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Technical Note

The zygomatic implant perforated flap in the reconstruction and early rehabilitation of low-level maxillectomies: A technical note

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ABSTRACT

The "Zygomatic Implant Perforated Flap" (ZIP flap) technique, first described by Butterworth in 2017, combines the closure of bucco-sinusal or bucco-nasal communications using a fasciocutaneous free flap with early implant-based prosthetic rehabilitation via zygomatic implants that perforate the flap. This approach enables rapid dental rehabilitation within weeks of tumor resection, promoting early recovery of oral function. We present the case of a 49-year-old male who underwent delayed ZIP flap reconstruction one year after maxillectomy and radiotherapy. Four zygomatic implants were placed using a surgical guide, followed by inset of a radial forearm free flap perforated over each implant emergence. A prefabricated transitional prosthesis was immediately screwed onto the implants. This technical note highlights the advantages of the ZIP flap in reconstructing Brown Class II maxillectomy defects, offering reduced rehabilitation time, improved prosthesis retention, and enhanced functional and psychological outcomes.

1. Introduction

Malignant tumors of the maxilla are rare, accounting for <6 % of head and neck cancers, but they pose a significant therapeutic challenge due to their considerable aesthetic and functional consequences [1]. Maxillectomies result in oro-sinusal or oro-nasal communications, which impair speech, mastication, and swallowing, with major psychological and social repercussions [2]. The primary objective of treatment is to restore separation between the oral and sinuso-nasal cavities, while enabling effective functional and aesthetic prosthetic rehabilitation [3].

The Brown classification, initially proposed in 2000 and revised in 2010 [4,5], is widely used to assess the aesthetic and functional implications of post-maxillectomy defects [6]. Reconstruction options depend on the extent of the defect. Obturator prostheses are typically indicated for smaller defects [1] or in patients with significant comorbidities, and they allow for easier oncologic surveillance [7,8]. For more extensive defects, reconstruction with a free flap is generally preferred.

Introduced by Butterworth in 2017 [9], the innovative "Zygomatic Implant Perforated Flap" (ZIP flap) technique combines the use of a fasciocutaneous free flap, most commonly the radial forearm free flap (RFFF), with the placement of zygomatic implants that perforate the flap. This approach enables simultaneous soft tissue reconstruction and implant-based rehabilitation, allowing for early prosthetic loading, generally between 3 and 6 weeks [2]

1.1. Technical note

A 49-year-old male with no relevant medical history presented with a right hemi-palatal mass, diagnosed as cystic adenoid carcinoma (T4a N0 M0) on biopsy and imaging (54 mm lesion). The patient received 70 Gy of external radiotherapy, complicated by a persistent 2 cm oro-nasal fistula (Fig. 1). Following tumor downstaging to 26 mm, a right maxillectomy with ipsilateral neck dissection was performed, and the defect was initially managed with a conventional obturator.

The decision was taken not to proceed immediately with reconstruction to monitor for any tumor recurrence, given the absence of healthy margins on extemporaneous analysis.

After one year of disease-free follow-up, a ZIP flap reconstruction was planned (Fig. 2).

Under general anesthesia, a crestal incision in sector 2 and an incision through the palatal defect exposed the bilateral zygomatic buttresses. A resin implant positioning guide was then placed, stabilized by the contralateral healthy hemi-maxilla and the preserved tooth 23. This

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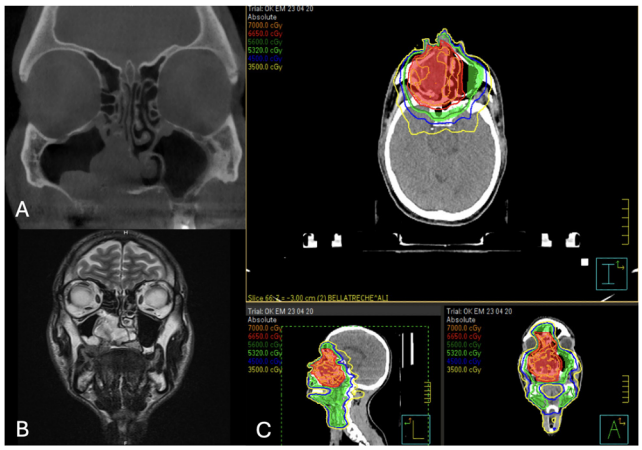

Fig. 1. Pretherapeutic imaging and radiotherapy mapping. A, coronal scan showing lesion located in the right nasal cavity associated with bone lysis affecting the nasal floor and palatine bone. B, coronal T2-weighted MRI showing a well-vascularized 54 mm lesion infiltrating the right nasal cavity. C, isodose map illustrating the distribution of radiation doses in axial, sagittal, and coronal views. The maximum dose of 70 Gy is centred on the right maxillary region, with a gradient of decreasing dose extending to adjacent structures. Lower doses are observed in the zygomatic bones and surrounding tissues.

