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"Pre-Prosthetic Surgery"- A Narrative Review

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ABSTRACT: Pre-prosthetic surgeries include a variety of surgical procedures designed to improve the fit, functionality, and appearance of prosthetic appliances by optimizing the oral and maxillofacial structures. The success of both removable and fixed prostheses is hampered by anatomical restrictions such ridge resorption, bone irregularities, shallow vestibules, and soft tissue abnormalities, which are addressed by these procedures. Alveoloplasty, vestibuloplasty, sinus lift, tori excision, and ridge augmentation are common surgical procedures. Patient outcomes have been greatly enhanced by recent developments in minimally invasive procedures including piezoelectric surgery and laser-assisted interventions, as well as surgical techniques and biomaterials like guided bone regeneration (GBR), platelet-rich fibrin (PRF), and others. Cone beam computed tomography (CBCT), 3D printing, and CAD/CAM systems are examples of digital technologies that have further improved surgical accuracy and predictability. Promising substitutes for treating severe cases of atrophy or reduced bone structure include stem cell therapy, biologic enhancers, and zygomatic implants. For prosthetic rehabilitation to be effective, pre-prosthetic operations are essential for maintaining stability, comfort, and aesthetics. With the help of evidence-based references, this paper examines the pre-prosthetic surgery indications, classifications, procedures, materials, and current developments. In order to further improve results and patient happiness, future initiatives will focus on integrating augmented reality (AR) with artificial intelligence (AI).

I. INTRODUCTION

Preparing a patient's oral tissues and supporting structures for the implantation of a prosthesis, such as dentures or other dental appliances, is known as pre-prosthetic surgery. To ensure that the prosthesis fits, functions, and is comfortable, the alveolar ridge—the bony structure in the jaw that supports teeth—and the surrounding tissues are optimized in size, shape, and condition.

Common Objectives of Pre-Prosthetic Surgery:
*Enhance the Ridge Shape: To support the prosthesis, a smooth, well-contoured ridge should be created.
*Remove Soft Tissue Irregularities: Removing extraneous or floppy tissue that can compromise the stability of the prosthesis.
*Correct Bony Irregularities: Resolving excessive bone, undercuts, or sharp ridges that could make it uncomfortable or make it difficult to retain a prosthetic.
*Improve Prosthetic Retention: Making structural changes to detachable prosthesis to increase stability and suction.
*Facilitate Function and Aesthetics: Making sure the prosthesis can help the patient regain their natural ability to speak, chew, and smile. [1]

Common Pre-Prosthetic Procedures:
*Alveoloplasty: Reshaping or smoothing the jawbone.
*Tori Removal: Removing bony growths (e.g., palatal or mandibular tori) that may interfere with prosthetic placement.
*Frenectomy: Removing or repositioning frenal attachments that could affect prosthetic fit.
*Exostosis Removal: Eliminating excess bony projections.
*Vestibuloplasty: Deepening the vestibular space (the area between the cheek and the jawbone) to enhance prosthesis retention.
*Soft Tissue Grafting: Adding or adjusting soft tissue to improve the prosthetic foundation.
Implant Placement (optional): Placing implants to support an overdenture or fixed prosthesis.[2]

Indications and Contraindications for Pre-Prosthetic Surgery
When certain clinical or anatomical problems make it difficult for a prosthesis to be placed or function properly, pre-prosthetic surgery is carried out. An extensive list of indications and contraindications can be found below:[2]

Indications
*Asymmetrical Alveolar Ridge
existence of irregular bone surfaces, undercuts, or sharp ridges.

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To improve prosthesis fit and lessen damage, smoothing or reshaping is required. [3]
Modern Implant Dentistry, Fourth Edition, Misch CE, 2020.
*Exostoses or Growths of Bone
removal of bony protuberances that obstruct the placement of a prosthesis, such as palatal or mandibular tori. [4]
*Insufficient Depth of Vestibular
When denture stability is compromised by shallow vestibules, vestibuloplasty is necessary. [1]
*Flabby Ridge or Hypermobile
When the ridge is too movable for proper] prosthesis retention, soft tissue augmentation or excision is required. [5]
*Excess Fibrous Tissue
repair of enlarged tissue brought on by trauma or poorly fitting dentures (epulis fissuratum). [6]
*Preparation for Implant Placement [7]
When bone volume is inadequate, augmentation techniques (such as bone grafting) are used to support implants.
*Interference of Frenulum [8]
When frenum attachments compromise denture stability or result in ulceration, a frenectomy is performed.

