International Journal of Research in Medical Sciences
*Rendón-Medina MA et al. Int J Res Med Sci. 2023 Feb;11(2):688-690*
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20230186

**Case Report**

# 3D printing for surgical planning in bone grafts for cleft-palate: a case report

**Marco Aurelio Rendón-Medina*, Leidy Arias-Salazar, Alejandro Covarrubias-Noriega, Edgardo Araiza-Gómez, Maria De Los Angeles Mendoza-Velez, Rubén Hernandez-Ordoñez, Hecly Lya Vázquez-Morales, Ricardo C. Pacheco-López**

Department of Plastic and Reconstructive Surgery in The General Hospital ¨Ruben Leñero¨, Mexico City, Mexico

**Received:** 23 September 2022
**Accepted:** 03 January 2023

***Correspondence:**
Dr. Marco Aurelio Rendón-Medina,
E-mail: dr.rendon1989@gmail.com



## ABSTRACT

3D printing has been used for teaching purposes. Creating models for simulating surgeries. Gong et al presented a workflow for digital planning for surgery and Rendon et al previously presented a low-cost method with acceptable precision. This paper aims to present a case where 3D printing surgical planning was applied for bone graft shape and dimensions. A 16-year-old female patient with a history of bilateral cleft lip and palate has received 6 surgical interventions to treat her congenital pathology. She begins orthodontic management at the age of 6 years and is referred to the plastic surgery service 10 years later, presenting oral and nasal fistula on the nasal floor with mainly liquid leakage. A bone graft was taken and applied from the patient's left iliac crest. the iliac crest is taken and the bone graft is molded Assisted with 3D printed model which is fixed in the premaxilla with a 14-hole linear plate. We proposed a new application for low-cost 3D printed models. Patient specific models have applications in cleft palate bone grafting. We present a case and more studies are required to measure variables as time, graft integration, and patient satisfaction.

**Keywords:** 3D-Printing, Cleft palate, Plastic surgery, Bone grafts

## INTRODUCTION

Cleft lip and cleft lip and palate are some of the most common congenital anomalies involving the face. The range of affection is variable, including bone and soft tissues, including the lip, oral cavity, nasal cavity, having a great impact on the growth and development, mostly affecting feeding and nutrition, language development, and dentition.[1,2]

The failure in the fusion of the medial palatine process with both lateral processes during the intrauterine development will result in the primary cleft palate. The secondary cleft palate results when a fusion of both lateral processes fails to occur.[3]

The first cleft lip and palate patient ever reported was a mummy more than 2000 BC. There is also a Greek terracotta statuette with cleft lip features from IV century BC. The first surgery documented to correct cleft lip and palate was allegedly performed by Celso, a Roman surgeon, during de year 25 AC.[4] There are multiple descriptions of this pathology in ancient China. One of them was found in a book written by Liu An (179-122 BC) named Huainan Zi, where he describes a patient born with a cleft lip and palate. The first cleft lip and palate-related surgery in ancient China were performed and described during the Jin Dynasty (265-420 AC), in a book called Jin Shu, where they describe the case of a patient called Wei Yongzhi.[5]

It is estimated that cleft lip and/or palate is one of the four most frequent congenital malformations and the main

head and neck congenital malformation. It affects between 1 in 500 to 1 in 2500 of the newborns in the world.[6] In general, the Asian and Amerindian populations, have the highest prevalence, around 1 in 500. In the European population, the prevalence is documented as intermediate, being 1 in 1000, and in the African population, the lowest prevalence, 1 in 2500.[7] In Mexico, Navarrete et al, published a study where they found that cleft lip and cleft lip and palate was one of the main congenital malformations in newborns, documenting a prevalence of 4.9 in 10 000 live and death births (0.49/1,000).[8] In another study with the same population, carried out between 2008 and 2012, the prevalence was 0.508 for every 1,000 births.[9] In more recent studies published in 2014 the prevalence of cleft lip and cleft lip and palate has been observed to be 5.3 for every 10 000 births.[10]

The etiology of this malformation is multifactorial, the alterations that are produced by alterations between the fourth and twelfth weeks of intrauterine life at the time when the primary and secondary palates are developing, produce the malformation. Cleft lip and palate are mainly caused by the lack of unity of the maxillary processes.[11]

To explain this malformation, theories with different foundations have been put forward. Some support the hereditary character, others, the infectious toxic action. Naso-lip-alveolus-palatine fissures are almost always present in trisomies of chromosomal groups.[13-15] Family incidence varies from 4% with an affected sibling, to 17% when a sibling and the parents present the malformation.[11]

3D printing has been used for teaching purposes. Creating models for simulating surgeries.[12,13] Gong et al presented a workflow for digital planning for surgery and Rendon et al previously presented a low-cost method with acceptable precision.[14,15] El-Ghafour et al and also Shen et al presented the application of molding appliance that improved the maxillary arch.[16,17] To our knowledge no previous description of 3D printing was published earlier.

This paper aims to present a case where 3D printing surgical planning was applied for bone graft shape and dimensions.

## CASE REPORT

A 16-year-old female patient with a history of bilateral cleft lip and palate has received 6 surgical interventions to treat her congenital pathology. She begins orthodontic management at the age of 6 years and is referred to the plastic surgery service 10 years later, presenting oral and nasal fistula on the nasal floor with mainly liquid leakage

Previous written consent signed by both parents a bone graft was taken and applied from the patient's left iliac crest; For this, we made an oblique incision with an inferior and posterior orientation to the left iliac crest, 1cm from the dorsum of the anterior superior iliac spine with an approximate length of 5 cm. The incision is made parallel to the iliac crest, beginning 3 cm behind the anterior superior iliac spine to avoid the lateral femoral cutaneous nerve.