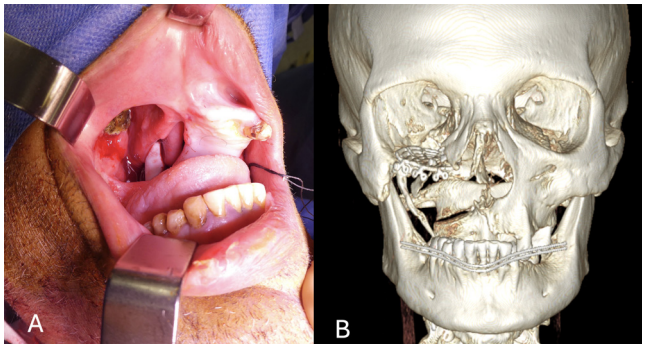

Fig. 2. Defect overview before reconstruction A, preoperative photograph showing the defect to be reconstructed. B, 3D reconstruction showing the maxillectomy defect.

guide was planned based on the patient's existing prosthesis and fabricated using 3D printing technology.

After locating the implant emergences using the surgical guide, the drilling sequences were performed under irrigation, and four zygomatic implants NobelZygoma (Nobel Biocare®) of lengths ranging from 40 to 42,5 mm were manually inserted at positions 12, 15, 22 and 25. Oncologic, smooth-surfaced implants were placed with high primary stability (Fig. 3). Straight 5 mm multi-unit abutments were placed and covered with protective caps.

Simultaneously, the radial forearm free flap (RFFF) was harvested. After creating a cervical tunnel for the pedicle, the flap was inset into the maxillary defect. Microsurgical anastomosis was performed by end-

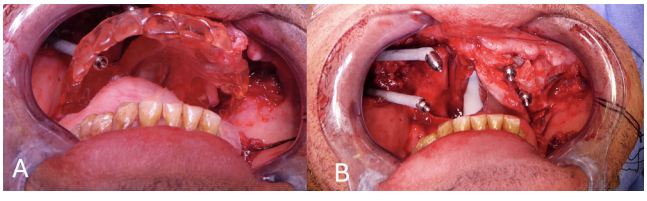

Fig. 3. Zygomatic implant placement. A, preoperatively planned resin positioning guide. B. placement of the four zygomatic implants.

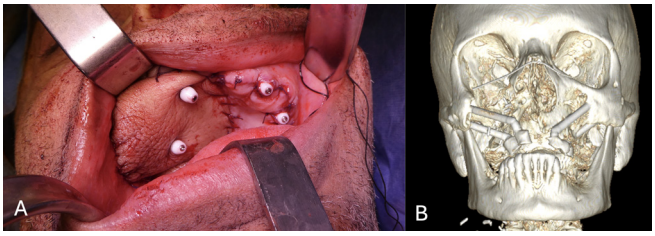

Fig. 4. Surgical outcome of ZIP flap reconstruction. A, antebrachial flap in place, anastomosed, and perforated by zygomatic implant abutments. B, 3D reconstruction showing the positioning of the zygomatic implants.

to-end anastomosis of the radial artery to the right external carotid artery, and of the cephalic vein to the right external jugular vein. The flap was then perforated over each implant abutment using blunt dissection into the flap to allow their transcutaneous emergence (Fig. 4).

The operation was completed with a prefabricated transitional prosthesis, which was screwed on the four zygomatic implants. The transitional prosthesis was designed preoperatively in collaboration with the prosthodontic team. After installing a dental dam and temporary abutments on the multi-unit abutments, the prosthesis is passively inserted through the abutments. Once the occlusion was adjusted, the abutments are bonded to the prosthesis using light-curing resin (Fig. 5).

The prosthesis is then unscrewed and hollowed out on the palate, and the top surface of the prosthesis is trimmed at the lateral edges. After final polishing, the prosthesis was screwed back into the multi-unit abutments of the four zygomatic implants, ensuring satisfactory occlusion (Fig. 6).