Contraindications: [9-11]
*Systemic Health Concerns
Uncontrolled medical conditions (e.g., diabetes, cardiovascular disease) that pose surgical risks.
*Poor Oral Hygiene
Patients with poor oral hygiene or non-compliance with postoperative care are at a higher risk of infection.
*Psychological Factors
Anxiety, lack of motivation, or unrealistic expectations may affect outcomes and compliance.
Brennan DS et al., Community Dentistry and Oral Epidemiology, 2014.
*Thin or Atrophic Ridge
Severe bone loss may contraindicate surgery unless augmentation is possible.
*Presence of Acute Infections
Active infections, such as abscesses, should be treated before surgical intervention.
*High Surgical Risk
Patients with bleeding disorders or on anticoagulant therapy without proper medical clearance.
*Age and Healing Potential
Very young or elderly patients with limited healing capacity may not be suitable candidates for extensive surgery.

Key Considerations
Treatment Planning: Comprehensive assessment of the patient's medical history, oral anatomy, and prosthetic requirements is critical.
Informed Consent: Patients should be informed about potential risks, benefits, and alternative treatments.
Postoperative Care: Successful outcomes depend on proper healing and follow-up.
For further reading, peer-reviewed journals like the Journal of Prosthetic Dentistry and standard textbooks are excellent resources for detailed clinical guidelines.

Classifications of pre-prosthetic surgery
The goals of pre-prosthetic surgery, the tissues used, or the procedure's intricacy can all be used to categorize it. These categories aid in treatment planning and customization for the best possible prosthetic results. The widely recognized pre-prosthetic surgery classifications are as follows:

I. Classification Based on Tissues Involved [12,13]
Soft Tissue Procedures
Designed to improve the quality or quantity of soft tissue for prosthetic stability.
Examples:
Frenectomy: Removal or repositioning of frenal attachments.
Removal of hyperplastic tissue (epulis fissuratum).
Vestibuloplasty: Deepening the vestibule for better denture support.
Hard Tissue Procedures
Aim to reshape or augment the bony foundation for prosthetics.
Examples:
Alveoloplasty: Contouring the alveolar ridge.

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Removal of exostoses or tori.
Bone grafting to augment atrophic ridges.

II. Classification Based on Objectives [4,11,14]
Preparative Surgery
Procedures performed to remove or correct anatomical anomalies that hinder prosthetic placement.
Examples:
Excision of soft tissue lesions.
Correction of ridge undercuts.
Reconstructive Surgery
Aimed at rebuilding lost tissues to support prostheses.
Examples:
Ridge augmentation using autografts or allografts.
Sinus lift procedures for implant placement.
Functional Surgery
Focused on enhancing function by correcting issues like shallow vestibules or mobile ridges.
Examples:
Muscle repositioning for better prosthetic retention.

III. Classification Based on Complexity [15,16]
Minor Pre-Prosthetic Surgery
Simple procedures typically performed under local anesthesia with minimal surgical intervention.
Examples:
Frenectomy, Simple alveoloplasty, Removal of small tori.
Major Pre-Prosthetic Surgery
Complex surgeries requiring advanced techniques, often performed under general anesthesia.
Examples:
Ridge augmentation using bone grafts. Segmental osteotomy for ridge reconstruction. Maxillary sinus elevation.

IV. Classification Based on Anatomical Location [6,17]
Maxillary Procedures
Surgeries focused on correcting defects in the upper jaw.
Examples: Maxillary sinus lift. Removal of palatal tori.
Mandibular Procedures
Surgeries aimed at correcting defects in the lower jaw.
Examples:
Mandibular ridge augmentation. Removal of mandibular tori.

V. Classification Based on Timing [11,18]
Immediate Pre-Prosthetic Surgery
Performed during or immediately after tooth extraction to prepare the ridge for prosthetic placement.
Examples:
Immediate alveoloplasty post-extraction.
Delayed Pre-Prosthetic Surgery
Conducted after initial healing or when specific anatomical corrections are required before prosthetic fabrication.
Examples:
Ridge augmentation months after tooth loss.

