Case Report

Explicit Collaboration Of Stereolithography And Osseointegration For Prosthetic Rehabilitation Of Total Maxillectomy; Case Report

Chippalapally Arun Kumar[1*], Nithisha Brahmandabheri[2], Kasarla Himaja[3], Uma Devi Rapolu[4]

[1]Senior lecturer, Department of Prosthodontics And Crown & Bridge, Mamata Dental College, Khammam, Telangana, India

[2]Senior Consultant, Department of Prosthodontics and Crown & Bridge, Pragathi Nagar, Hyderabad, Telangana

[3]Senior lecturer, Department of Prosthodontics and Crown & Bridge,Tirmula Institute of Dental Sciences & Research centre, Dichpally, Nizambad, Telangana, India

[4]Senior Consultant, Department of Prosthodontics and Crown & Bridge, Nalgonda, Telangana, India

Received: 20-10-2021 / Revised: 01-12-2021 / Accepted: 23-12-2021

Abstract

Background: Chronic idiopathic pain syndromes are amongst the most challenging and demanding conditions to treat across the whole age spectrum. Despite these patients having undergone numerous diagnostic work ups, their pain remains a challenge to all known diagnostic and treatment methods.**Objectives**: To study the efficacy of diagnostic laparoscopy in identifying the etiology of undiagnosed chronic abdominal pain. **Materials and methods**: Thirty two patients with chronic pain abdomen were included in this study. The pain in all these patients was either of unclear etiology or not responding to the treatment given after clinical assessment and lasting for more than 3 months duration. Pain of shorter duration and patients less than 15 years of age were excluded from the study. All patients were subjected to diagnostic laparoscopy and procedure. The results were tabulated and analyzed.**Results**: Females were more affected by this condition and the most common site of pain being the periumbilical region. A definitive diagnosis was made per operatively in 28 patients (87.50%) while in the remaining four (12.50%), no obvious pathology was detected. The most common findings in our study was recurrent appendictis (62.5%), followed by post operative adhesions (12.5%), gall stones(6.25%) ,tubo ovarian pathology (3.12%) and abdominal TB (3.12%). Pain assessment done at 1 month follow up showed pain relief in 84.6% and 3 month follow up showed pain relief in 87.5% of patients.**Conclusion**: Recurrent appendicitis form a majority of cause for causing chronic pain abdomen.Diagnostic laparoscopy is a safe and effective modality for the diagnostic and therapeutic management of such patients.

Keywords: laparoscopy, appendicitis, abdominal pain, adhesions, laparotomy

Introduction

Reconstruction of the maxillary defect remains a considerable challenge because the 3 dimensional architecture of the mid face serves both functional and aesthetic roles. The ideal goals are to maintain a patent nasal airway and oronasal separation creating a sufficient platform for mastication, speech quality, and potential dental rehabilitation to restore an adequate and symmetric facial contour.[1]The development of Rapid Prototyping(RP) systems has led to the creation of complex customized three dimensional anatomic models with Computer Numeric Controlled milling machine. RP methodologies use an additive process of building an object in layers defined by a computer model that has been virtually sliced. This allows for the production of complex shapes with internal detail and undercut areas. One such method is Stereolithography (SL), which produces three dimensional objects by curing a liquid resin under a computer guided laser.[2]

**Correspondence*

Dr. Chippalapally Arun Kumar

Senior lecturer, Department of Prosthodontics And Crown & Bridge, Mamata Dental College, Khammam, Telangana, India

E-mail: arun8763@gmail.com

Stereolithographic 3-D models are utilized for maxillofacial reconstruction, trauma surgery, pathology induced defects, tissue engineering,complex TMJ reconstruction,complicated facial asymmetry,surgical guides and templates, design soft tissue incisions, assess bony defects for grafting, adaptation and pre-bending of reconstruction plates, and fabrication of custom prostheses.[3] Osseointegrated implants provide the most reliable retention for dental prostheses. Endosseous implant supported prostheses have been reported for bilateral maxillectomies.[4]The present case represents total maxillectomy which is Cordeirotype IIIA defect[5]and hence needed rehabilitation and thus a multidisciplinary approach was made wherein Stereolithographic models were used as templates for the reconstruction.

