A novel method of 3D PSI mandibular reconstruction- a case report

Dr. G. Muralidharan[1], Dr. M. Jeevitha[2], Dr. G. Govindaraj[3]

[1]Department of Oral and Maxillofacial Surgery, Best Dental Science College and Hospital, Madurai

[2]Department of Periodontics, Saveetha Dental College and Hospitals, Chennai

[3]Managing Director, Harshamitra Super Speciality Cancer Centre & Research Institute.

[1a]**Corresponding author:** M. Jeevitha, Department of Periodontics, Saveetha Dental College and Hospitals, Chennai- 77, Mail id: jeevitham.sdc@saveetha.com

Abstract

Background:

The surgical repair and reconstruction of defects in the craniomaxillofacial region can be a cumbersome procedure because of complex anatomy, sensitivity of the involved systems, and uniqueness of each defect. High level precisions are attempted in reconstructing the defect for enhancing patient outcomes and well-being. Autogenous grafts that are widely preferred for reconstruction are many times associated with an unpredictable resorption and donor site morbidity. The introduction of 3-dimensional printing in the biomedical field has led to the utilization of patient-specific implants (PSI) in the surgical repair of maxillofacial defects especially in resection cases. PSI not only fit quickly with greater accuracy but also with added benefit of shorter rehabilitation time.

Materials and Methods:

A 27-year-old male with a history of pain and swelling in right mandibular region for past 1 year He underwent PSI guided surgical resection and followed by PSI(titanium) reconstruction of the right hemimandiblar region sparing condyle for articulation

Results: Good esthetic results with no postoperative complications are obtained.

Conclusion: PSI should be considered as one of the novel alternative methods for oral and craniomaxillofacial defects for higher precision and aesthetic outcomes. The major drawback of PSI is its high cost, but many advantages of using PSI outweigh this disadvantage.

Keywords: Patient-specific implants, titanium implants, 3D printing.

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Introduction

Osteous free flaps are considered to be the gold standard surgical approach for the reconstruction of most of the mandibular defects. The main bone sources for mandible include the fibula, scapula and iliac crest [1]. The most commonly used technique for mandibular reconstruction is the pedicled / distant osteocutanious flaps with a titanium Reconplate [2]. Although this method offers good facial results it has its own complications like plate exposure, flap rejections, infections and donar site morbidity etc [3–5]. Recently, three-dimensional (3D) patient specific titanium implants(PSI) have been used for mandibular reconstructions, which offer an alternative surgical options for those patients who concerned about second surgery or donar site morbidity. various alloplastic materials such as silastic sheets and blocks, Polymethylmethacrylate (PMMA), or polyether ether ketone have been used in 3d reconstruction [16]. A High medical grade titanium are also used in 3d printing craniofacial defects which are considered to be more biocompatible comparing all the other 3d printing materials. This paper is a case report of unicystic recurrent ameloblaostoma in which aurgical hemimandibular resection with help of preformed surgical guides with PEEK and reconstructing the same with novel CAD CAM patient specific titanium implants.

Case Report

A 28-year-old Male presented recurrent ameloblastoma in right posterior mandibular region. O/E intra oral swelling present in rt buccal vestibular region extending from 43 till retromolar region . radiologically the multiloculor combined lesion extends anteroposteriorly from 43 till ramus region in rt side of the mandible which has histopathologically confirmed as unicystic ameloblastoma through insicional biopsy.