VI. Advanced Classifications (for Implant-Based Prosthetics) [19,20]
Site Preparation for Implants
Procedures to prepare the alveolar ridge for implant-supported prosthetics.
Examples: Guided Bone Regeneration (GBR). Ridge splitting or expansion.
Soft Tissue Management for Implants.
Focused on achieving adequate keratinized tissue around implants.
Examples: Connective tissue grafting. Free gingival grafts.

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Step by step procedures for pre-prosthetic surgery
The precise type of surgery being performed determines the detailed pre-prosthetic surgery treatments. A broad overview of the essential phases is provided below, followed by particular instances of typical pre-prosthetic surgical techniques.

Generalized Steps for Pre-Prosthetic Surgery [6,11,13,14,21-22]
*Preoperative Assessment and Planning
Conduct a thorough medical history review, including systemic conditions and medications.
Perform clinical and radiographic evaluation (e.g., CBCT, OPG) to assess bone and soft tissue anatomy.
Discuss treatment options, risks, benefits, and obtain informed consent.
*Anesthesia
Administer local anesthesia or, in more complex cases, general anesthesia.
*Surgical Site Preparation
Aseptic protocol: Clean and disinfect the surgical site.
Place appropriate draping to maintain sterility.
*Incision and Tissue Management
Make precise incisions using a scalpel or electrosurgical unit.
Reflect soft tissue flaps as needed to expose underlying bone or address soft tissue irregularities.

Perform the Specific Procedure
Hard or soft tissue modifications as per the planned surgery. Examples include:
*Bone smoothing (alveoloplasty).
*Frenectomy or frenotomy.
*Removal of tori or exostoses.
*Vestibuloplasty or ridge augmentation.
*Hemostasis
Control bleeding using hemostatic agents, sutures, or electrocautery.
*Closure
*Suture soft tissues carefully to promote optimal healing and minimize scar formation.
Use resorbable or non-resorbable sutures as appropriate.
*Postoperative Care and Instructions
Prescribe medications (e.g., antibiotics, analgesics) and provide detailed postoperative instructions for hygiene and diet.
*Schedule follow-up appointments for suture removal and healing assessment.

Step-by-Step Examples for Specific Pre-Prosthetic Procedures
1. Alveoloplasty [11]
Objective: Smooth and reshape the alveolar ridge.
Steps:
Administer local anesthesia. Make a mucoperiosteal incision along the ridge crest.
Reflect soft tissue flaps to expose the bone. Use bone files, rongeurs, or burs to contour the ridge.
Smooth sharp edges and irrigate the site. Reposition soft tissues and suture.

2. Frenectomy [23]
Objective: Remove or reposition a high or interfering frenum.
Steps: Administer local anesthesia. Use a scalpel, laser, or electrosurgery unit to excise frenal tissue. Undermine surrounding tissues to release tension. Suture the wound edges to prevent reattachment.

3. Vestibuloplasty [4]
Objective: Deepen the vestibule for improved denture retention.
Steps: Administer local anesthesia. Make a horizontal incision in the mucosal tissue at the vestibular depth. Displace and reposition the tissue flap to create a deeper vestibule. Secure the flap using sutures or graft material (e.g., skin or mucosa).

4. Removal of Tori (Tori Reduction) [13]
Objective: Excise bony outgrowths to allow for proper prosthesis fit.
Steps:
Administer local or general anesthesia. Make an incision over the tori and reflect the mucosal flap.
Use a surgical bur or chisel to remove the bony growth. Smooth the area and irrigate thoroughly.

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Reposition the soft tissue and suture.

5. Ridge Augmentation [18]
Objective: Rebuild atrophic ridges for prosthetic or implant support.
Steps:
Administer anesthesia. Make an incision and reflect soft tissue flaps. Place autograft, allograft, or bone substitute material. Secure the graft with fixation screws or membranes. Suture soft tissues for primary closure.
Postoperative Considerations
Healing Period
Allow sufficient healing before prosthesis fabrication (4-6 weeks for minor surgery, up to 6 months for grafting).
Monitoring
Regular follow-ups to assess tissue healing and ensure readiness for prosthesis.
Complication Management [24]
Address issues like infection, delayed healing, or suture dehiscence promptly.

