Utilization Of Transnasal Implants – A Scoping Review

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***Abstract*—Objective: This scoping review aims to assess the scope and nature of evidence concerning transnasal implants.**

Introduction: Transnasal implants are dental implants placed through the nasal cavity to anchor into the upper jaw bone, often used for patients with significant bone loss, particularly in the anterior maxillary region. They restore both aesthetics and function of teeth and serve as an alternative to traditional implants when bone density is insufficient. These implants can support various dental restorations, including full-arch prostheses, and offer an alternative to quad zygomatic implants in certain cases.

Methods: An extensive literature search was conducted across three databases (Google Scholar, PubMed, and Scopus) from January 2020 to March 2024. English-language articles were included, emphasizing keywords related to oral surgery, transnasal implants, and quad zygoma.

Results: Extended transnasal implants can be an appropriate therapeutic alternative for individuals with atrophic maxillae, contingent upon adequate bone volume in the frontal process of maxilla for stabilizing apical implant placement. The canine or frontomaxillary pillar offers dense bone and protects the nasal fossa. While the technique involves grafting, it offers graftless benefits like reduced morbidity, simpler surgery, and shorter operating time, enabling immediate function. However, its applicability is limited by anatomical factors.

Conclusions: To enhance implant distribution and load management during function, transnasal implants should be considered in treatment plans for severely resorbed maxillary arches. When part of the therapeutic approach, they may be utilized in conjunction with zygomatic or posterior implants.

***Index Terms*—Transnasal implants, atrophic maxilla, quad zygoma, rehabilitation**

I. INTRODUCTION

Maxillary sinus pneumatization, ridge resorption in edentulous arches, and periodontal disease contribute to bone loss in the maxilla, making implant preparation challenging due to insufficient bone for placement without significant grafting. When traditional implants cannot be positioned in the premaxilla, quad zygomatic implants are frequently utilized to avoid severe anterior resorption. However, their placement is limited when the infraorbital foramen intersects with the implant's trajectory or when the zygomatic bone lacks sufficient volume to anchor two implants.

Following alveolar bone loss from periodontal disease or tooth loss, denser bone remains separating the nasal fossa and maxillary sinus, called trans-nasal bone. By using extra-long implants placed into this trans-nasal bone, anterior support for the prosthesis can be provided, offering an alternative to quad zygomatic implants. This approach combines extra-long trans-nasal implants with unilateral zygomatic implants for improved results.

II. METHODS

A. Search Strategy

For publications in English from January 2020 to December 2024, searches were performed through Google Scholar, PubMed, and Scopus databases. The following keywords were employed: "transnasal implants" OR "quad zygoma" OR "atrophic maxilla." Additionally, reference lists of individual publications were reviewed to identify more articles.

B. Types of Sources

This scoping review addressed pre- and post-research, randomized controlled trials, non-randomized controlled trials, interrupted time-series research, and additional experimental and quasi-experimental research methods. Case-control, prospective, retrospective cohort, analytical cross-sectional, and analytical observational studies were additionally included. Additional descriptive observational research approaches including cross-sectional research, case series, and individual case reports were considered.

C. Inclusion Criteria

Participants:

- Adults aged 18-75 years requiring maxillofacial reconstruction due to trauma, congenital defects, or severe atrophy of the upper jaw
- Patients with insufficient bone volume or poor bone quality in the maxilla, particularly in posterior regions, unsuitable for traditional dental implants or conventional zygomatic implants
- Patients with complex maxillofacial or craniofacial deformities necessitating alternative implant solutions

Concept:

- Studies evaluating or undergoing transnasal implants as a method of securing dental prostheses, specifically targeting those who might otherwise need quad zygoma implants
- Research comparing efficacy, success rates, and long-term outcomes of transnasal implants with quad zygomatic implants or other alternatives
- Consideration of both single-stage and multi-stage procedures for implant placement

Context:

- Clinical settings such as oral and maxillofacial surgery centers, hospitals, or specialized clinics focusing on craniofacial reconstruction
- Geographical settings with access to advanced surgical techniques and post-operative care
- Cases in both primary and secondary surgeries

