable for All-on-4 planning. Cone beam computed tomography (CBCT) is the imaging modality of choice, as it provides three-dimensional assessment of bone volume, bone density, and the relationship of proposed implant sites to vital anatomical structures such as the maxillary sinus, nasal floor, inferior alveolar nerve, and mental foramen.

In the maxilla, assessment of sinus pneumatization and anterior bone availability guides the decision to tilt posterior implants rather than perform sinus grafting. In the mandible, evaluation of the interforaminal region is crucial, as All-on-4 implants are typically confined to this zone to avoid nerve injury.

4. Prosthetically Driven Planning

The All-on-4 concept is inherently prosthetically driven, meaning implant placement is dictated by the requirements of the definitive prosthesis rather than available bone alone. Diagnostic wax-ups, digital smile design, and denture duplication techniques are commonly employed to visualize the final prosthetic outcome before surgery.

One of the most critical diagnostic distinctions is between a **tooth-only defect** and a **composite defect**.

- **Tooth-only defects** involve minimal hard and soft tissue loss and may be restored with prostheses replacing teeth alone.
- **Composite defects** involve combined loss of teeth, alveolar bone, and soft tissue and typically require prostheses that replace both teeth and gingiva.

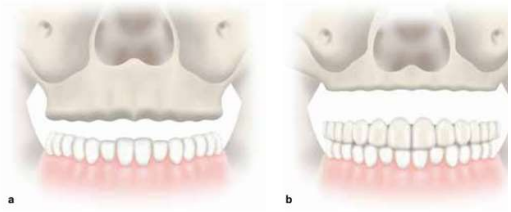

Fig. (a) Tooth-only defect. (b) Composite defect.

This distinction influences prosthesis design, restorative material selection, and the need for alveolar bone reduction.

5. Transition Line and Esthetic Planning

The transition line—the junction between the prosthesis and the soft tissue—must be strategically positioned to ensure optimal esthetics. If the transition line is visible during smiling, esthetic compromise may occur. In such cases, planned alveoloplasty is often required to reposition the transition line apically, allowing it to be concealed beneath the upper lip.

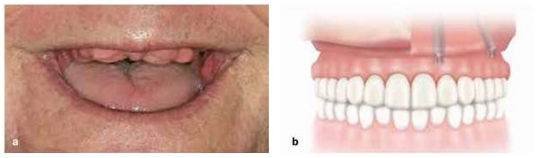

Fig. (a) Visible edentulous maxillary crestal soft tis sues in maximum smile. (b) A visible transition line results in an unesthetic outcome.

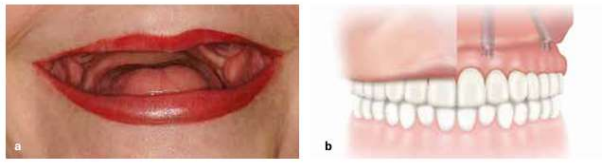

Fig. (a) Hidden edentulous maxillary crestal soft tissues. (b) A hidden transition line results in an esthetic outcome.

Failure to diagnose transition line visibility at the planning stage may result in an unesthetic outcome that cannot be corrected prosthetically without additional surgery.

6. Evaluation of Restorative Space

Adequate restorative space is essential for prosthesis strength, hygiene access, and biomechanical stability. Insufficient space may result in thin prosthetic components, increasing the risk of fracture and mechanical failure. When restorative space is inadequate, controlled bone reduction is often preferred over prosthetic compromise.

The evaluation of restorative space directly influences:

- Framework material selection
- Acrylic thickness
- Tooth size and position
- Occlusal scheme

General guidelines for space requirements	
Space available/obtained (measured from implant head to opposing dentition)	Type of restoration
≥ 10 mm	Monolithic full-contour zirconia fixed restorations
≥ 12 mm	Porcelain fused to metal/zirconia fixed restorations
≥ 15 mm	Acrylic resin bonded to titanium fixed restorations
≥ 16 mm	Implant-supported overdentures *(2–3 mm for heat-cured acrylic resin+ space for acrylic tooth)*

7. Anteroposterior (A-P) Spread and Implant Distribution

A-P spread is a key biomechanical consideration during treatment planning. It refers to the distance between the most anterior and posterior implants and determines the permissible cantilever length. Wider A-P spread reduces cantilever forces, improves load distribution, and decreases the risk of mechanical complications.