The materials used during pre-prosthetic surgeries
The tissues involved, the type of technique, and the particular objectives of the surgery all influence the materials utilized during pre-prosthetic surgeries. These materials fall into the following general categories: adjunctive agents, graft materials, suture materials, and surgical equipment. Here is a thorough summary:
***1. Surgical Instruments** [11,13, 18, 25,26]
Used for incision, tissue manipulation, bone contouring, and hemostasis.
Scalpel Blades: Typically #15 or #12 for soft tissue incisions.
Electrosurgical Units or Lasers: For precise cutting and coagulation (e.g., CO_2 or diode lasers).
Bone Files and Rongeurs: For bone contouring and smoothing during alveoloplasty.
Burs and Surgical Drills: Used with handpieces to remove bone or tori.

***2. Graft Materials**
Used in ridge augmentation or sinus lift procedures to enhance bone volume and quality.
Bone Grafts
*Autografts: Bone harvested from the patient's own body (e.g., mandibular ramus, iliac crest).
Advantage: No risk of rejection, excellent osteogenic potential.
*Allografts: Bone from human donors, processed and sterilized (e.g., freeze-dried bone allografts - FDBA).
*Common brands: Puros®, MinerOss®.
*Xenografts: Bone derived from other species (e.g., bovine bone).
Examples: Bio-Oss®.
*Synthetic Grafts: Calcium phosphate, hydroxyapatite, or bioactive glass.
Examples: PerioGlas®, OsteoGen®.
*Soft Tissue Grafts
Connective Tissue Grafts: Harvested from the patient (e.g., palate) for vestibuloplasty or keratinized tissue augmentation.
*Allogenic Materials: Acellular dermal matrix (e.g., AlloDerm®) for soft tissue reconstruction.

***3. Suture Materials**
Used to secure tissues after surgery, chosen based on tissue type and healing requirements.
*Absorbable Sutures:
Materials: Polyglycolic acid (Vicryl®), chromic gut.
Used for soft tissues to eliminate the need for suture removal.
Non-Absorbable Sutures:
*Materials: Silk, nylon, polypropylene.
Used in areas requiring longer-term support.

***4. Hemostatic Agents**
Aid in controlling bleeding during and after surgery.
*Collagen Sponges: Promote clot formation and support hemostasis (e.g., CollaCote®).
*Oxidized Regenerated Cellulose: Absorbable hemostatic agents (e.g., Surgicel®).
*Gauze with Topical Agents: Impregnated with thrombin or epinephrine.

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***5. Membranes for Guided Tissue/Bone Regeneration (GTR/GBR)**
Used to support tissue regeneration by preventing soft tissue ingrowth into graft sites.
*Resorbable Membranes: Made of collagen (e.g., Bio-Gide®).
*Non-Resorbable Membranes: Made of PTFE (e.g., Cytoplast®).

***6. Adjunctive Materials**
Bone Morphogenetic Proteins (BMPs): Enhance bone regeneration in graft sites (e.g., Infuse® Bone Graft).
Platelet-Rich Plasma (PRP) or Platelet-Rich Fibrin (PRF): Used to promote healing and regeneration.

***7. Postoperative Care Materials**
Antiseptic Solutions: Chlorhexidine gluconate mouthwash for infection control.
Analgesics and Antibiotics: To manage pain and prevent infection.
Common antibiotics: Amoxicillin, clindamycin.

Recent advancements in pre-prosthetic surgeries [3-5,11,23,25]
Significant progress has been made in pre-prosthetic surgery in recent years, improving patient outcomes and increasing available treatment options. Among the noteworthy developments are:
#1. Tissue Engineering and Regenerative Techniques
Growth Factors and Biomaterials: The integration of growth factors, such as Bone Morphogenetic Proteins (BMPs), with biomaterials has improved bone regeneration in alveolar ridge augmentation. These combinations promote osteogenesis, leading to better support for prosthetic devices.
Stem Cell Therapy: Research into mesenchymal stem cells has shown potential in regenerating bone and soft tissues, offering promising results for pre-prosthetic applications.

