

ORIGINAL ARTICLES

Reliability of Patient Specific Implant for Mandible Reconstruction in Large Lesions: Remotest Effort for Newborn Technology to Replace Microvascular Flaps

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ABSTRACT

This case shares about the outcome of PSI in large sized lesion of the Mandible and Our experience regarding the factors leading to the failure of Patient specific Implants. The Patient was suffering from odontogenic keratocyst, extending from right side angle to left side angle of the mandible. After segmental mandibulectomy, Patient Specific Implant was delivered. Thereafter 1 month, PSI was exposed and got infected. On the next step, we retrieved the PSI and did microvascular free fibula flap for reconstruction of jaw. This paper focuses on the scope of improvement for mandibular reconstruction by Patient Specific Implant.

KEYWORDS

• Segmental Mandibulectomy • Patient Specific Implant • Microvascular free fibula flap • Odontogenic Keratocyst • Mandibular Reconstruction

INTRODUCTION

Mandible is one of the most common site of occurrence for various pathologies like

odontogenic cysts and tumor and comminuted fracture. After Hemimandibulectomy and segmental mandibulectomy, various

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reconstruction procedures become a must for functional and aesthetic purpose. The ultimate goal of reconstruction of severe mandibular defects is to restore the mastication, swallowing and facial contour. Sometimes it also becomes necessary for restoring the Oro-pharyngeal airway anatomy.

Currently few methods used to treat large sized deformities of Mandible include micro-vascular reconstruction, reconstruction plates, transport distraction osteogenesis and autogenous bone grafts. However, all of these techniques have their own short comings.¹

Free fibula flap surgery remains gold standard for mandibular reconstruction, for having some benefits like long vascular pedicle, segmented blood supply for collateral formation, abundant tissue presence, and huge bone volume for further rehabilitation procedure (Lee, 2018; Patel *et al.*, 2019; Toure and Gouet, 2019).²

The procedure of bone graft placement also lengthens the surgical time, causing higher costs, the need for donor site repair and an increased donor and recipient site complication. (Niedhart, 2010; Heinemann *et al.*)¹

CASE REPORT

A 55 year old male patient came to OPD with a complaint of mild swelling and pain on the lower jaw since 1 year. He had no history of chewing tobacco and smoking. He was hypertensive and having amlodipine 5 mg regularly for it. On clinical examination, it had been found that a firm swelling present on the mandible which is extending from right side angle-ramus region of the mandible to left side body-angle interface. There is no palpable lymph nodes were found on cervical region. Mild visible asymmetry of face noted and Mild Cortical expansion of buccal cortex found anteriorly in mandible from Canine to Canine region. (Fig. 1 a & b)



Fig. 1 a & b: Pre-Op photograph of patient

On OPG, it showed that there was a lesion of 13 cm x 3.5 cm x 2.8 cm residing on the mandible which was radiolucent with well defined border by nature. It has scalloped bone loss margin along with lesser degree of root resorption of the adjacent teeth. (Fig. 2) The radiographic extent of the lesion confirmed

the range of lesion from right side angle ramus region (below 4.5 cm to the sigmoid notch) to the left side body of the mandible (Upto distal to the root of Second Premolar). Thinning of the lower border was observed in several places, where the length of the lower border was less than 1 cm. (Fig 3a)



Fig. 2: Pre-Op OPG

An Incisional bone biopsy had been planned, which histopathologically depicted the lesion to be Odontogenic Keratocyst. In terms of recurrence, OKC had higher potency to come back, so proper resection with normal tissue barrier had been considered for treatment planning. As it was a large sized lesion, reconstruction became tricky job to be done. Moreover, patient did not give his consent for

another site of surgery for free fibula flap. In this situation, Patient specific implant arose as the suitable alternative option. A Contrast CT scan of face had been advised for 1mm cut for achieving better precision of the PSI. Design was made through virtual planning and specifications of Titanium screws for osteosynthesis was also guided by the surgeon. (Fig. 3a,b,c & d)

