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Zygomatic Implants: A Review

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Abstract
Zygomatic implants are an advanced treatment modality used for the rehabilitation of severely atrophic maxilla where conventional implant placement is difficult or impossible. These implants are anchored in the zygomatic bone, providing strong support for prosthetic rehabilitation without the need for extensive bone grafting procedures. The technique reduces treatment time, avoids donor site morbidity, and allows immediate or early loading in many cases. Zygomatic implants have become a predictable and effective alternative for restoring function and esthetics in patients with maxillary bone deficiency.

Background
Rehabilitation of a severely resorbed maxilla is challenging because conventional implants often require bone grafting or sinus lift procedures. To overcome these limitations, Per-Ingvar Branemark introduced zygomatic implants, which gain anchorage from the zygomatic bone. This approach provides a reliable alternative for implant-supported prosthetic rehabilitation in patients with severe maxillary bone loss.

Keywords
Zygomatic implants; Atrophic maxilla; Implant rehabilitation; Sinus slot technique; Maxillary reconstruction; Immediate loading.

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I. Introduction

Dental implants are commonly used and are recognized as one of the effective treatment options for replacing missing teeth. They have been successfully utilized in various clinical situations, including the replacement of a single tooth, multiple teeth, or even the rehabilitation of a fully edentulous jaw.

Conventional implant treatment cannot be performed in the edentulous maxilla of some patients because of advanced bone resorption on the presence of extensive maxillary sinuses leading to inadequate amount of bone tissue for the anchorage of implants. Thus, to pursue alternatives to grafting procedures as well as to avoid the need for sinus lift procedures, zygomatic implants were introduced by Brane mark.

These zygoma implants, when combined with standard implants placed in the anterior maxilla, would be able to support masticatory forces transmitted and fixed implant complete denture prosthesis screwed to the implants and employing cross-arch stabilization[1,2].

Stella and Warner et al. (2000)- introduced the sinus slot technique, a modification of the Brane mark approach. A slot is created in the zygomatic buttress, allowing the implant to pass beside the sinus instead of through it, preserving the sinus membrane. The implant is placed more vertically, making the procedure simpler, less invasive, and more efficient.[3] (figure.1)

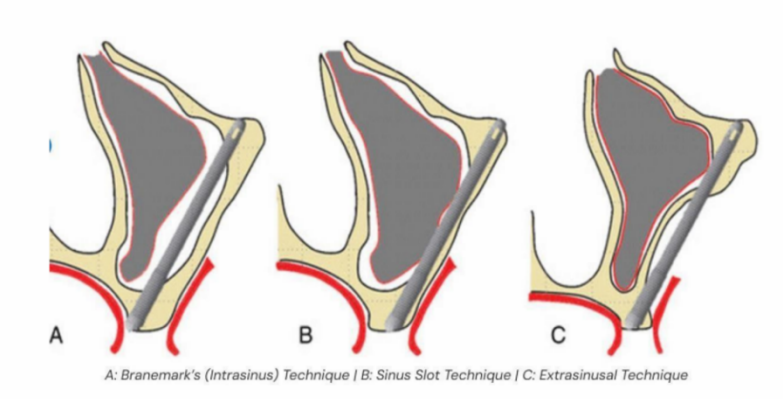


FIG 1

Evolution of zygomatic implants

Zygomatic implants were introduced for rehabilitation of severely resorbed maxilla, but the original Brane mark technique caused palatal implant emergence leading to phonetic, hygiene, and comfort problems[4].

Based on the zaga (zygoma anatomy guided approach) protocol, implant placement can be classified into five types, depending on the path of the implant:

ZAGA 0 (Group 0):
- Flat anterior maxillary wall with implant head positioned on the alveolar crest.
- Implant follows an intra-sinus path.
- Implant contacts bone at the alveolar crest and zygomatic bone (sometimes lateral sinus wall).

ZAGA 1 (Group 1):
• The anterior maxillary wall is slightly concave
• The implant head is located on the alveolar crest
• Although the implant can be seen through the wall, most of the implant body has an intra-sinus path.