#2. Minimally Invasive Surgical Techniques
Piezoelectric Surgery: Utilizing ultrasonic vibrations, piezoelectric devices allow for precise bone cutting with minimal damage to surrounding tissues, reducing postoperative discomfort and promoting faster healing.
Laser-Assisted Procedures: Lasers provide enhanced precision in soft tissue management, leading to reduced bleeding, less postoperative pain, and quicker recovery times.

#3. Advanced Imaging and Digital Planning
Cone Beam Computed Tomography (CBCT): CBCT offers high-resolution, three-dimensional imaging, enabling detailed assessment of the alveolar ridge and surrounding structures. This facilitates accurate surgical planning and execution.
Computer-Aided Design and Manufacturing (CAD/CAM): Digital technologies allow for the design and fabrication of custom surgical guides and prosthetic components, improving the precision and fit of prosthetic devices.

#4. Neuro-Controlled Prosthetics
Bionic Limbs: Innovations in neurotechnology have led to the development of bionic limbs controlled by the nervous system, restoring natural gait and function to amputees. Techniques such as the agonist-antagonist myoneural interface (AMI) reconnect muscles and nerves, enabling intuitive control of prosthetic limbs.
Financial Times

#5. Patient-Specific Implants and Prosthetics
Custom Implants: Advances in 3D printing and biomaterials have enabled the creation of patient-specific implants that conform precisely to individual anatomical requirements, enhancing prosthetic stability and comfort.

#6. Enhanced Soft Tissue Management
Acellular Dermal Matrices: The use of acellular dermal matrices in soft tissue augmentation has improved outcomes in vestibuloplasty and other soft tissue procedures, providing better support for prosthetic appliances. These advancements have collectively improved the efficacy and patient experience of pre-prosthetic surgeries, leading to more predictable outcomes and expanded treatment possibilities.

Latest improvements in pre-prosthetic surgery
Recent improvements in pre-prosthetic surgery have focused on enhancing precision, reducing patient morbidity, and improving outcomes for prosthetic rehabilitation. Key advancements include:

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1. Digital Technology Integration [11,27]
3D Printing: Custom-made surgical guides and prosthetics designed using 3D printers improve precision in bone reshaping and graft placement.
Example: Patient-specific implants for ridge augmentation or custom prosthetic devices.
Cone Beam CT (CBCT): Advanced imaging techniques provide high-resolution 3D views of the oral structures for surgical planning.
Impact: Improved visualization of bone defects and precise implant placement.
CAD/CAM Technology: Digital design and manufacturing of dentures and prosthetic components ensure better fit and stability.

2. Minimally Invasive Techniques [28]
Piezoelectric Surgery: Ultrasonic devices allow for precise bone cutting with minimal trauma to soft tissues.
Impact: Faster healing and reduced postoperative discomfort.
Laser Surgery: Use of lasers (e.g., CO_2, diode) in soft tissue procedures for frenectomy, vestibuloplasty, or tori removal.
Advantages: Reduced bleeding, infection risk, and quicker recovery.

3. Advanced Bone and Tissue Regeneration [29]
Biologic Enhancers: Growth factors like Platelet-Derived Growth Factor (PDGF) and Bone Morphogenetic Proteins (BMPs) promote faster and more robust tissue regeneration.
Applications: Ridge augmentation and sinus lifts.
Stem Cell Therapy: Emerging applications of mesenchymal stem cells for bone and soft tissue regeneration.
Platelet-Rich Fibrin (PRF): A bioactive material derived from the patient's blood to enhance healing and regeneration.

4. Enhanced Soft Tissue Management [30]
Acellular Dermal Matrices (ADMs): Products like AlloDerm® used for soft tissue grafting improve vestibular depth and keratinized tissue coverage.
Impact: Better prosthesis retention and aesthetics.
Collagen-Based Biomaterials: Used in soft tissue surgeries to promote healing and minimize scarring.

5. Patient-Specific Implants [31]
Custom Ridge Augmentation Solutions: Use of 3D-printed titanium mesh or patient-specific grafts for ridge defects.

6. Improved Prosthetic Integration [32]
Zygomatic Implants: For cases of severe maxillary atrophy, zygomatic implants bypass the need for grafting procedures.
Osseodensification Techniques: Innovative drills used during implant site preparation to enhance primary stability and promote bone compaction.