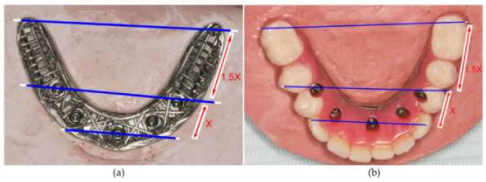

***Fig*. A-P spread and length of cantilever for (a) framework and (b) final restoration.**

Tilted posterior implants are strategically used in the All-on-4 concept to maximize A-P spread while avoiding anatomical limitations. Treatment planning must ensure that implant positioning allows a favorable biomechanical framework design.

8. Occlusal Planning

Occlusal planning begins at the diagnostic stage and must consider opposing dentition, parafunctional habits, and cantilever length. Because implants lack periodontal ligament proprioception, occlusal overload can be detrimental. Therefore, occlusal schemes must be designed to minimize lateral forces and protect the bone–implant interface.

The principles of implant-protected occlusion should be incorporated early in treatment planning to reduce biomechanical stress and enhance prosthesis longevity.

9. Digital Planning and Guided Surgery

Advancements in digital dentistry have significantly enhanced diagnostic accuracy and treatment predictability. Virtual implant planning software allows three-dimensional visualization of implant positioning relative to prosthetic design. Surgical guides derived from digital planning help translate the virtual plan accurately to the clinical setting, particularly in immediate loading protocols.

Digital workflows also facilitate communication between the surgical and prosthetic teams, reducing cumulative errors and improving outcomes.

10. Interdisciplinary Coordination

Successful All-on-4 rehabilitation requires close collaboration between the surgeon, prosthodontist, and dental laboratory. Diagnostic decisions regarding implant angulation, prosthetic materials, occlusal scheme, and maintenance protocols must be made collectively to ensure a predictable and harmonious outcome.

SURGICAL PROTOCOL

The surgical protocol of the All-on-4 implant concept is based on the strategic placement of four implants to rehabilitate completely edentulous arches with a fixed full-arch prosthesis.

The surgical procedure generally begins with crestal incision and full-thickness mucoperiosteal flap reflection to expose the alveolar ridge. The two anterior implants are placed axially in the canine or lateral incisor region, where bone density is usually favorable. The posterior implants are intentionally tilted distally at an angle of approximately 30°–45° to avoid critical anatomical structures such as the maxillary sinus in the maxilla and the inferior alveolar nerve in the mandible. Tilting of posterior implants increases the anteroposterior spread, enhances prosthetic support, and reduces distal cantilever length, thereby improving biomechanical load distribution.

Sequential osteotomy preparation is performed according to the manufacturer's drilling protocol under copious irrigation to prevent thermal bone injury. Achievement of high primary stability, typically greater than 35 Ncm insertion torque, is considered crucial for immediate loading protocols. Following implant placement, multiunit abutments are connected to compensate for implant angulation and establish a common prosthetic path of insertion. Primary closure of the surgical site is achieved using interrupted or continuous sutures. Following implant placement, impression procedures or digital scanning may be performed for fabrication of an immediate provisional prosthesis.

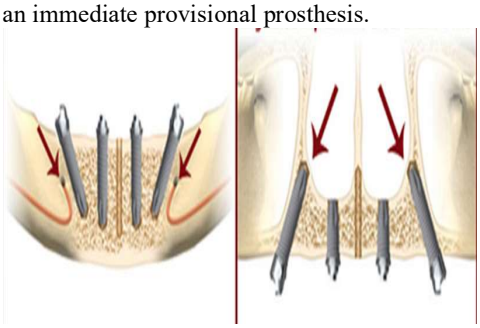

Fig. The vital structures are avoided by Implant positioning

PROVISIONALIZATION IN THE ALL-ON-4 TREATMENT

Provisionalization is a key prosthetic phase in the All-on-4 protocol, enabling immediate restoration of function and esthetics while ensuring biomechanical protection of implants during early healing. Clinically, following implant placement and connection of multi-

unit abutments, temporary cylinders are attached to the abutments and an existing complete denture or prefabricated prosthesis is modified and intraorally picked up using autopolymerizing acrylic resin. This chairside conversion technique allows rapid fabrication of a passive-fitting provisional bridge. The prosthesis is subsequently contoured, polished, and screw-retained to establish immediate fixed support.