ZAGA 2 (Group 2):
• The anterior maxillary wall is concave
• The implant head is located on the alveolar crest
• The implant can be seen through the wall and most of the body has an extra sinus path

ZAGA 3 (Group 3):
• The implant head is located on the alveolar crest
• The drill has performed osteotomy following a trajectory that goes from the palatal to the upper buccal alveolar bone, then the implant body leaves the concave part of the anterior sinus wall to penetrate into the zygomatic bone.

ZAGA 3 (Group 3):
• The maxilla and the alveolar bone show extreme vertical and horizontal atrophy
• The implant head is located buccally of the alveolar crest. There is no or minimal osteotomy at this level
• The drill has arrived at the apical zygomatic entrance following a path outside the sinus wall.

ZAGA 4 (Group 4):
• The maxilla and the alveolar bone show extreme vertical and horizontal atrophy
• The implant head is located buccally of the alveolar crest. There is no or minimal osteotomy at this level
• The drill has arrived at the apical zygomatic entrance following a path outside the sinus wall.

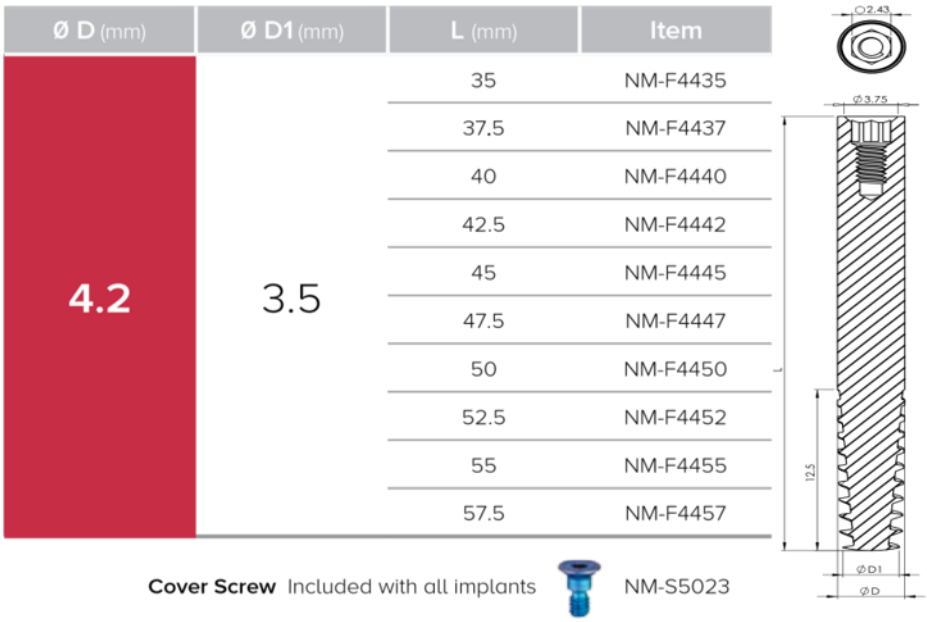
Indications of Zygomatic Implants
- Severely atrophic or resorbed maxilla with insufficient posterior bone.
- Failed graft/sinus lift, maxillary defects, or pneumatized sinuses.
- Immediate loading cases and syndromic/congenital defects (e.g., cleft palate, ectodermal dysplasia).[5]

Contraindications of Zygomatic Implants
Absolute Contraindications
1. Active sinus infection (acute or chronic sinusitis

2. Uncontrolled systemic diseases
3. Malignancy in the maxillofacial region
4. Severe psychiatric disorders or poor patient compliance

Relative Contraindications
1. Severe parafunctional habits (e.g., bruxism)
2. Smoking (heavy smokers at higher risk)
3. Previous failed zygomatic implants or grafts
4. Thin or compromised sinus walls limiting anchorage.

Implant design
- Extra-long titanium implants (30–52.5 mm) with 4 mm apical and 4.5 mm crestal diameter for zygomatic bone anchorage.
- Angulated head (≈45–55°) with threaded apical rough surface and smooth coronal portion for stability and prosthetic connection. (fig.2)[6]



Types

Zygomatic implants are used in severely atrophic maxilla as an alternative to conventional implants without bone grafting.

Common implant body designs include flat and round types, chosen based on anatomy and biomechanical requirements.