7. Augmented Reality (AR) and Artificial Intelligence (AI) [33]
Augmented Reality: Real-time visualization during surgery to enhance precision and efficiency.
Example: AR-assisted alveoloplasty.
AI for Surgical Planning: AI algorithms predict outcomes and guide surgical procedures for optimal prosthetic fit.

Pre-prosthetic surgeries for specific prosthetic situations
Pre-prosthetic surgeries are particularly beneficial for specific prosthetic situations where anatomical or structural deficiencies must be addressed to ensure successful prosthetic rehabilitation. Here's an overview of their utility in various prosthetic contexts:

1. Complete Dentures [34]
Common Challenges:
Shallow vestibule, sharp ridges, or extensive tori may hinder denture fit and stability.
Useful Surgeries:
Vestibuloplasty: Improves the depth of the vestibule to enhance denture retention and stability.
Tori Removal: Ensures proper seating of the denture base.

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2. Removable Partial Dentures (RPDs) [11]
Common Challenges:
Bony undercuts, irregular alveolar ridges, or soft tissue interference.
Useful Surgeries:
Alveoloplasty: Smoothens irregular ridges for better adaptation of the prosthesis.
Frenectomy: Reduces interference of high frena during prosthesis insertion and use.

3. Fixed Prostheses (Implant-Supported) [26,35]
Common Challenges:
Insufficient bone height/width, poor quality bone, or sinus proximity in the maxilla.
Useful Surgeries:
Alveolar Ridge Augmentation: Addresses severe resorption, enabling implant placement.
Guided Bone Regeneration (GBR):
Success in creating adequate bone for implant placement in 97% of cases.
Autogenous Block Grafting:
Urban IA, International Journal of Periodontics & Restorative Dentistry (2022): Achieved reliable outcomes for fixed implant prosthetics.
Sinus Lift: Ensures sufficient vertical bone height for maxillary implants.

4. Overdentures [6,11]
Common Challenges:
Insufficient ridge height or width for supporting overdentures.
Useful Surgeries:
Ridge Augmentation: Restores ridge dimensions for better prosthetic stability.
Implant Placement After Bone Grafting: Stabilizes overdentures in cases of severe atrophy.

5. Immediate Prosthetic Loading [11,22]
Common Challenges:
Suboptimal alveolar bone structure for immediate implant loading.
Useful Surgeries:
Osseodensification: Enhances bone compaction and primary implant stability for immediate loading.
Zygomatic Implants: An alternative for patients with severe maxillary atrophy.

6. Aesthetic Prosthetics [5,6]
Common Challenges:
Deficient soft tissue contours or compromised ridge shape affecting prosthetic aesthetics.
Useful Surgeries:
Soft Tissue Augmentation: Improves keratinized tissue for aesthetic implant-supported crowns.
Collagen Matrix Grafts: Enhance soft tissue contour around aesthetic restorations.

II. CONCLUSION

Pre-prosthetic procedures improve the fit, functionality, and lifetime of prosthetic devices by preparing the mouth and maxillofacial region for effective prosthetic rehabilitation. These surgeries open the door to solid and comfortable prostheses, whether they are fixed, implant-supported, or detachable, by resolving anatomical issues such tori interference, soft tissue abnormalities, ridge resorption, and inadequate bone height.

The discipline has undergone a revolution thanks to recent developments in digital technology, biomaterials, and surgical methods that provide more accurate, minimally invasive solutions with quicker recovery times. The use of 3D imaging, CAD/CAM systems, guided bone regeneration (GBR), platelet-rich fibrin (PRF), and other innovations have improved patient outcomes, decreased complications, and improved the functional and aesthetic elements of prosthetic care. Additionally, the development of zygomatic implants and the use of stem cell therapies offer encouraging remedies for patients suffering from severe bone atrophy, increasing the possibility of rehabilitation in situations that were previously difficult.

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The long-term success of prosthetic rehabilitation ultimately depends on pre-prosthetic procedures. Further developments in digital tools, biomaterials, and regenerative medicine will further hone the methods as the field develops, providing patients with more individualized and predictable results. Pre-prosthetic procedures are crucial in contemporary prosthodontics, and more study and the incorporation of new technology could increase surgical accuracy and patient satisfaction.

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