Beyond stabilization, the provisional prosthesis serves as a functional and esthetic diagnostic aid, allowing assessment of occlusion, vertical dimension, phonetics, and facial support. Occlusal contacts are kept light with reduced cantilever loading to limit excessive forces during healing. Additionally, the prosthesis contours guide peri-implant soft tissue adaptation, facilitating development of an optimal emergence profile for the definitive restoration.

The provisional phase typically lasts three to six months, during which necessary prosthetic refinements can be made prior to final rehabilitation. Consequently, provisionalization in the All-on-4 concept is not merely a temporary measure but a biologically and mechanically strategic step that significantly enhances long-term clinical outcomes.

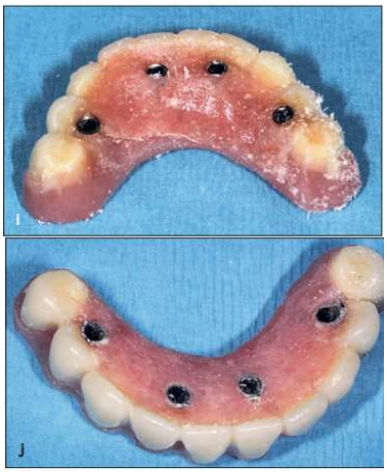

Fig. – Provisional prosthesis

IMPRESSION PROTOCOLS FOR ALL-ON-4 PROSTHESIS

Accurate impression making is fundamental to the long-term success of implant-supported full-arch prostheses. Unlike natural teeth, implants lack a periodontal ligament and cannot compensate for inaccuracies through physiological movement. Consequently, any discrepancy in impression transfer may result in non-passive prosthetic fit, leading to mechanical complications or peri-implant bone loss.

For All-on-4 restorations, impressions may be made at either the implant level or abutment level. Abutment-level impressions using multiunit abutments are often preferred, as they reposition the restorative margin away from the crestal bone, simplify prosthetic procedures, and reduce cumulative errors. Open-tray impression techniques—particularly when impression copings are splinted—have demonstrated superior accuracy in transferring implant positions. Splinting impression copings with resin or metal frameworks minimizes micromovement during impression removal and analog repositioning, contributing to improved passivity of the final prosthesis.

Polyvinyl siloxane and polyether materials are the materials of choice due to their dimensional accuracy and stability.

THE DEFINITIVE PROSTHESIS IN ALL-ON-4 REHABILITATION

The definitive prosthesis represents the final and most critical phase of rehabilitation in the All-on-4 treatment concept. It is designed to provide long-term function, esthetics, comfort, and biomechanical stability while protecting the underlying implants and peri-implant tissues. Unlike provisional restorations, which primarily serve diagnostic and transitional purposes, the definitive prosthesis must withstand functional loads over many years with minimal biological and mechanical complications.

Successful definitive prosthetic rehabilitation in All-on-4 therapy is dependent on accurate diagnosis, proper implant distribution, adequate restorative space, material selection, occlusal design, and maintenance considerations.

Timing of the Definitive Prosthesis

The definitive prosthesis is typically fabricated after a healing period of **3–6 months** following implant placement and immediate loading. This interval allows for complete osseointegration, stabilization of peri-implant soft tissues, and functional evaluation of the provisional prosthesis.

Information gathered during the provisional phase—such as patient comfort, speech, occlusal vertical dimension, esthetic preferences, and soft tissue response—plays a crucial role in refining the design of the definitive prosthesis.