D. Exclusion Criteria

Participants:

- Patients with active infections, severe systemic diseases (e.g., uncontrolled diabetes), or other contraindications to surgery or implant therapy
- Children or adolescents under 18 years
- Patients with severe psychological conditions or non-compliance issues

Concept:

- Studies focusing on implants not related to transnasal or zygomatic approaches
- Research involving implants placed using other methods or for purposes unrelated to maxillofacial reconstruction

Context:

- Clinical environments with limited access to advanced surgical tools, imaging technologies, or post-operative care
- Studies conducted in non-specialized clinics or general dental practices

III. INDICATIONS AND CONTRAINDICATIONS

A. Indications

Full-arch maxillary rehabilitation combining zygomatic and transnasal implants must fulfill the following anatomical requirements:

1. Inability to perform the standard all-on-4 procedure due to lack of bone needed for inserting 4 implants in the maxillary arch
2. D-V or D-VI bone quantity (Cawood-Howell classification)
3. Minimum bone height of 4mm in the posterior maxillary region within the maxillary ridge and nasal cavity
4. To enable apical anchorage of extra-long implants, the maxilla's frontal process must have a minimum of 3mm of "crista conchalis corporis maxilla"

For extra-long implants to be apically stabilized, the maxilla's frontal process at the Z-point must have a minimum 3mm bone volume. The 'Z-Point' refers to the inferior turbinate-level lateral nasal and maxillary sinus walls. Patients frequently demonstrate thickening at the turbinate's anterior-most point. If

bone height is lesser, immediate loading may be rendered unfeasible.

B. Contraindications

A very wide nasal cavity where lateral limits are distally placed is a limitation of this process due to the increased nasal antrum.

Placing four zygomatic implants may be unfeasible if:

1. The infraorbital foramen is in the way of the zygomatic implant
2. The zygomatic bone's dimensions are insufficient to allow anchoring 2 zygomatic implants
3. Due to the patient's prominent facial concavity within the alveolar ridge, maxillary sinus, and zygomatic bone (ZAGA 3 and 4), there is a possibility that tissue would dehisce and expose the implant body

IV. SURGICAL PLANNING

Virtual planning software is required for computed tomography (CT) scans and surgical simulation following clinical evaluation. Once virtual planning is complete, a stereolithographic model of the middle third of the face, including the expanded maxilla, must be printed before surgery. This allows for safer planning and provides an opportunity for hands-on training.

Extra-long transnasal and zygomatic implants can be virtually placed during simulation, which additionally allows for evaluation of the maxilla and zygomatic bone's frontal processes. Virtual placement assists in predicting the ideal diameter and length of each implant, ensuring more accurate positioning based on bone availability. Additionally, it serves as a valuable tool when combined with anatomical knowledge of the face, allowing for visualization of implant trajectories and ensuring a safe distance from critical structures such as the infraorbital foramen, orbit, and lacrimal canal.

A. Nasolacrimal Duct Considerations

The nasolacrimal duct requires special attention as a result of its foramen's position beneath the conchal crest and inferior nasal turbinate. The nasolacrimal duct is the most critical anatomical structure to consider when planning and performing the procedure, as injury to this duct can result in epiphora and require complex surgical intervention.

A study by Simmen et al. (2017) evaluated the distance between the anterior wall of the maxilla at the level of the frontal process and the nasolacrimal duct in 100 patients. They found that 56.5% of patients had a distance of 3–7 mm, 12.5% had a distance greater than 7 mm, and 31.5% had a distance of less than 3 mm. Camargo et al. (2019) recommended maintaining at least a 5mm distance to avoid damage to the nasolacrimal duct, emphasizing the importance of prior planning and measurement to prevent complications.

