



Simplified Zygomatic Implant Perforated (Zip) Flap for Rehabilitation in Low Level Maxillary Defects

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Abstract Rehabilitation in Low level maxillectomy cases has plethora of options right from local flaps to microvascular flaps. Subsequent to flap surgery, a maxillary dental rehabilitation can be demanding and a fixed or removable prosthesis is obligatory to provide them with near-normal function and aesthetics. Unlike the original ZIP flaps which were dedicated to microvascular flaps, we present here our unique experience with ZIP-Temporalis flap specifically for rehabilitation for patients of CAM (covid associated mucormycosis), its methods, advantages and limitations.

Keywords Low level maxillectomy · Zygomatic implant perforated flaps (ZIP) · Temporalis flap · Maxillary defect · Oroantral communications

Introduction

An endemic that rattled the Indian subcontinent to a large extent in post-COVID times between 2020 and 2021 was without doubt Mucormycosis. A large population of these patients received surgery resulting in total or subtotal maxillectomy defects. The Browns Class 2 maxillary defects [1] are challenging one to rehabilitate as it results in chewing, swallowing and speech problems. The original Zip-flap

technique advocated by Butterworth [2] was used for reconstruction of post cancer low level maxillary defects

Many of the CAM (covid associated mucormycosis) patients had COVID-related lung changes and embolic vascular diseases which made them unsuitable for reconstruction with complex microvascular flaps. To rehabilitate such patients with numerous co-morbidities, we put forward, a distinctive clinical technique, in which the CAM patients were treated exclusively using ZIP-Temporalis flap, for closure of oro-nasal communication and dental rehabilitation with fixed prosthesis.

Methods

Our clinical paper was a retrospective study conducted at Manipal Hospitals, Yeshwanthpur and Nandana Healthcare Hospitals, Rajajinagar, Bangalore, India.

Nine among the 26 patients treated for mucormycosis between January 2020 and January 2021 were candidates for reconstruction due to oronasal communication, bilateral palatal soft tissue defect, and complete/partial loss of dentition in the maxilla. Among these, 5 were males and 4 were females with a mean age of 47 years (30–60years). CAM was seen in 8 patients, and one patient presented with no previous history of COVID-19 (Figs. 1, 2, 3, 4, 5).

Among the 8 patients who had a Positive COVID history, all were known diabetics, had been hospitalized at tertiary care center during covid-19, and received conservative management with steroids and high flow oxygen therapy.

Inclusion criteria for this study among the series were only Browns class 2 maxillary defects which were seen in 9 patients. Post resection, 5 of the patients were treated with ZIP Temporalis Flap, 2 patients—with only Zygomatic implants as there was no soft tissue defect seen and 2

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Fig. 1 CECT showing cam involving bilateral maxilla

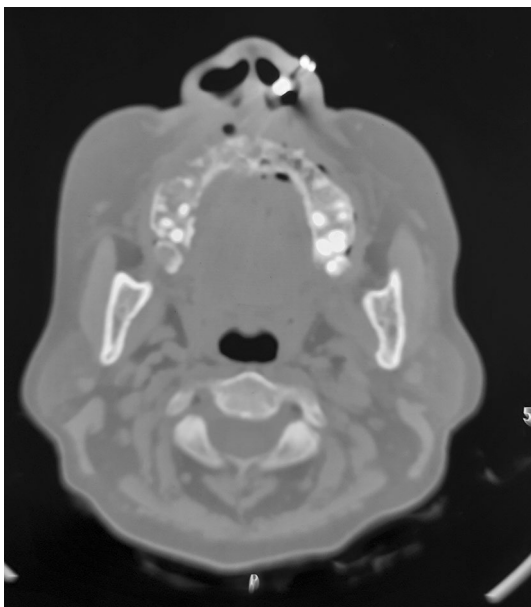


Fig. 2 CT scan showing bony window of CAM affected bilateral maxilla

patients with only temporalis flap for soft tissue defect closure as the zygomatic bone was resected. Of the 5 patients of ZIP flaps, 1 was initially treated with fibula free flap which failed and was planned for ZIP flap as secondary procedure for rehabilitation. One implant failure was seen among the ZIP flap (Figs. 6, 7, 8, 9).