TYPES OF DEFINITIVE PROSTHESES IN ALL-ON-4 REHABILITATION

1. MARUIS BRIDGE (FIXED DETACHABLE PROSTHESIS)

The Maruis bridge is a screw-retained, implant-supported full-arch prosthesis

composed of a rigid metal or CAD/CAM-milled framework that provides structural support, over which acrylic resin denture teeth and a prosthetic gingival component are incorporated. The framework is directly connected to multi-unit abutments, creating a unified splint across all implants. The acrylic resin base replaces lost alveolar tissues, while the denture teeth restore occlusal function and esthetics, making this prosthesis particularly suitable for patients with extensive hard and soft tissue deficiencies requiring both tooth and gingival replacement.

Fig. Marius bridge

Indications

- Moderate to severe ridge resorption
- Composite defects requiring replacement of teeth and soft tissue
- Patients demanding a fixed solution but requiring prosthetic gingival support

Advantages

- Fixed in the mouth but retrievable by the clinician
- Restores lost teeth and gingival architecture
- Provides excellent lip and facial support
- Improved patient satisfaction compared to overdentures

Limitations

- Food impaction beneath the prosthesis
- Speech adaptation challenges in some patients
- Requires strict hygiene maintenance

The Maruis bridge forms the foundation of many modern hybrid and CAD/CAM-based designs used in All-on-4 therapy.

2. HYBRID PROSTHESIS (METAL–ACRYLIC FIXED PROSTHESIS)

The **hybrid prosthesis** is the most commonly employed definitive prosthesis in the All-on-4 concept. The hybrid prosthesis consists of a cast or milled metal framework that forms the load-bearing substructure of the restoration, veneered with acrylic resin that supports prefabricated or customized denture teeth. The metal framework is screw-retained to implant abutments, providing rigidity and stability, while the acrylic resin acts as a shock-absorbing medium between occlusal forces and the implants. This combination allows replacement of both teeth and missing soft tissues while maintaining retrievability, making it the most commonly utilized definitive prosthesis in All-on-4 rehabilitation.

Fig . Hybrid prosthesis

Indications

- Increased inter-arch space (>15 mm)
- Severe ridge resorption
- Patients requiring shock-absorbing materials

Advantages

- Acrylic provides stress-modulating properties
- Easy to repair chairside
- Cost-effective
- Well documented long-term success

Disadvantages

- Acrylic wear and tooth debonding
- Veneer fracture
- Long-term color instability

Despite these limitations, hybrid prostheses remain a reliable option, particularly during the transition from provisional to definitive rehabilitation.

3. METAL–CERAMIC (PORCELAIN-FUSED-TO-METAL) PROSTHESIS

The metal–ceramic prosthesis comprises a rigid metal substructure fabricated through conventional casting or CAD/CAM milling, which is veneered with layers of dental porcelain to simulate natural tooth morphology and translucency. The framework is screw-retained onto implants, while the ceramic veneer forms the functional and esthetic occlusal surfaces. Unlike acrylic-based restorations, this prosthesis primarily replaces dental structures with minimal gingival prosthetic components, making it appropriate for patients with limited ridge resorption and sufficient restorative space.

Fig. Porcelain-fused-to-metal prosthesis

Indications

- Tooth-only defects
- Adequate restorative space
- High esthetic demands

Advantages

- Superior esthetics compared to acrylic
- Excellent wear resistance

Limitations

- Increased rigidity and reduced shock absorption
- Risk of porcelain chipping
- Requires highly precise framework passivity

Due to the risk of veneer fracture under cantilever loads, metal–ceramic prostheses are less commonly used in All-on-4 than in conventional multi-implant rehabilitations.

4. MILLED TITANIUM FRAMEWORK PROSTHESIS

The milled titanium framework prosthesis utilizes a precisely fabricated CAD/CAM titanium substructure that serves as the primary load-bearing component of the restoration. This framework is designed to achieve optimal passive fit over implant abutments and is subsequently veneered with acrylic resin or composite material supporting denture teeth and, when required, gingival prosthetic contours. Titanium's high strength-to-weight ratio and corrosion resistance enhance prosthetic longevity while minimizing mechanical complications associated with framework distortion.