They are available in 2 different designs
1. Flat
2. Round

(Figure.3) Flat Zygomatic Implant

Figure.4) Round Zygomatic Implant

Flat Zygomatic Implants
Design:
- Body has flat or machined surfaces (usually unthreaded) in the mid portion of the implant, with threads only at the apical portions
- This reduces bone contact in the sinus wall region(fig.3).[6,7]

Biomechanical Concept:

- Flat body allows the implant to pass through the sinus with minimal friction and reduces risk of sinus wall resorption
- Threaded apex ensures strong anchorage within the dense zygomatic bone.

Advantages:
- Minimizes trauma to the thin maxillary sinus walls.
- Reduces risk of sinusitis due to less bone compression inside sinus.

Examples: Nobel Biocare Zygoma implant (classic design – smooth midsection, apical threads).

Round (Threaded) Zygomatic Implants Design:
- Entire implant body (including the intra-sinus portion) is fully threaded with a round/tapered profile.
- Provides continuous bone contact throughout its length(fig.4)

Biomechanical Concept:
- Threads increase surface area, creating higher bone-to-implant contact (BIC) along the whole trajectory.
- Achieves stability not only in zygoma but also from maxillary bone contact.

Advantages:
1. Greater primary stability, especially useful in poor bone quality cases
2. Distributes occlusal forces more evenly along the implant body.[6,7]

Dimensions & Range
- Zygomatic implants are long implants (≈30–52.5 mm, up to 60 mm) designed to anchor in the zygomatic bone, with diameters around 3.5–4.3 mm. They usually have tapered or straight bodies with smooth midsections and rough apical threads to improve osseointegration and reduce sinus complications. (fig.5)[7,8]

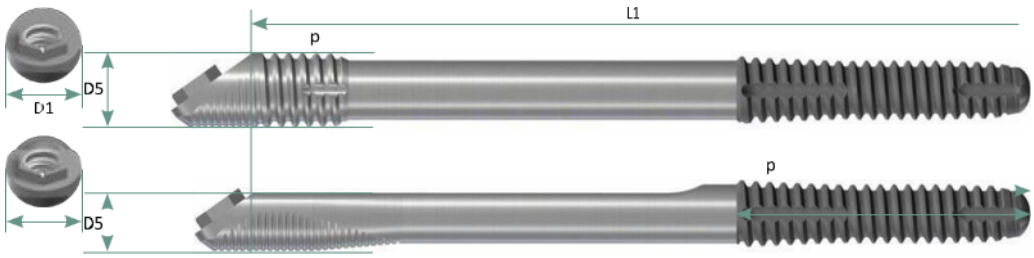


FIG 5

Comparison between Conventional Implants and Zygomatic implants

Feature	Conventional Implants	Zygomatic implants
Length range	8 – 16 mm	30 – 52.5 mm (some up to 60 mm)
Diameter range	3 – 4 mm	3.5 – 4.5 mm
Anchorage site	Alveolar/maxillary bone	Dense zygomatic bone
Path of insertion	With in alveolar ridge	Crosses/skirts the maxillary sinus to reach zygoma
Primary use	Single/multiple tooth replacement in normal bone	Severe maxillary atrophy, maxillectomy, oncology or trauma
Prosthetic connection	Straightforward, axial emergence	Angulated emergence (prosthetic correction is often required)

General guidelines for zygomatic implants-

Zones of maxilla: There are primarily 3 zones (figure.6)[9,10]

Zones	Region
i	Premaxilla
ii	Premolar
iii	Molar

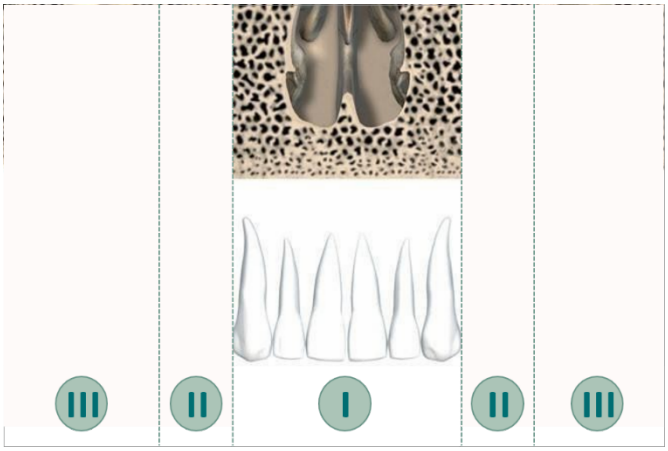


Figure.6 zones of maxilla

Treatment recommendations based on the presence of bone in the different zones of the maxilla (Bedrossian)