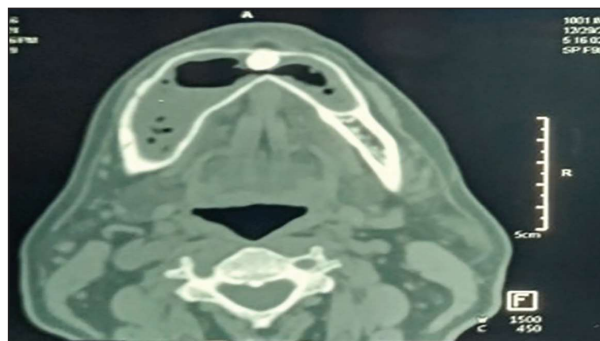


Fig. 3a: Pre-Op CT Scan

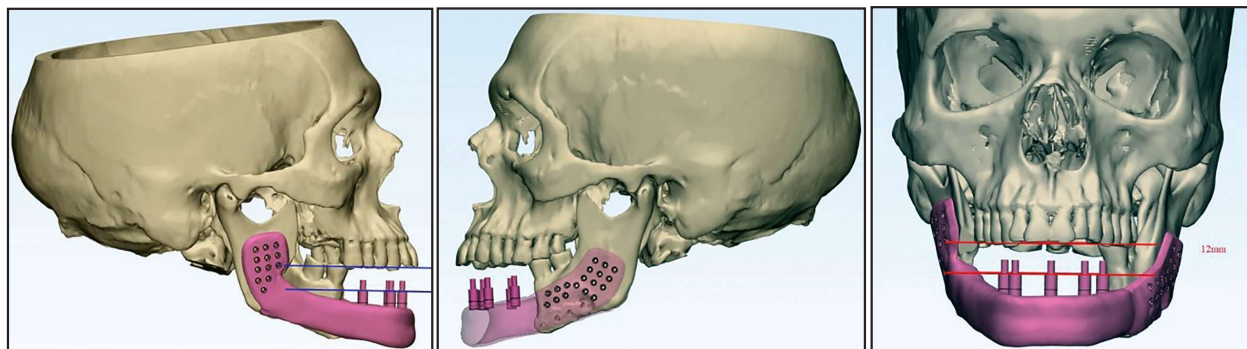


Fig. 3b, c & d: 3D Virtual Planning of Surgery & PSI designing

Extraoral Visor incision placed on neck to approach upto the mandible. Segmental Mandibulectomy was done from right side angle to left side angle of mandible along with Periosteum as there was perforation present at multiple points. The mandibular

PSI was placed and the intraoral wound was sutured by 2-0 silk and the extraoral wound was sutured on two layers with 3-0 Vicryl and 3-0 Prolene suture. An appreciable result was achieved through Patient specific implant placement. (Fig. 4a, 4b, 4c & 4d)

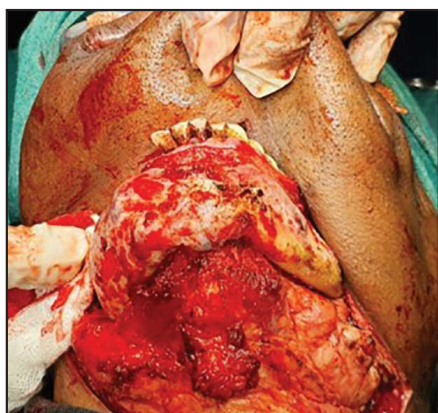


Fig. 4a: Surgical exposure of the tumor



Fig. 4b: Segemental Mandibulectomy of Primary tumor

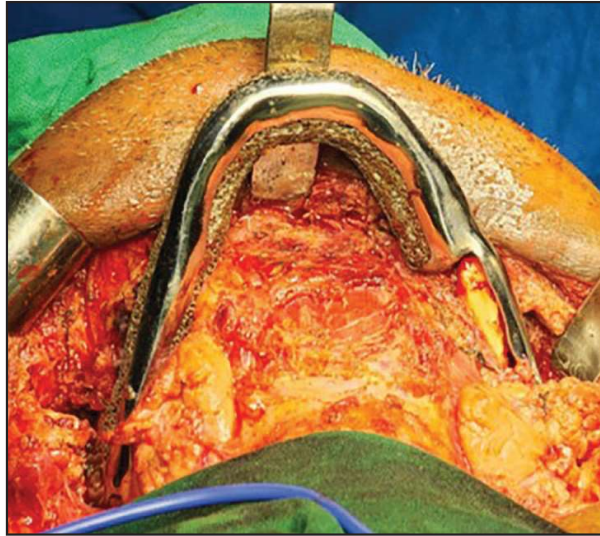


Fig. 4c: PSI placement

After 1 month of surgery, patient complaints about pain and swelling in the submental region, along with discharge from chin skin. When he was recalled for follow up, on clinical examination we found there was a site of Metal surface exposure and extraoral exposure of the PSI with discharge. (Fig. 5) Then the patient was prepared for Re-exploration and



Fig. 4d: Post-Op photograph after PSI placement

planned for Free fibula flap placement. Colour Doppler angiography was advised for left leg to check the viability for flap. The anastomosis of the free fibula was done with Superior thyroid artery and External jugular vein. The OsteoMyocutaneous Free Fibula flap was fixed with 2-0 system Ti Miniplates with residual bone. (Fig 6 & 7).



Fig. 5: Exposure of PSI

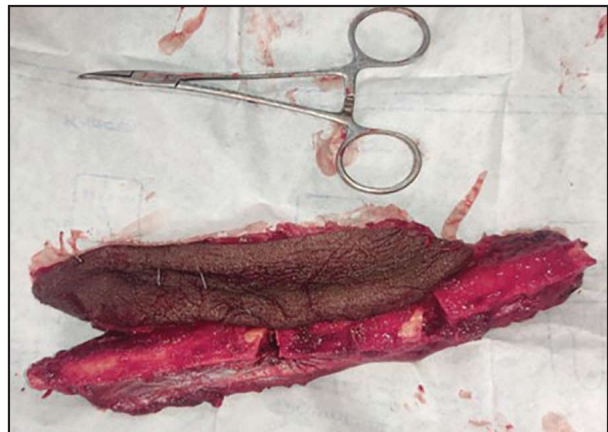


Fig. 6: Free Fibula Flap Harvesting Technique



Fig. 7: Re-shaping of Fibula as Mandible



Fig. 8a: Post-Op 1 Year



Fig. 8b and 8c: Post OP 1 Year Profile Photograph



Fig. 8d: Post-Op 1 year OPG

Post-operative 1st year follow up after free fibula placement, Patient is doing well and TMJ and Jaw movements and other functions are all in normal range. (Fig. 8a, 8b, 8c & 8d)