Case Report

A 65 year old male patient reported to our institution with a chief complaint of defect in the upper jaw since 3 years along with difficulty to eat, speech and aesthetics. Patient's medical history revealed diabetes, hypertension and asthma for which he has been taking medication. Past surgical history revealed that the patient underwent craniectomy for frontal sinus infection 18 months back. Past dental history revealed that the patient was operated for osteomyelitis of maxilla 3 years back and underwent a total maxillectomy. The clinical examination revealed total palatectomy with orbital floor being intact. The defect was totally mucosa supported and no bony undercuts were present for anchorage [Figure1].

The treatment plan was to have an interdisciplinary approach and to restore oral function and aesthetics as soon as possible. The following case has been done after obtaining the approval from institutional ethical committee. The primary task in the treatment was the fabrication of stereolithographic model of the maxilla followed by reconstruction with a titanium clip on denture.At first stereolithographic 3-dimensional prototypedphysical models of the skull, maxilla and mandible were fabricated which is as follows. Initially, patient's skull, maxilla and mandible DICOM (Digital Imaging and Communication in Medicine) images were collected, Using MIMICS software, 3D SL models were obtained from DICOM images. This SL file was sent into Mojo 3D printer (Stratasys, USA) to manufacture the physical model simulating the patient's anatomy. This process of obtaining the physical model/ RP model was through Fused Deposition Modelling (FDM) process [Figure 2]. Using the models an acrylic framework was fabricated using which try in was done [Figure 3]. Eventually a titanium clip-on denture along with titanium screws were fabricated and reconstruction of the maxillary defect was done as follows [Figure 4]. The surgical procedure was done under general anesthesia with aseptic precautions. An incision was made from distal of zygomatic buttress on right side to the distal of zygomatic buttress on left side along the maxillary arch without involving the midline. A full thickness mucosal flap has been reflected and the titanium clip-on prosthesis placed into the surgical site. Fixation of the this titanium plate is done with the help of six 2.5×8mm titanium screws with two each on both zygomatic buttress and one near canine buttress on each side. After obtaining adequate hemostasis, surgical sutures were placed [Figure 5A & 5B]. Patient was recalled after one week, and a 24 and 50 day follow up has been done for evaluation and orthopantomogram (OPG) was taken to check for osseointegration [Figure 6A & 6B]. There were no signs of mobility of the prosthesis, tenderness or infections seen. After 3 months, patient was recalled for prosthesis.

Using the stereolithographic models a maxillary impression was made using a metal stock tray and an irreversible hydrocolloid impression material (Jeltrate Type II; Dentsply, Milford, Del). The impression was poured in ADA Type V dental stone ((Die Keen; Bayer Corp, South Bend, Ind). Autopolymerizing acrylic resin (Lucitone 199 Repair Material; Dentsply Intl, York, Pa) was used to make the record base on which the occlusal rim was made using baseplate wax (Modern No. 3 pink wax; Jelenko Co, Armonk, NY) and jaw relations were recorded[Figure 7A, 7B, 7C &7D]. Teeth arrangement was done followed by try in. An interim prosthesis was made with vacuum pressed thermoplastic material. Final prosthesis was made in heat-polymerized acrylic resin (Lucitone 199;Dentsply Intl) [Figure 8A, 8B, 8C &8D].The main mechanism of retention of denture would be by mechanical method through titanium framework underneath and physiologically through surface tension. Upon postoperative follow-up, the patient was completely satisfied with the denture, his speech has improved a lot with decreased resonance and his quality of life has been improved.