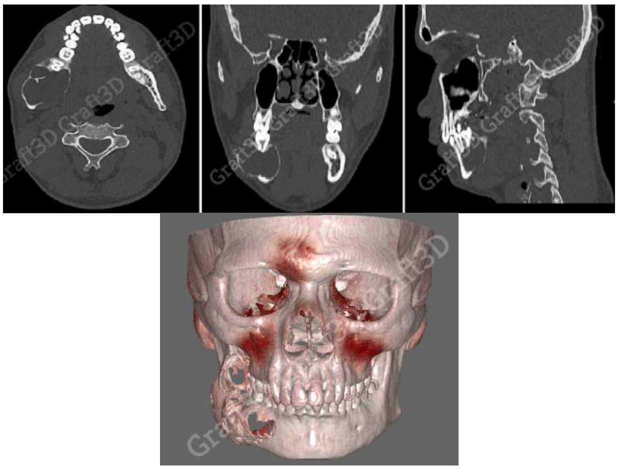

Figure - 1

Conversion of CBCT to 3D file for detailed diagnosis of the lesion

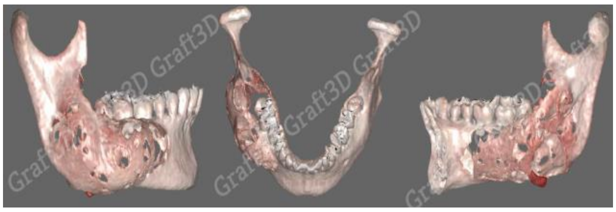

Figure -2

Preoperative 3D files of the mandible. Typical ameloblastoma (unicyctic) feature reported on right side of the mandible

Segmental resection has been planned extending from 42 to till neck of the condyle with additional 10mm adjacent anatomical normal bone region from the radiological margins for attaining histopathological clearance through '3D virtual planning'. This virtual planning reduces intraoperative timing to a great extent .

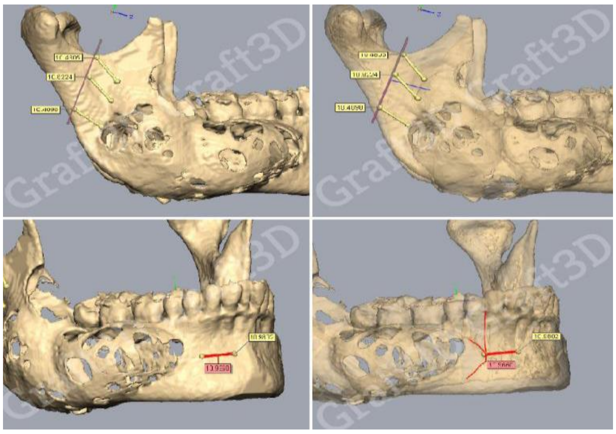

Figure -3; Preoperative cutting level marking in virtual 3D planning

Fig 4.a

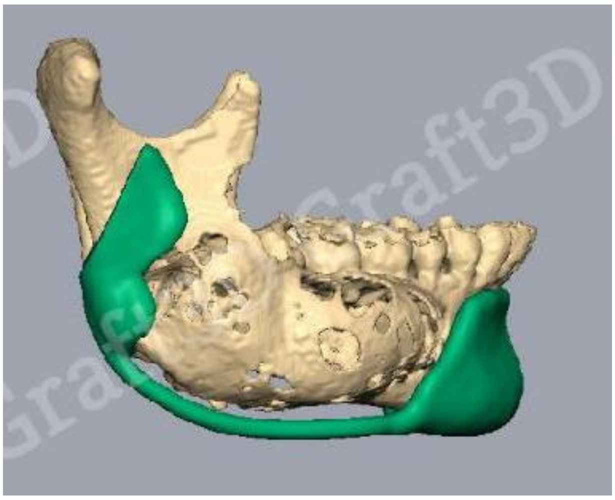

Fig 4.b

Figure -4: Region of excision is demarcated in green shades followed by cutting guide designing is performed using Geomagic Freeform haptic device , Fig.b shows Surgical Cutting Guide

Virtual surgical planning and 3D printing facilitated level of resection and near normal anatomical reconstruction in surgical treatment with the help of D2P and Geomagic freeform software and haptic devic.