B. NASA Classification

Patients should be categorized according to the crestal approach for transnasal implant implantation applying the Nasal Anatomic Systematic Approach (NASA). Classification includes:

- NASA type-0 (crestal approach from foramen)
- NASA type-1 (crestal approach from central incisor)
- NASA type-2 (crestal approach from lateral incisor)
- NASA type-3 (crestal approach from canine)
- NASA type-4 (crestal approach from canine with an exposed screw thread)

V. SURGICAL TECHNIQUE

With nasal intubation and general anesthesia, the surgical operation should ideally be performed in a hospital. For zygomatic and transnasal implant procedures, employ infiltrative anesthesia with vasoconstrictor to minimize local bleeding and post-operative pain.

A. Surgical Approach

Begin treatment with a midline incision before relaxing the alveolar ridge crest, which is slightly palatalized towards the distal region of the first molars. Alveoloplasty is then performed to level the alveolar bone and remove any bone affected by periodontal disease. The nasal cavity, infraorbital foramen, and zygomatic bone can be observed by raising the palatal and vestibular flap.

Nasal mucosa, which is purplish compared to gingival mucosa, is removed employing a maxillary sinus lift detacher (Hu-Friedy, Leimen, Germany) and Lucas curettes (Hu-Friedy, Germany), exposing the lateral

wall and floor of the nasal cavity. Carefully detaching the distal region of nasal mucosa exposes the nasal cavity's lateral wall and floor. Since nasal mucosa is thicker than maxillary sinus, it rarely ruptures; however, if it occurs, absorbable sutures must be utilized for suturing wounds.

B. Osteotomy and Implant Placement

Employing a surgical kit with extra-long burs (Helix Compact Surgical Kit GM® Long Neodent®) at a perforation speed of 500–800 RPM, osteotomy proceeds with a conventional or palatine approach, similar to regular implant placement techniques. Before moving on to the maxillary frontal process, the initial spear bur should gently touch the nasal cavity's lateral wall. Then, 3.75mm and 2.5mm burs are employed. Utilizing curettes or maxillary sinus lift periosteal elevators, the nasal membrane should remain retracted during osteotomy.

To accommodate the thin region of the maxilla's frontal process, the implant is selected based on two essential features: narrow diameter and adequate length (at least 21mm). Maximum insertion torque of 60Ncm and maximum speed of 30RPM are employed for inserting implants. It is recommended to utilize extra-long implants with a diameter up to 3.75mm and lengths of 20, 22.5, or 25mm since the maxilla's frontal process is thin (HelixGM® Long Implants Neodent®).

Particulated bone grafting should be conducted in the nasal cavity's floor and lateral region after implant installation to prevent nasal mucosa from adhering to implant threads, which could increase the risk of infection or interfere with respiratory function.

C. Zygomatic Implant Integration

Following completion of extra-long transnasal implant insertion, zygomatic implants are inserted through osteotomy. To lower the risk of vestibular soft tissue dehiscence and subsequent exposure of the zygomatic implant body and threads, Bichat's buccal fat pad can be placed against the implant head.

D. Immediate Loading Protocol

Most implants can be loaded immediately if they reach a minimum insertion torque of 30Ncm. Following microunit abutment placement, transfer impressions are collected utilizing a multifunctional surgical guide, and a hybrid prosthesis with cast bar is provided a few hours post-surgery. Performing final panoramic radiography is required for verifying that there are no gaps and ensuring proper prosthesis passivity.

VI. POST-OPERATIVE MANAGEMENT

A. Medication Protocol

The following medications should be prescribed for a two-week course:

- Corticosteroids on a regressive schedule (30mg on day of surgery and first 2 post-operative days, 20mg on days 3 and 4, 10mg on day 5, and 5mg on days 6 and 7)
- Anti-inflammatory drugs every 12 hours from days 8-15
- Antibiotics every 8 hours for 7 days, then every 12 hours until day 15
- Analgesics for post-operative pain (administered for first 3 days as required)

B. Follow-up Assessment

During follow-up appointments, clinical assessments should include evaluation of implant mobility (via manual testing), checking for suppuration, modified plaque and bleeding indices, and probing/mucosal seal efficacy. Additionally, dental hygiene and prophylaxis instruction should be given.