Fig 1: Intraoral defect

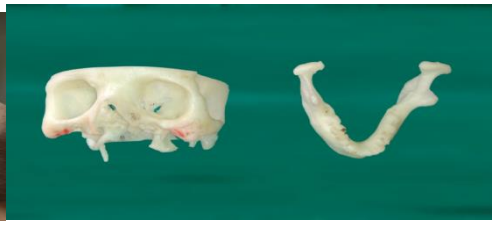

Fig 2: Stereolithographic models

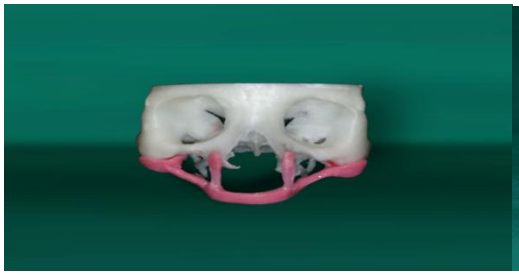

Fig 3: Acrylic framework on stereolithographic model

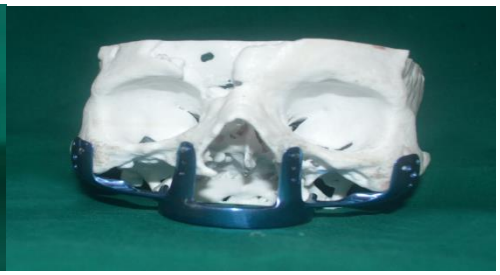

Fig 4: Fabrication of titanium clip on denture

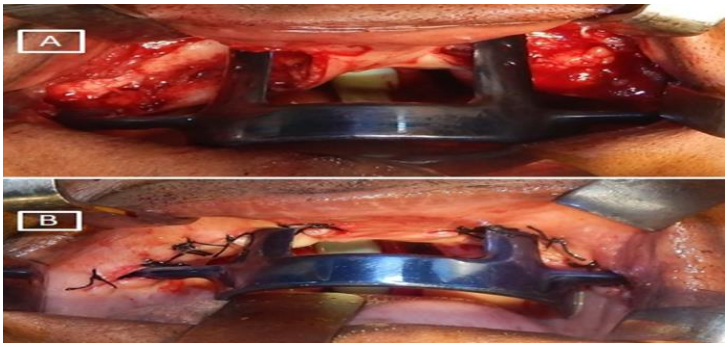

Fig 5: Intraoperative picture showing the reconstruction procedure using titanium framework.

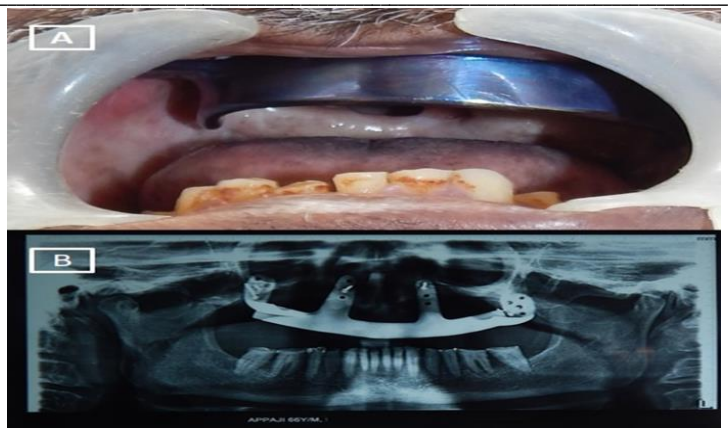

Fig 6: 6A: Postoperative intraoral picture of the titanium prosthesis (2 months follow-up)
6B: Postoperative OPG for evaluation of the titanium clip on denture (2 months follow-up)

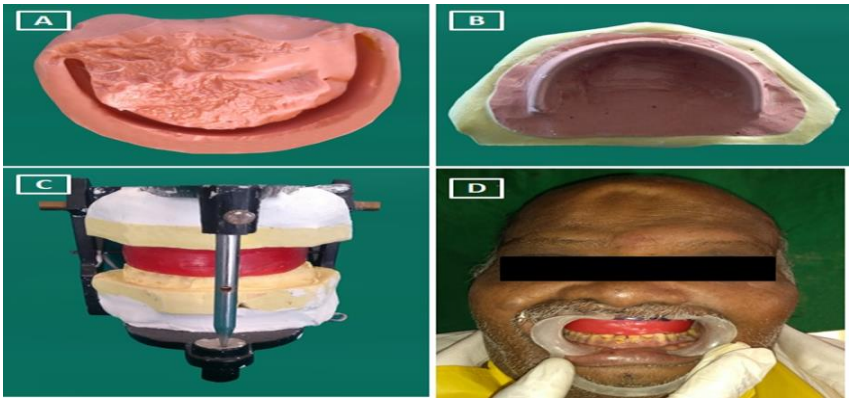

Fig 7: 7A- Irreversible hydrocolloid impression; 7B- Dental cast; 7C- Occlusal rims fabrication; 7D- Jaw relations recorded.