(Table.7)[10]

Presence of bone	Surgical approach
Zones I, II and III	Traditional (axial) implants
Zones I and II	Four traditional implants (tilted)
Zones I	Zygomatic implants plus two or Four traditional implants
Insufficient bone	Four Zygomatic implants

Components of Zygoma Implant Kit

Zygomatic implant placement uses long drills across multiple planes, making control difficult. Small angular deviations can cause large apical errors, known as the sine error.(fig.7)[11,12,13]

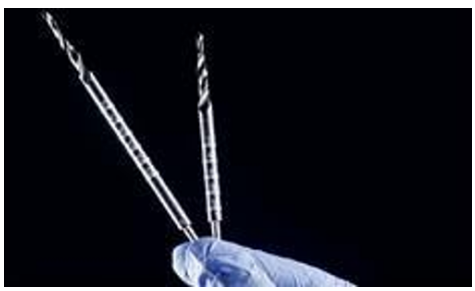
Diamond drills

Are long cylindrical instruments with a blunt conical tip used to create an initial tunnel along the lateral sinus wall. They improve drill guidance and accuracy while reducing sinus membrane damage compared to carbide burs.

(Figure 7). Diamond drills in various grits

Osteotomy drills

The osteotomy drills are a set of three laser-marked drills (no. 1, 2, and They are available in lengths of 40, 50, 60, and 80 mm.(figure.10)



(Figure.8) Osteotomy drills in various lengths

Depth probe

A laser-marked depth probe measures osteotomy depth, allowing 1–2 mm extension beyond the zygomatic bone. Extraoral palpation confirms direction, and the marked length indicates the correct implant size.

(Figure.11) Depth probe

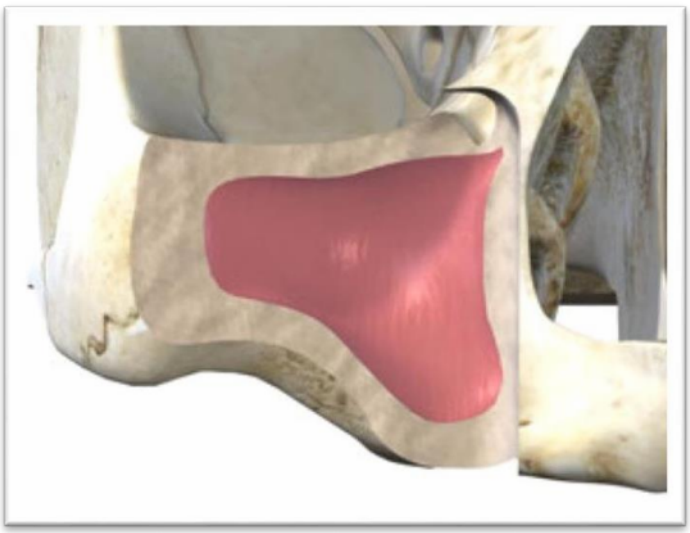
Implant hand driver

The implant hand driver is a long driver that offers better grip and control during implant placement.

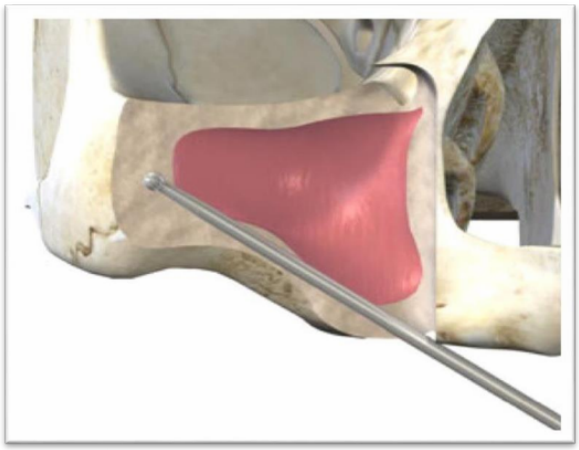
(Figure.12) Handheld implant driver that offers better control of the implant.