C. Potential Complications

Post-operative complications reported in some studies include:

- Temporary paresthesia of the nasal ala, with sensations of pins and needles, typically improving within 30 days
- Nasal-oral fistula due to excessive biomaterial in the nasal cavity, resolving within 90 days
- Initial temporary difficulty with breathing in patients with deviated nasal septum

Detaching periosteum near the infraorbital nerve, covering transnasal implants with fine-grained biomaterial, and arranging implants tangentially to the nasal cavity's distal bone wall, particularly in patients with deviated nasal septum, all require careful consideration.

VII. DISCUSSION

Alveolar bone resorption and cumulative bone remodeling often cause atrophic jaws, posing rehabilitation challenges. Tooth loss will inevitably result in this condition. Maxillary inlay bone grafts, Le Fort I osteotomy, and nasal floor enlargement employing autogenous bone or graft replacement assist in inserting conventional dental implants in the atrophic pre-maxilla. However, these techniques may involve increased morbidity, unpredictable bone resorption, higher treatment costs, and extended rehabilitation times due to the need for multiple surgical procedures, with immediate loading typically not being feasible.

Immediate loading is highly desirable when rehabilitating atrophic jaws because it significantly reduces treatment time and overall costs. However, performing immediate loading on a grafted maxilla is complex since newly grafted or reconstructed bone often lacks the necessary density for immediate implant function.

A. Zygomatic Implants

Zygoma-anchored implants demonstrate efficacy in supporting posterior prosthetics. This method was developed and introduced by Brånemark to eliminate the requirement for bone grafting and entails inserting bilateral zygomatic implants in addition to 2-4 conventional dental implants in the front maxilla. When there isn't enough anterior bone for placing implants longer than 10mm, the quad zygoma technique should be employed, as some research indicates that application of dental implants shorter than 10mm decreases implant survival.

Quad zygoma (all-on-4 with double zygomatic implants) was developed years following single zygomatic implants being combined with conventional implants. Quad zygoma surgery is an extremely difficult technique that requires proper and precise performance, with careful planning and training.

B. Limitations of Quad Zygoma

While zygomatic implants are an excellent option for patients with severe bone resorption and are associated with low morbidity and complication rates, the quad zygoma technique has some important limitations. These include small zygomatic bones, implant pathways close to the infraorbital foramen, large orbital cavities, significant portions of the implant passing through the maxillary sinus, and the concavity in the anterior maxilla, which can complicate the positioning of anterior implants.

C. Extra-Long Transnasal Implants

Another option for rehabilitating the atrophic maxilla is using extra-long dental implants. Maló et al. (2013) classified extra-long implants as those ranging from 20 to 25 mm, typically used to ensure immediate loading when zygomatic implants are contraindicated or when avoiding cantilevers in dental prostheses.

The nasal fossa is protected by the canine or frontal-maxillary pillar, a region with high density of cancellous and cortical bone. This thickened area protrudes medially into the nasal cavity although remaining relatively thin. The lateral wall is situated where the nasal concha and internal surface of the maxilla connect.

Even with severe atrophy, paranasal bone at the pyriform and nasal crest is present; however, extra-long implants are utilized in extreme resorption cases with less than 7mm of residual bone. This emphasizes implant shape. Anchorage at the crest, especially at the thinner apex, is crucial to implant stability. The authors recommend narrow-diameter implants to reduce bone removal during drilling.

Extra-long transnasal implants can serve as a potential treatment for atrophic maxillae provided there is sufficient bone volume in securing the apical portion of implants in the frontal process.

VIII. CONCLUSION

To enhance implant distribution and load management during function, transnasal implants should be taken into account in treatment plans for severely resorbed maxillary arches. When part of the therapeutic approach, they may be utilized in conjunction with zygomatic or posterior implants. The technique offers graftless benefits including reduced morbidity, simpler surgery, and shorter operating time, enabling immediate function. However, careful patient selection based on anatomical factors is essential for successful outcomes.

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