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Assessment and Treatment Planning in Maxillofacial Surgery by using Additive Manufacturing Technology

Santosh Kumar malyala^a, Ravi Kumar Y^a, Lavanya Kankanala^b, Praveen vasamsetty^c,
Adityamohan Alwala^c,

^aDepartment of Mechanical Engineering, National Institute of Technology Warangal, Warangal, Telangana, India.

^b private dental practitioner - karimnagar, India.

^cDepartment of oral & maxillofacial surgery, Panineeya Institute of Dental Science & Research Center, Hyderabad, Telangana, India

Abstract

Additive Manufacturing is one of the latest technology, which provides the physical models uniquely as per the requirement. Medical industry is most benefitted one with help of AM Technology and healthcare continue to be deeply-intertwined in the modern era of healthcare. It increases the ease of performing many complex surgeries, improving the care and patient outcomes. The management of many common disease processes and seek cost effective measures while maintaining the quality of patient care. AM is one such mode which has become the third eye to the surgeon. This technology is widely used for two main purposes like diagnostic and treatment. This paper mainly focuses on highlighting the use on additive manufacturing in treatment planning in the field of maxillofacial surgeries with help of various case studies. The importance of AM model is explained for each case in detail.

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Corresponding author. Tel.: +91-9963343361;
E-mail address: msantoshpdd@gmail.com.

1. Introduction

Additive Manufacturing (AM) is one of the latest manufacturing process, which adds the layer upon layer till the model is achieved [1]. This AM process follows exactly opposite approach compared to conventional mechanical manufacturing process which include drilling, turning, shaping, laser cutting and planning etc., In the conventional manufacturing process a block of material, which is having dimensions greater than required part and multiple operations are performed on block to achieve desired shape of the part. The other major conventional way of manufacturing approach is formative manufacturing process, where high amount of forces are applied on the work piece to attain the desired shape. Even though there are many other manufacturing process in existence but the current study is majorly focused on the various AM processes and its applications.

F Edward Boas & Dominik Fleischmann has conducted study on CT artifacts, Causes and reduction techniques in 2012. Artifacts or errors are generally occurs in clinical CT acquisition and some of the common errors are beam hardening, noise, motion and metal artifacts etc. These artifacts directly effects on the quality of the CT data, which is resembles on the accuracy of the anatomy or physical medical model [2]. These artifacts plays crucial role in case of complex surgeries, since the assessment of infected zone should be exactly identified before planning of surgery..

2. Methodology

To overcome the limitations of virtual data in complex surgeries the importance of physical model came in to the use. In the current case studies AM medical models are fabricated using the fused deposition technology, the material and process parameters are applied as per the demand in the case to case.

2.1. Tumor effected case.

The current case is refers to the male patient of 31 years old suffering from the tumor on right side of the mandible. The tumor effected region can be seen in the below [Figure 1]. The below shown tumor is need to be removed completely from the affected region, because if any portion of tumor remains it will start growing again. This is very tough to plan surgery by visualizing the tumor effected zone using virtual data and other complication is that the inferior alveolar nerve passes through the same region. The surgeon has to plan that such that nerve should not damage, which can be done more efficiently using physical model [3, 4]. The MIMICS 18.0 software is used to process the computer Tomography CT data to transform into the physical model. The region of interest is segregated from the complete scan data which is shown in the below [Figure 1].

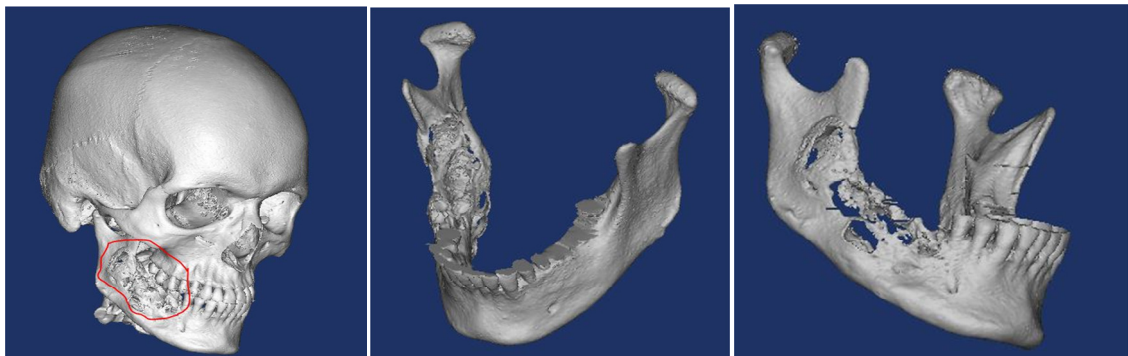


Fig. 1. Full Scan data and segregated required region of interest (Tumor affected portion of mandible) .

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