Fig. Milled titanium framework prosthesis

Advantages

- Excellent passive fit
- Reduced prosthetic space requirement
- High strength-to-weight ratio
- Decreased incidence of screw loosening

5. MONOLITHIC ZIRCONIA PROSTHESIS

The monolithic zirconia prosthesis is fabricated as a single, full-contour restoration milled entirely from high-strength zirconia ceramic, eliminating the need for veneering porcelain in most designs. It may incorporate either minimal gingival shading or layered ceramic in esthetic zones but primarily functions as a solid ceramic structure providing both framework strength and occlusal morphology. This prosthesis is screw-retained to implants and offers exceptional fracture resistance, dimensional stability, and long-term esthetic durability, making it increasingly popular for definitive All-on-4 rehabilitations.

Monolithic Zirconia Prosthesis

Indications

- High occlusal loads
- Bruxism (with controlled occlusion)
- Patients demanding superior esthetics

Advantages

- High fracture resistance
- Excellent color stability
- Reduced plaque accumulation

Limitations

- Limited shock absorption
- Difficult repair if fracture occurs
- Requires precise occlusal planning

Zirconia prostheses demand strict adherence to implant-protected occlusion principles to prevent biomechanical overload.

6. PEEK-BASED PROSTHESES

The PEEK-based prosthesis employs a high-performance polymer framework fabricated through CAD/CAM technology as an alternative to traditional metal substructures. This framework is veneered with composite resin and denture teeth to restore occlusion and esthetics, while the elastic modulus of PEEK allows for more favorable stress distribution to the implants and surrounding bone. The prosthesis is screw-retained and designed to combine structural strength with biomechanical shock absorption, representing a contemporary approach aimed at reducing prosthetic and implant overload.

PEEK-Based Prosthesis

Advantages

- Elastic modulus closer to bone
- Reduced stress transmission
- Lightweight and biocompatible

Limitations

- Limited long-term clinical evidence
- Technique-sensitive bonding to veneering materials

PEEK prostheses remain an emerging option requiring further longitudinal evaluation.

Framework Passivity and Fit

Passive fit of the definitive prosthesis is a non-negotiable requirement in All-on-4 therapy. Even minimal misfit may result in:

- Screw loosening or fracture
- Peri-implant bone loss
- Implant fracture
- Prosthesis failure

CAD/CAM-fabricated frameworks generally exhibit superior passivity compared to cast frameworks. Verification jigs, intraoral try-ins, and radiographic evaluation are essential steps to confirm accurate framework seating.

Occlusal Considerations in the Definitive Prosthesis

Occlusal design must adhere to the principles of **implant-protected occlusion**, aiming to minimize lateral and cantilever forces.

Key occlusal features include:

- Even bilateral contacts in centric occlusion
- Narrow occlusal tables
- Reduced cusp inclination
- Minimal cantilever length
- Shallow anterior guidance

Occlusal adjustments should be finalized only after complete seating and torqueing of the definitive prosthesis.

Prosthesis Retention and Retrievability

Screw-retained prostheses are preferred in the All-on-4 concept due to:

- Ease of retrievability
- Elimination of cement-associated peri-implantitis
- Improved long-term maintenance

Screw access channels are typically sealed with polytetrafluoroethylene tape and composite resin to allow future access without compromising prosthesis integrity.

CONCLUSION

The All-on-4 implant concept has emerged as a transformative approach for full-arch rehabilitation in edentulous and terminal dentition patients. By optimizing implant distribution and leveraging biomechanical principles, this technique provides a graftless, cost-effective, and immediately functional alternative to conventional implant protocols.

Prosthodontic success in All-on-4 therapy depends heavily on meticulous planning, accurate impression protocols, appropriate prosthetic material selection, and controlled occlusal schemes. Advances in CAD/CAM technology, particularly the use of milled titanium and zirconia prostheses, have further enhanced predictability and long-term outcomes.

While the All-on-4 concept is not without limitations, careful patient selection, rigorous maintenance, and ongoing research continue to refine its application. When executed with sound prosthetic principles, the All-on-4 approach offers durable function, high patient satisfaction, and a reliable solution for comprehensive oral rehabilitation.

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