The postoperative course was uneventful. The flap remained viable, and the patient tolerated the immediate prosthesis. During the follow-up, the patient reported significant improvement in oral functions and quality of life. The definitive prosthesis was delivered at 6 months.

2. Discussion

The choice of free flap in maxillary reconstruction depends on multiple factors, including the defect classification and the volume to be restored. According to Brown's classification, most indications for ZIP flap reconstruction fall under Class II maxillectomies, which are characterized by limited vertical resection and moderate aesthetic impact. In such cases, bone reconstruction is not necessary.

The radial forearm free flap (RFFF) and the anterolateral thigh flap (ALT) are the most frequently used in ZIP procedures. The RFFF is generally preferred due to its thin, pliable tissue and ease of insetting in confined spaces. When greater soft tissue volume is required, the ALT flap may be considered a suitable alternative [10].

Zygomatic implant survival is influenced by several parameters, particularly previous radiotherapy [11]. Although zygomatic bones radiation doses vary depending on tumor size and location, exposure exceeding 55 Gy has been associated with higher implant failure rates [12]. Nevertheless, implant survival remains high; Butterworth et al. reported a 99 % overall survival rate in a cohort where 48 % of the patients had undergone radiotherapy.

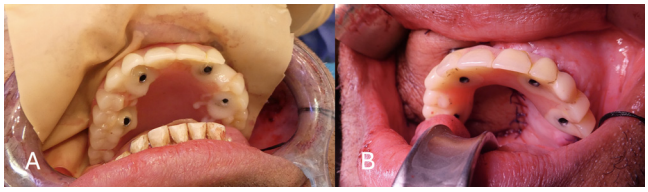

Fig. 5. Prosthetic step. A, insertion of the provisional prosthesis and registration of abutment positions using light-curing resin. B, temporary prosthesis positioned and secured to the multi-unit abutments of the four zygomatic implants after regularization and polishing.

Fig. 6. Temporary prosthesis in occlusion.

Timing of implant placement also plays a role. Butterworth et al. [2] evaluated the differences in zygomatic implant survival between primary and secondary implantation protocols; While primary implantation appears to yield better survival (96 %) than secondary placement (89 %), the difference did not reach statistical significance.

Immediate loading is feasible but requires cautious flap monitoring. Butterworth et al. recommend a 3−4 week delay to prosthesis loading Monitoring of the soft tissue flap is possible within the first 48 h, and there is no obstacle to revision surgery [10].

From a functional perspective, ZIP flap reconstruction offers significant quality-of-life improvements. Watson et al. demonstrated both functional and psychological benefits in ZIP flap patients [13]. The combined use of free tissue transfer and zygomatic implants enhances prosthesis retention, reduces its bulk, improves naso-oral sealing, and allows earlier return to oral functions compared to obturator prosthesis.

This technique is also advantageous in medically compromised patients, as it reduces operative time, hospital stay, and allows timely initiation of adjuvant therapy [9].

However, certain complications must be anticipated. Fistulas are a recognized risk with the RFFF, particularly in irradiated patients. To minimize tension and reduce this risk, oversizing the flap is recommended [9,14].

Peri-implant inflammation and tissue overgrowth may occur, potentially obstructing prosthetic loading. Careful prosthetic planning and hygiene accessibility are therefore essential [7].

While highly effective for small to moderate defects, the ZIP flap has limitations in reconstructing larger maxillary defects where a bony component is necessary for facial support.

3. Conclusion

Since its introduction in 2017, the ZIP flap technique has emerged as an innovative, reliable, and effective solution for the reconstruction of low-level maxillectomy defects, particularly those classified as Brown Class II. By combining a fasciocutaneous free flap with the immediate placement of zygomatic implants, this approach enables simultaneous soft tissue reconstruction and early fixed dental rehabilitation. As a result, it significantly shortens the functional recovery period and enhances the patient's oral quality of life. The ZIP flap thus represents a valuable option in the multidisciplinary management of selected maxillary defects.

Informed consent

Written informed consent was obtained from the patient prior to the preparation and publication of this technical note.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Maxime Lavigogne: Writing – original draft. **Jordan Bouchet:** Validation. **Benjamin Pomes:** Validation. **Gaoussou Toure:** Validation, Supervision.

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