Surgical sequence

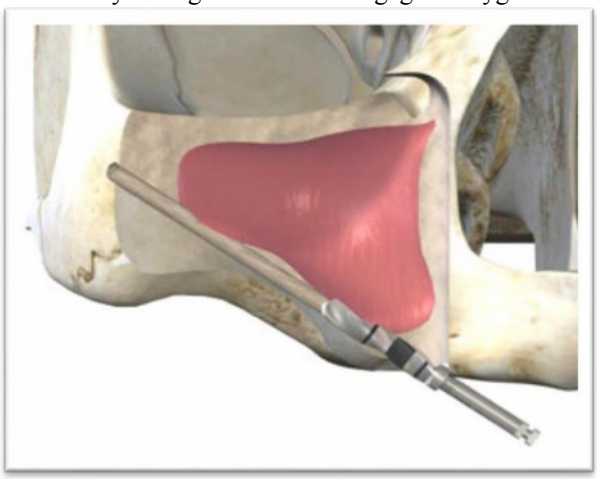
A crestal incision with three vertical releases is used to raise buccal and palatal flaps for wide exposure. A channel retractor over the zygomatic arch improves visibility and protects soft tissues.[14,15]



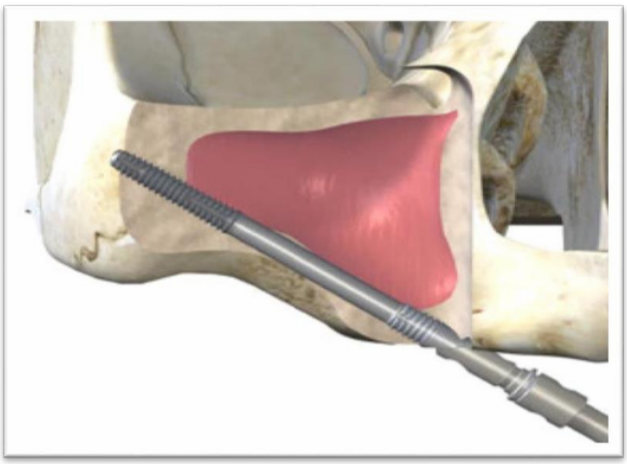
Step 1: A small lateral sinus window (~10 mm) is created and the sinus membrane is carefully reflected. This allows clear visualization of drilling and implant placement while preventing membrane entrapment.



Step 2 -The osteotomy entry point is usually in the premolar–molar region, often palatal to the crest. A round bur or needle drill prepares the entry through the sinus to engage the zygoma and stabilize the initial drill.



Step 3-The 2.9 mm drill passes through the zygoma and exits the buccal cortex near the frontozygomatic notch. Direct visualization ensures the drill avoids orbital penetration.



Step 4: A transition drill enlarges the osteotomy in the zygoma to final size. A 3.5 mm twist drill is used only in dense crestal bone and avoided in soft bone.

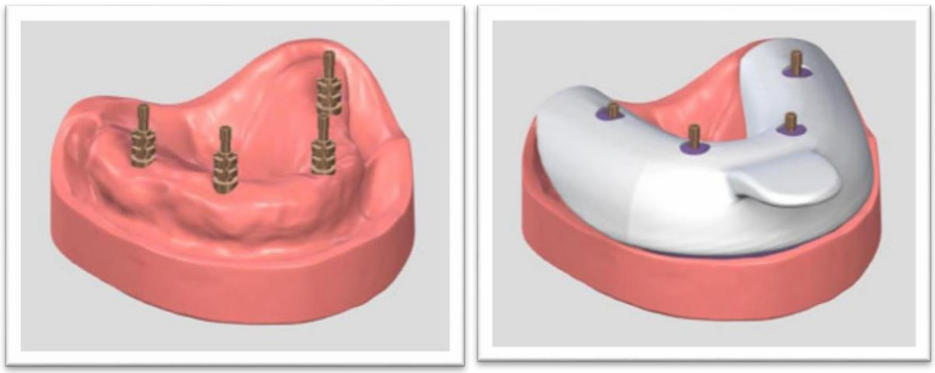
Step 5 -Attach the connector to the handpiece, secure the implant with a hex driver, and connect the fixture mount (I-CON-X). Remove the implant from the holder by gentle rotation and lifting.