Five patients among the series required rehabilitation with Temporalis flap along with Zygomatic implants. 3D

planning for all the Zygomatic implants were done with Nobel Clinician Guide software preoperatively. Following the resection, the rehabilitation was done with Temporalis flap. Under standard sterile surgical protocols and general anesthesia, the temporalis soft tissue flap was raised for every patient. Intraorally the defect margins were freshened and mucoperiosteal flap raised to access the zygomatic bone. After sequential drilling, the zygomatic implants were placed with initial primary stability obtained above 55 Ncm in 4 patients. In 1 patient the primary stability obtained was 30 Ncm.

Post Implant placement, the temporalis flap was tunneled below the zygomatic arch and transferred intraorally and the flap inset to the maxillary defect was performed and the flap secured. The flap was perforated with the abutment fixed to the zygomatic implant. Donor site was closed in layers and skin staples. Prior to extubating, RT was inserted for post-op feeding.

Postoperatively, the patients were closely monitored and all patients received antibiotics, analgesics, IV fluids. RT feed was started at 200 ml/hr and was continued for 2 week. RT feed was removed after 2 weeks and soft diet was advised from 2nd week once initial healing occurred.

The detailed table of the demographics of the patient, site of operation and number of implants used are presented in Table 1. Postoperatively the follow-up of patients was done at end of 1 week, 1 month, 3 month and 4 months and assessment for re-infection, donor site scar, fistula formation, implant uptake were evaluated postoperatively.

The prosthetic work was started on an average 3–4 months after implant placement. The first sitting consisted of alginate impressions and an obturator fabrication. Debulking of the Temporalis flap was done under Local anesthesia with RF cautery, following which a fixed obturator on temporary cylinders attached to the implants, was given for 3 weeks (Figs. 10, 11, 12, 13, 14, 15, 16).

The implant prosthetic phase consisted of an open tray impression, jaw relation and framework trial. The final definitive prosthesis for the 4 ZIP flap patients was a milled magnet bar-retained overdenture prosthesis for easy maintenance in long run. Three of the patients were given Cast partial dentures which included one patient with failed zygoma implant. 1 of the patients with only quad zygomatic implants received a fixed prosthesis. 1 of the patients who underwent only zygomatic implants without zip flap also received a magnetic retained Implant supported overdenture. The prosthetic flow is as follows:

ZIP Flaps & Magnet Retained Overdentures

Step 1 Intraoral digital scanning Using Scan bodies attached to multiunit (MU) abutment.



Fig. 3 a Post resection extraoral frontal view. b Post resection extraoral left lateral view. c Post resection extraoral right lateral view



Fig. 4 Post resection intraoral view

Step 2 Metal Bar trial, Mouth preparation and Pickup impression.

Step 3 Metal bar with magnets and cast partial framework trial.

Step 4 Jaw relation.

Step 5 Teeth trial.

Step 6 Final Prosthesis.

Quad Zygoma—Fixed Prosthesis

Step 1 Intraoral scanning Using Scan bodies attached to MU abutments.

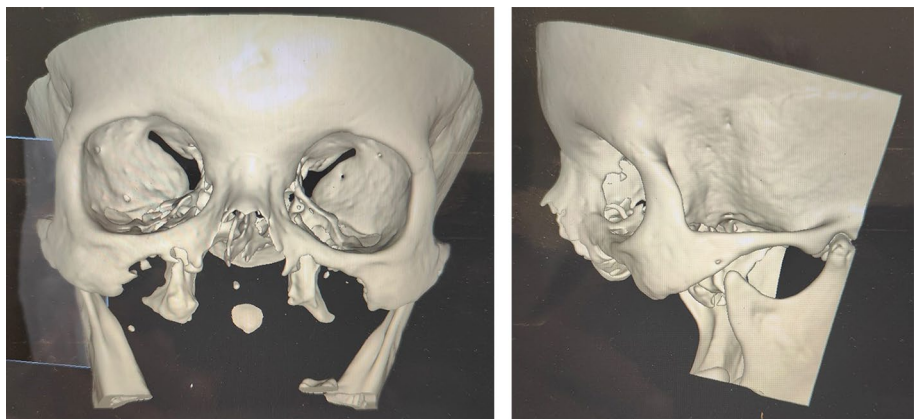
Step 2 Jaw relation.

Step 3 Metal Framework trial.

Step 4 Bisque trial, teeth trial.

Step 5 Final Prosthesis insertion.