Prior to the surgery patient specific titanium implants (PSI) are designed by mirroring the existing left mandibular region. 3D printing design is finalized and datas are feeded in for 3D titanium printer device . figure 5

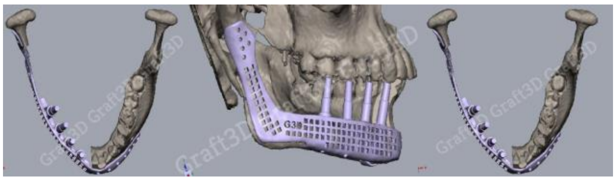

Figure – 5 PSI designed and positioned in resected region virtually

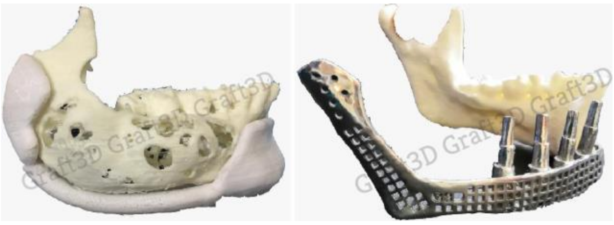

Fig – 6.a Fig – 6.b

Figure -6 fig(a) shows 3D printed resection guide in STL MODEL and fig(b)shows 3D printed patient specific titanium implants along with abutment for hybrid prosthesis checked with STL model again

Figure 7 shows intra operative resection with a help of 3D printed surgical guide , the second images shows the accurate resected segment along with the guide

Figure 8 shows securing the 3D printed PSI with 2.5 *10 mm screws in the symphysial region and remaining condylar region , tmj movements ,and occlusion checked. closure done with 3,0 vicryl with skin staples .

Under G.A Naso tracheal intubation done . insicion made from midline of the chin to mastoid process. platysmal flap elevated, layer by layer dissection done, marginal mandibular branch has been identified and preserved , resectable site exposed , resection done from 42 to till neck of the condyle with help of 3D printed guide and PSI fixed as per 3D virtual planning with 2.5*10 mm screws in their respected planned regions. Sufficient haemostasis achieved , Drain placed ,layer by layer closure done with 3,o vicryl , and skin closed with staples .

DISCUSSION

This case presents a hemimandibular reconstruction utilizing 3D PSI . The 3D virtual planning allows precise resection of the lesion with the help of the surgical cutting guides. This method of reconstruction simulate the original anatomy after resection in that particular site which is more esthetically accepted than the traditional recon plate [3]. additionally, the porous PSI permits the tissue ingrowth from the adjacent tissues for improved integration [6]. Interestingly, its mechanical strength is apparently similar to cortical bone [7, 8]. To our knowledge, only a few papers have presented 3D porous PSI for mandibular reconstructions; additionally, follow-ups are not more than 2 years. Qassemyar et al. [3] documented two cases demanding reconstruction of the mandibular body, with bone-free flap contraindicated individuals . Those patients had a history of ameloblastoma and squamous cell carcinoma. Touré and Gouet [5] managed a patient with a massive recurrence of ameloblastoma of the right hemimandible with a period of 18 months follow up and was treated with an implant-supported prosthesis. Rachmiel et al. [9] described a case of a patient with a large ramal defects with one-year follow-up . Lee et al. [10] presented a case with a history of squamous cell carcinoma on the left floor of the mouth with 14 months follow-up. In contrast to the present case that was followed during four years, those cases were followed in the course of less than one and a half years; however, one of the difficulties of 3D PSI is that the long-term tolerance is not documented , but it can be considered that the quality of tolerence undoubtedly will not be inferior to that of traditional plates [3, 11]. all though the alloplastic graft used in this case was 3D CAD/CAM porous titanium, these mechanics do not remove the probability of exposure; therefore, it is essential to monitor patient's tissues and, most importantly, evade the symphysis area [3, 11, 12,16]. The present case, together with the cases previously described by Qassemyar et al. [3] and Touré and Gouet [5], has used dental implants. The different advantages presented by this kind of 3D PSI for complete reconstructions together with dental implants are relevant [3, 5, 13, 14]. Constant follow ups are needed for these kind of procedures [5, 13, 15,16]. The 3D PSI are considered to have favorable postoperative esthetic outcome, quick and predictable novel alternative choice of method especially for bony anatomical reconstructions .

Conclusion

This paper shows the new possibilities for complex geometries and mass customisation of parts, one such part of PSI is 3D printed using this technique as a reconstructive component. 3D printing demands high need in medical field because of its accuracy post operatively . Form Function and Aesthetics planned prior to surgery is achieved during and after the surgery . so this novel method of 3D PSI can be considered in oral and craniofacial resection as well as for reconstruction.

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