DISCUSSION

During planning for PSI there are few rooms to improvise the scenario, those are be like

1. Decreasing surface defects contributes to not only lowering the crack initiation potential on the implant surface but also decreasing the intruding of biological fluids containing Ca, P, O and H through

surface/subsurface defects.³

2. The increased porosity presumably leads to a lower implant stiffness, which is beneficial for reducing stress shielding.⁴
3. Substituting the titanium properties in the finite element analysis with PCL properties for both designs revealed that the stress was beyond the strength limits of PCL.⁵

But till date microvascular reconstruction procedure comes up as better technique to rehabilitate larger defects over this new venture because of,

1. In direct contact between the implant and the bone tissue, the implant with its increased mechanical robustness takes a higher share of the load. In contrast, the surrounding bone tissue is often underloaded and will degrade according to Wolff's law. This can lead to unwanted loosening or even to migration of the implant.
2. Mirroring is not possible if both sides of the mandible are affected. For example, the mirroring technique is not applicable to central defects or lesions that cross the midline. Moreover, the presence of asymmetry in the mandibular body, rami, and condyles may hamper the accurate reconstruction of the resected areas.
3. The most probable reasons for the misfit of the PSIs are related to the placement of the condylar segment and unidentified bony interferences at the osteotomy site.⁶
4. Stress cannot be transferred to the neo-mandible, and the stimulus for maintaining bone mass and preventing disuse atrophy and osteoporosis is reduced. This may also provoke non-union.⁷
5. Stress concentration is a leading cause of failure in any endoprosthesis hardware used. Stress beyond the limits of the strength of a material would result in a fracture.⁵

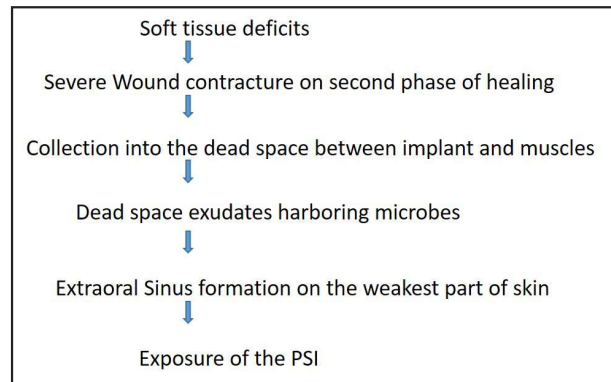
Usually in other studies it has been stated, Intraoral wound dehiscence and breakdown that started within the first 3 weeks after the surgery. The areas of tissue breakdown reached a maximum of 2-6 cm.⁸

Attempts to use modular endoprostheses for mandibular reconstruction faced many problems that can be traced back to two main factors: the scarcity of soft tissue coverage and the concept of "modularity" where screws connecting different parts of a prosthesis can experience loosening under cyclic loading.⁸

The fact that any metallic device was only separated from the oral cavity by a single layer of mucosa was the main reason behind the reported dehiscence. This was particularly true in our case series where all cases that experienced wound breakdown were those bounded cases especially that crossed over the midline. This area suffers particularly thin mucosal coverage and high pull due to the attached muscles. More posterior defects

benefited from a thicker tissue bed particularly because of the masseter and medial pterygoid muscles as well as less downward muscle pull.⁸

We have gone through our case very thoroughly to know the phenomenon of failure, which may be explained in such best possible way in the following flowchart graph 1.



Graph 1: Flowchart of PSI failure phenomenon

After going through all the present evidences and our experience from the above mentioned case and other surgeons experience, it is better to summarize that incorporation of few features can improvise the future of PSI.

1. Avoid large size reconstruction with PSI.
2. In case of Central lesions, still now questionable.
3. Avoid any kind of rough surface/ lattice design.
4. Lighter will be the PSI, More chances to withstand.
5. Avoid PSI in Re-do Cases.
6. In case of Body defects, PEEK with Ti Miniplate osteosynthesis is more advisable.
7. PSI 3d Mandible is better than PS recon plates to use at Peripheral defects (Size <5 cm).
8. Never Distort Periosteum while delivering PSI, as it acts as a metabolic barrier.
9. Its better to pre consider the situation of wound contracture and design the PSI accordingly.

CONCLUSION

Reconstruction is a tedious job as it needs more

precision along with utmost hard and soft tissue handling. Bypassing the step-ladder of reconstruction will also be a time taking issue. Any technology like Patient Specific Implant, should also be judged by large sample clinical trial studies. Still now no study have shown any long term follow up of Patient specific Implant. Patient Specific Implant is still a nascent technology to apply for reconstruction of larger defects, more investment of time in it's study is advisable.

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