Fig. 5 a Post resection 3D CBCT image of maxilla. b Post resection 3D CBCT lateral image of maxilla



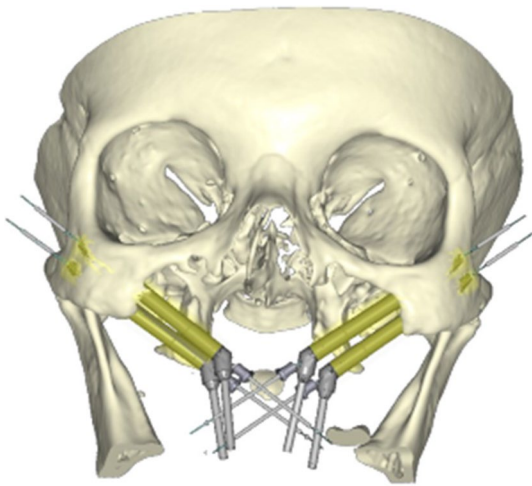


Fig. 6 implant planning for rehabilitation of midface using quad zygoma implants



Fig. 8 PNS view post quad zygoma

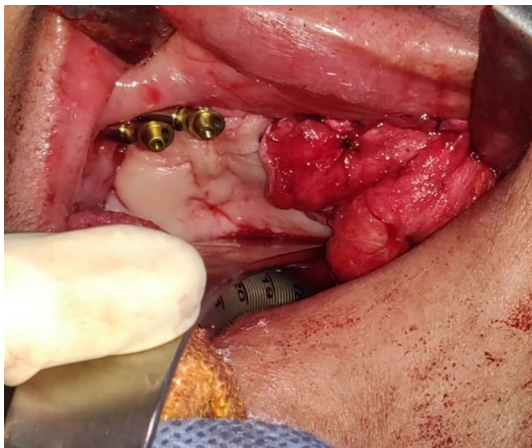


Fig. 7 Intra operative view of quad zygoma and zip flap reconstruction



Fig. 9 Flap healed with quad zygoma exposed

Cast Partial Denture

- Step 1* Primary impression.
- Step 2* Border molding & Secondary Impression.
- Step 3* Jaw relation.
- Step 4* Framework trial and Teeth trial.
- Step 5* Final Prosthesis insertion.

Results

Among the study group, 55% were males, 45% females. Post resection all the patients were treated with L-Amphotericin. Delayed reconstruction was considered for all the patients and was started when they were disease free. Right side defect was more common than left side [Right = 44.4%, left

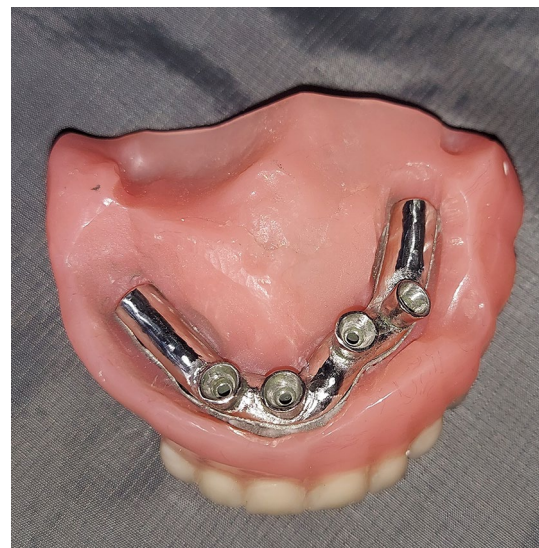


Fig. 10 Scan bodies for digital impression

Table 1 Case series of reconstruction in mucormycosis

Case	Age/sex	Covid H/O	Resection	Reconstruction	Zygo- matic implants	Outcome
1	30/M	Yes	B/L LL maxillectomy	Quad zygomatic implants	4	1Year follow-up, fixed IS prosthesis delivered
2	53/M	Yes	R LL maxillectomy	R Temporalis flap	2	8 months follow-up, IS magnetic prosthesis delivered
3	52/M	No	L LL maxillectomy	L Temporalis flap	2	1 year follow-up,1 implant failed, CPD prosthesis delivered
4	60/F	Yes	R maxillectomy + R OE	R temporalis flap + Temporo-parietal flap(orbit)	-	1 year follow-up, ocular prosthesis and CPD delivered
5	60/F	Yes	L LL maxillectomy	L temporalis flap	-	7 months follow-up, CPD delivered
6	37/M	Yes	R LL maxillectomy	1st- L fibula free flap 2nd-R temporalis flap	3	6 months follow up, FFF failed, 2nd surgery-temporalis + IS magnetic prosthesis delivered
7	45/M	Yes	L LL maxillectomy	L Temporalis Flap	3	8 months follow-up, implants survived, IS magnetic denture
8	48/F	Yes	R LL maxillectomy	Zygomatic implants only	3	IS magnetic denture
9	60/F	yes	B/L LL maxillectomy	L Temporalis flap	4	IS magnet retained denture