Fig 8: 8A-Teeth arrangement and try in; 8B- Vacuum pressed thermoplastic material interim prosthesis; 8C & 8D - Final prosthesis.

Discussion

In the past, prosthetic obturation was the only reconstruction option for maxillectomy cases allowing immediate dental restoration without further surgery, but it had problems such as instability, poor retention, oronasal incompetence, discomfort of wearing a prosthesis, the inconvenience of removing and cleaning the prosthesis, inability to successfully retain a prosthesis when the defect is large or when dentition is lacking, and the frequent need for readjustments by a prosthodontist.[6] The advent of microsurgery has permitted primary, single-stage reconstruction of these complex facial defects.[7] Because maxillectomy is an uncommon surgical resection, very limited evidence exists regarding the best reconstructive procedure. As a result, controversy remains as to selecting the optimal method of reconstruction, and rehabilitation.

In the present case, a postmaxillectomy defect with an oro nasal communication was corrected using titanium clip on denture prosthesis with the help of a stereolithographic model. Research about Stereolithography (SL) for 3D applications in diagnoses began in early 1980s, when Hebert, Kodama and Hull worked on the concept of rapid prototyping of 3D objects using light cured resin and laser light. Hull developed a system for automatic fabrication of detailed acrylic models calling the process “Stereolithography”. The first stereolithographic apparatus (SLA) was introduced at the Autofact show in Detroit, Michigan in November 1987.This SLA has widened prosthodontics applications like implant prosthesis, fixed

dental prosthesis and complete dentures.[8, 9]Stereolithographic apparatus (SLA) consists of a container filled with liquid resin (acrylic or epoxy), a movable elevator platform inside the container, an ultraviolet laser with beam focusing optics on the top and a deflecting mirror system to control the laser beam.[10]The methodology of stereolithography in process has been detailed after analysis of various case studies. The various steps involved in the process includes; acquisition of medical data using digital imaging like CT/MRI, creation of a 3D CAD data, manufacturing of an medical model, preplanning of surgery on the medical model, followed by actual surgery. [11] The CAD model of the anatomical part to be created is cut into a series of two-dimensional slices and this data is used to control a laser beam which draws each slice of the model into a resin model. The photosensitive resin is instantaneously cured to a solid where the laser beam strikes. [12]

Barker et al. conducted a study to determine the dimensional accuracy of anatomical replicas derived from X-ray 3D computed tomography (CT) images and models which are produced using the rapid prototyping technique of stereolithography (SLA) of a dry bone skull. They found a mean difference of 0.85 mm, with accuracy ranging 97.7–99.12% between the dry bone skull and its geometric phantom and concluded stating that SLA models are accepted for clinical use.[13]Likewise Choi et al. performed a similar study on analysing the errors in medical rapid prototyping models and reported that they found a small error percentage of 0.56%, which was deemed acceptable for clinical use.[14] Mehra et al. in their study on various case reports to assess the feasibility of the use of 3-dimensional (3-D) stereolithographic (SLA) technology in complex maxillofacial reconstructive surgeries concluded that Stereolithographic models can be used for complete facial reconstruction, trauma surgery, correction of post-traumatic defects, mandibular tumour surgery, mandibular augmentation and for TMJ reconstruction.[3]Osseointegrated implants provide best retention for dental prostheses. The physical extension of the implant-supported denture base is not as crucial in gaining retention and stability. Endosseous implant-supported prostheses have been reported for bilateral maxillectomies.[15] Use of endosseous implants is based on viable bone capable of remodelling and turnover. Identifying an adequate residual bone bed for endosseous implant placement may be difficult for patients with a bilateral maxillectomy. Suboptimal implant angulation and compromised access for prosthodontic procedure and routine maintenance also limit the application of endosseous implants in bilateral maxillary resection defects.[16]