Impressions

Open-tray impression:

- Make sure the abutments are torqued down with 35 Ncm

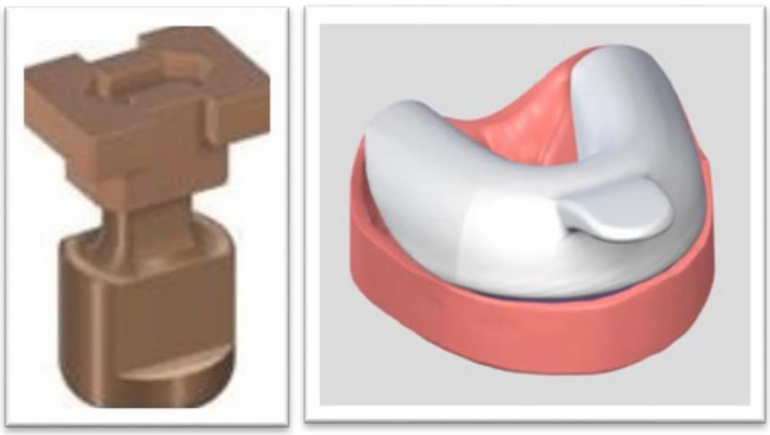
- Place the open-tray impression posts onto the abutments and fix them with the screw
- Ensure correct positioning of the impression posts on the abutments
- Use the impression components with the non-engaging feature[16]



(Figure.13) open tray impression

2) Closed-tray impression: -

• Make sure the abutments are torqued down with 35 Ncm
• Place the closed-tray impression (fig.14) posts onto the abutments and fix them with the screw
• Ensure correct positioning of the impression posts on the abutment[16]



(Figure.14) closed tray impression

Temporary restoration:

1) Using protective caps - Mount the protective caps on the abutments and hand-tighten the screws with the SCS Screwdriver. (figure.15)

Note: Do not keep protective caps in the patient's mouth for longer than 180days.[17,18]

(Figure.15) protective caps

2) Using temporary TAN copings or titanium copings-

• Based on dental impression, prepare the master cast using standard procedure. • Based on the impression and bite registration, prepare the provisional denture. • For the surgical procedure, prepare a duplication of the provisional in clear acrylic material. (figure.16)

(Figure.16) Titanium copings

I] Final restoration: Screw-retained- CADCAM option

Fabricate the master cast.

In order to transfer the impression data into the CARES software, use abutment- level scanbodies for the screw-retained abutments (figure.17

Figure.17) scan bodies

Hand-tighten the scanbodies onto the analogs in the dental model.

(Figure.18) Analogs

Place the dental model in the scanner and follow the scanning

(Figure.19) scanner

Protocol for Achieving Success with Zygomatic Implants

Rehabilitation with zygomatic implants, particularly extra-maxillary implants, differs from conventional implants in biomechanics and clinical procedures and is mainly indicated in cases of severe maxillary atrophy involving both alveolar and basal bone resorption.

In ZAGA Type 4 cases, the implant head lies buccal to the alveolar crest with no surrounding alveolar bone, and the non-axial implant position makes standardized intraoral radiographs difficult, preventing use of conventional implant success criteria.[18,19]

II. Discussion

Rehabilitation of severely atrophied or partially resected maxilla with conventional implants often requires extensive bone grafting and sinus augmentation, making treatment complex.

Zygomatic implants avoid bone grafting, reduce treatment time and surgery, eliminate donor site morbidity, and allow continuous use of transitional prostheses, improving patient comfort and compliance.

They show >96% success rates, require fewer procedures, reduce cost and laboratory work, and provide a stable and aesthetic fixed or removable prosthesis.

III. Conclusion

Zygomatic implant helps to surgically rehabilitate patients with severe maxillary resorption and presents with higher acceptance rate of treatment because of immediate use of dentures. Zygomatic implants have recognized as having better clinical results than bone grafting and may be the new "gold standard" therapy for conceding maxillary bone.

It has been in use for over a decade and provides a consistent outcome in the rehabilitation of individuals who are completely or partially edentulous. Their unique design and anchorage in the zygomatic bone provide excellent primary stability, enabling immediate or early loading protocols and reducing overall treatment time. Long-term studies demonstrate high survival rates and favorable functional and esthetic outcomes, making them a valuable alternative to bone grafting.

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