R right, L Left, LL Low level, OE Orbital exenteration, CPD cast partial denture, IS Implant supported, FFF Fibula free flap
 Bold values indicates the signifies the patients in whom ZIP-temporalis flap were performed among the case series of CAM

**Fig. 11** Frame work in situ**Fig. 12** Bar with magnetic frame work trial**Fig. 13** Final prosthesis

side = 33.3%] and in 2 cases bilateral maxillectomy was done. 2 patients among the group [22%] had good keratinized mucosa for primary closure post resection. 2 patients received quad zygoma, 1 among them with temporalis flap.

Post resection, 7 of the 9 patients had soft tissue deficiency. ZIP flap was done in 5 patients and in 2 patients only temporalis flap closure for soft tissue defect was done as their zygomatic bone was resected during primary surgery. Of the 5 ZIP flap patients, 1 patient underwent fibula free flap post resection, which failed after 3 weeks and secondarily reconstruction was done with



Fig. 14 a immediate post rehabilitation frontal view. b Immediate post rehabilitation left lateral view. c Immediate post rehabilitation right lateral view



Fig. 15 Post rehabilitation panoramic view

ZIP temporalis flap. 4 of the patients had a primary stability of more than 55 N whereas 1 had a primary stability of 25–30 N.

Postoperative period was accessed for pain, swelling, re-infection, donor site scar, at end of 1 week, 1 month, 3 months and 4 months. Donor site morbidity was minimal, though we had observed 1 implant failure among the ZIP flap series at end of 4 months. 1 patient had failure of fibula flap which was debrided and secondarily temporalis ZIP flap was performed after 2 months.

At the end of 4 months post reconstructions, 4 patients of ZIP flap received Implant supported magnetic denture. 3 patients received Cast partial denture. 1 of the patients with only quad zygomatic implants received a fixed prosthesis. 1 of the patients who underwent only zygomatic implants also received a magnetic retained Implant supported overdenture.

The mean follow-up of all the patients in this CAM patient’s series has been 18–20 months. None of the patients had recurrence of the mucormycosis disease during this



Fig. 16 1 year follow-up

period. The literature reviews in regards to ZIP Temporalis flap in case of mucormycosis specifically are very few, and long-term studies are needed in this regard.

Discussion

Mucormycosis, an angio-invasive fungal disease that is characterized by tissue infarction and necrosis [3], is caused by the fungi belonging to the order Mucorales. Though this disease is distributed globally, its prevalence in India is comparatively higher. Uncontrolled diabetes mellitus is the most common risk factor for its higher prevalence in India [4] as compared to hematological malignancies and solid organ transplant recipients in developed countries [5]. Up until late 2019 in the pre-pandemic era, the estimated prevalence of mucormycosis in India was nearly 70 times higher than the global data [6]. At the end of second wave of the pandemic, the COVID-19-associated mucormycosis (CAM), on a systemic review and observation constituted 0.3% of the co-infections [7].

Aggressive resection in survivors of the CAM leaves them with large facial defects along with functional and aesthetic disfigurement and loss of dentition. Reconstruction and rehabilitation improve their quality of life. Delayed reconstruction is advisable in these patients owing to the high chance of recurrence of disease in CAM. The aim of reconstruction is to provide wound coverage, closure of oronasal fistula, restoration of socially acceptable facial aesthetics of the patient. The need to functionally restore swallowing, nasal breathing, speech and oral nutrition is very important.

Free flaps or microvascular flaps can be advocated for reconstruction of low-level maxillary defects in post tumor resection/trauma. Post covid-patients have COVID-related lung changes/lobectomies and embolic vascular diseases, making them unsuitable for long hours of microvascular surgeries. The angio-invasive nature of the fungus in mucormycosis, has high risk for thrombosis and vascular events [8] making success of free flaps a risky gamble.

Siekaly et al. [9] described an elegant technique to rehabilitate patients with Maxillectomy defects with a vascularised Free Fibula and implant-retained prosthesis. The authors did, however, mention that the final rehabilitation often took 1 year, due to the need for osteotomy healing and soft tissue bulk.