Earlier, a maxillofacial surgery and prosthesis were planned using 2-Dimensional (2D) data like radiography and photographs, which limits the appreciation of movement of bone structures, exact dimensions of the anatomical structure and the extent of disease. Due to these reasons reconstruction of a surgical template would be inaccurate. So, usage of SLA for preplanning a surgery and its usage in making an accurate prototype model of anatomic part for reconstruction of the structures helps in providing a benefit both for the practitioner and patient satisfaction. Other benefits of 3D SLA models include: direct visualization of anatomic structures, surgical guides/templates, designing incisions, surgical resections, and assessment of bony defects for grafting, adaptation/pre O bending of reconstruction plates, fabrication of custom prostheses, wound exposure duration, more predictable results and as an educational tool for patients.[3]The present case represents a type IIIA defect according to the Cordeiro and Santamaria maxillary defect classification. [5] In the present case, since the maxillary defect was totally mucosa supported and there was lack of undercuts for anchorage. Present case is the first of its kind wherein Stereolithographic models were used as templates for prosthetic rehabilitation and a titanium clip on denture was fabricated while osseointegration was achieved. After various above mentioned lab procedures final prosthesis was delivered and patient satisfaction was achieved.

Conclusion

SLA models have an important role in contemporary oral and maxillofacial surgery. As illustrated in the above mentioned case, they can be utilized in a variety of ways in the surgical arena. They are a useful tool to assess traumatic and pathologic defects requiring complicated surgery and reconstruction.

Conflict of Interest: Nil
Source of support:Nil

References

1. Santamaria E, Cordeiro PG. Reconstruction of maxillectomy and mid facial defects with free tissue transfer. J Surg Oncol. 2006; 94(6):522–531.
2. Xu F,Loh TH. Toward generic models for comparative evaluation and process selection in rapid prototyping and manufacturing. J Manuf Syst. 2000; 19:283-96.
3. Mehra P, Miner J, Innocenzo RD, Nadershah M. Use of 3-D Stereolithographic Models in Oral and Maxillofacial Surgery J. Maxillofac. Oral Surg. 2011; 10(1):6–13
4. Kabcenell ,Kraut R. Restoration of a total maxillectomy patient using endosseous implants. Int J Prosthodont. 1992; 5:179-83.
5. Cordeiro PG, Santamaria E. A classification system and algorithm for reconstruction of maxillectomy and midfacial defects. Plast Reconstr Surg. 2000; 105:2331-46.
6. Rogers SN, Lowe D, McNally D, Brown JS, Vaughan ED. Health-related quality of life after maxillectomy: a comparison between prosthetic obturation and free flap. J Oral Maxillofac Surg. 2003; 61(2):174 –181.
7. Rosenthal E, Carroll W, Dobbs M, Scott Magnuson J, Wax M, Peters G. Simplifying head and neck microvascular reconstruction. Head Neck. 2004; 26(11):930–936.
8. Cunningham L, Madsen M, Peterson G. Stereolithographic modeling technology applied to tumor resection. J Oral Maxillofac Surg. 2005; 63:873–878.
9. Chander N G. An overview on 3D printing in prosthodontics. J Indian Prosthodont Soc. 2020; 20:121-2.
10. Joshi MD, Dange SP, Khalikar AN. Rapid prototyping technology in maxillofacial prosthodontics: Basics and applications. J Indian Prosthodon Soc. 2006; 6(4):175-8.
11. Malyala SK,Kumar YR, Alwala A. Manufacturing of Patient specific AM medical models for Complex Surgeries. Materials Today: Proceedings. 2017; 4(2):1134-9.
12. Bhat AM. Recent advances in the modelling of extraoral defects. J Indian Prosthodon Soc. 2005; 5(4):180.
13. Barker TM,Lisle DA. Accuracy of stereolithographic models for human anatomy. Australas Radiol. 1994; 38:106
14. Choi JY, Choi JH, Kim NK et al. Analysis of errors in medical rapid prototyping models. Int J Oral Maxillofac Surg. 2002; 31(1):23-32.
15. Kabcenell J, Silken D, Kraut R. Restoration of a total maxillectomy patient using endosseous implants. Int J Prosthodont. 1992; 5:179-83.
16. Lorant JA, Roumanas E, Nishimura R, Beumer J third, Wagman LD. Restoration of oral function after maxillectomy with osseous integrated implants retained maxillary obturators. Am J Surg. 1994; 168:412-4