Butterworth et al. [2] were the first group to propose the ZIP flap. Their technique described combined use of Zygomatic implants and a soft tissue microvascular free flap. In them all patients could be rehabilitated early with a prosthesis, a significant advantage of using zygomatic implant anchorage as opposed to the fibula free flap. Two patients however developed venous congestion and required flap exploration and 3 developed fistulae.

According to Navarro-Perea et al. [10], Temporalis muscle flap allows acceptable reconstruction in a single stage without the need of microvascular surgery and provides adequate vascularization in combination with a shorter healing

time than other techniques. Also flexible length of the flap and muscle bulkiness is effective in obliterating the defect cavity. The Temporalis flap heals with good mucosalization in oral cavity by 4 weeks.

As an alternative to microvascular flaps, in our opinion, The ZIP temporalis flap is an excellent option for post covid-mucormycosis patients in the following ways-ease of flap harvest, short surgical procedure, simultaneous Zygomatic implants and predictable outcomes. The use of a temporalis flap results in significant cost and time benefit, as these patients are often not fit for a prolonged surgical procedure. The temporalis flap is a suitable alternative to the microvascular free flap when the soft tissue defect is posterior to the canine.

Conclusion

Survivors of CAM, with maxillary tissue defects have multitude of options for rehabilitation. Case selection, size of tissue defect and the physical condition of these patients post covid, plays pivotal role in selecting the kind of flap. Low level Browns class 2 maxillary defects can be reconstructed with a more simplified ZIP-Temporalis flap which proves to be a good alternative to more complex rehabilitation. However, the limitations of the technique are that it cannot be used for defects of the anterior palate and maxilla, due to limited reach of the flap.

More experiences with rehabilitation in such patients are anticipated in future, which can lead to publication with a larger sample size to compare the successful outcome.

Declarations

Conflict of interest The author of this article has not received any remuneration, speaker honorarium or any research grant from any company or committee whatsoever. The author declares that she does not have any conflicts of interest.

Ethical approval The article was a retrospective study and does not involve any studies involving human participants or animal and did not need an ethical committee approval.

Informed Consent Informed consent was obtained from all the subjects of this study.

References

1. Dr James S, Brown MD (2010) Reconstruction of the maxilla and midface: introducing a new classification. *Lancet Oncol* 11(10):1001–1008
2. Butterworth CJ, Rogers SN (2017) The zygomatic implant perforated [ZIP] flap: a new technique for combined surgical reconstruction and rapid fixed dental rehabilitation following low-level

- maxillectomy. *Int J Implant Dent* 3:37. <https://doi.org/10.1186/s40729-017-0100-8>
3. Frater JL, Hall GS, Procop GW (2001) Histologic features of zygomycosis: emphasis on perineural invasion and fungal morphology. *Arch Pathol Lab Med* 125:375–378
 4. Prakash H, Ghosh AK, Rudramurthy SM, Singh P, Xess I, Savio J, Pamidimukkala U, Jillwin J, Varma S, Das A et al (2019) A prospective multicenter study on mucormycosis in India: epidemiology, diagnosis, and treatment. *Med Mycol* 57:395–402
 5. Kontoyiannis DP, Yang H, Song J, Kelkar SS, Yang X, Azie N, Harrington R, Fan A, Lee E, Spalding JR (2016) Prevalence, clinical and economic burden of mucormycosis-related hospitalisations in the United States: a retrospective study. *BMC Infect Dis* 16:730
 6. Prakash H, Chakrabarti Edward Sionov A (2021) Epidemiology of mucormycosis in India. *Microorganisms* 9(3):523
 7. Jeong W, Keighley C, Wolfe R, Lee WL, Slavin MA, Kong DCM, Chen SCA (2019) The epidemiology and clinical manifestations of mucormycosis: a systematic review and meta-analysis of case reports. *Clin Microbiol Infect* 25:26–34
 8. Alfano C, Chiummariello S, Dessy LA, Bistoni G, Scuderi N (2006) Combined mucormycosis and aspergillosis of the rhinocerebral region. *Vivo Athens Greece* 20(2):311–315
 9. Seikaly H, Idris S, Chuka R, Jeffery C, Dzioba A, Makki F et al (2019) The alberta reconstructive technique: an occlusion-driven and digitally based jaw reconstruction. *Laryngoscope* 129(Suppl 4):S1–S14
 10. Navarro-Perea C, Cañas-Zamarra I, Mencía-Gutiérrez E et al (2019) Rhino-orbito-cerebral mucormycosis: two cases with amaurosis as presentation, medical surgical management and follow-up. *Case Rep Ophthalmol Med* 2019:421598

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