### *Bone graft crafting assisted with 3D printing*

The anterior insertions of the external and internal oblique abdominal muscles and a segment of the tensor fascia lata muscle are sectioned, until reaching the periosteum, later with an oscillating saw, 4 cm of the iliac crest. Then de fact is measured according to the dimensions of the gap in the 3D model. And it was crafted until it was perfectly suited to the gap in the model in Figure 1. Then a plate of 2.0 with its respective screws was placed and fixed. Then a V-Y mucosal flap was raised and advanced for coverage without complications (no exposure, infection and with good graft survival. We chose this graft to give the chance of acquiring dental implants as soon as possible in case the mother and the patient decided.

**Figure 1: Here is the case illustration: On top is the 3D printed model with the plate pre-molded. On middle pre-operative images and bottom the post-operative images.**

## DISCUSSION

3D printing is a useful topic in plastic surgery, up to date more applications are emerging. In this particular case modeling the bone graft in patient-specific anatomy gives the surgeon a better understanding of the anatomy and geometrical distribution of specific patient requirements. To our knowledge applications of 3D printing in this context were not previously described.

Historically, since Manckovic, the use of 3D printing in plastic surgery has been used. We have previously proposed some uses in plastic surgery.[18,19] The dimensional error is very acceptable. We use the 3D model to pre-model the plates in fractures, proving that we reduce surgery time, trans-operative bleeding and patient satisfaction.[15,20] For these reasons we decided to use these advantages to carve the grafts and improve the contour and the contact surface.

## CONCLUSION

Anatomical models help surgeons for better understanding. We proposed a new application for low-cost 3D printed models. Patient specific models have applications in cleft palate bone grafting. We present a case and more studies are required to measure variables as time, graft integration, and patient satisfaction.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: Not required*

## REFERENCES

1. González-Osorio CA, Medina-Solís CE, Pontigo-Loyola AP, Casanova-Rosado JF, Escoffié-Ramírez M, Corona-Tabares MG et al. Estudio ecológico en México (2003-2009) sobre labio y/o paladar hendido y factores sociodemográficos, socioeconómicos y de contaminación asociados. An Pediatr (Barc). 2011;74(6):377-87.
2. Parada C, Chai Y. Roles of BMP signaling pathway in lip and palate development. Front Oral Biol. 2012;16:60-70.
3. Weissler EH, Paine KM, Ahmed MK, Taub PJ. Alveolar bone grafting and cleft lip and palate: A review: A review. Plast Reconstr Surg. 2016;138(6):1287-95.
4. Tresserra Llaurado L. Labio leporino: evolución histórica. Raco.cat. Available at: https://www.raco.cat/index.php/revistaramb/article/download/71297/91054. Accessed on 25 Nov, 2022.
5. Ma KW. Hare-lip surgery in the history of traditional Chinese medicine. Med Hist. 2000;44(4):489-512
6. Mossey PA, Modell B. Epidemiology of oral clefts 2012: an international perspective. Front Oral Biol. 2012;16:1-18
7. Dixon MJ, Marazita ML, Beaty TH, Murray JC. Cleft lip and palate: understanding genetic and environmental influences. Nat Rev Genet. 2011;12(3):167-78.
8. Navarrete HE, Canún SS, Reyes PA, Sierra RM, Valdés HJ. Prevalencia de malformaciones congénitas registradas en el certificado de nacimiento y de muerte fetal: México, 2009-2010. Bol Med Hosp Infant Mex. 2013;70(6):499-505
9. Serrano SC, Hernández EN, Pablo AE, Hernández JV. Prevalencia de malformaciones congénitas de herencia multifactorial de acuerdo con los certificados de nacimiento y muerte fetal. México, 2008-2012. Boletín Médico del Hospital Infantil de México. 2015;72(4):290-94.
10. Navarrete-Hernández E, Canún-Serrano S, Valdés-Hernández J. Prevalencia de labio hendido con o sin paladar hendido en recién nacidos vivos. México, 2008-2014. Rev Mex Pediatr. 2017;84(3):101-10.
11. Habbaby AN. Enfoque integral del niño con fisura labiopalatina. Médica Panamericana, Buenos Aires; México. 2000: 9-197.
12. Riedle H, Burkhardt AE, Seitz V. Design and fabrication of a generic 3D-printed silicone unilateral cleft lip and palate model. J Plast Reconstr Aesthetic Surg. 2019;72(10):1669-74.
13. Al Ali AB, Griffin MF, Calonge WM, Butler PE. Evaluating the Use of Cleft Lip and Palate 3D-Printed Models as a Teaching Aid. J Surg Educ. 2018;75(1):200-8.
14. Gong X, Dang R, Xu T, Yu Q, Zheng J. Full Digital Workflow of Nasoalveolar Molding Treatment in Infants With Cleft Lip and Palate. J Craniofac Surg. 2020;31(2):367-71.
15. Rendón-Medina MA, Andrade-Delgado L, Telich-Tarriba JE, Fuente-del-Campo A, Altamirano-Arcos CA. Dimensional Error in Rapid Prototyping with Open Source Software and Low-cost 3D-printer. Plast Reconstr Surg- Glob Open. 2018;6(1):e1646.
16. Abd El-Ghafour M, Aboulhassan MA, Fayed MMS. Effectiveness of a Novel 3D-Printed Nasoalveolar Molding Appliance (D-NAM) on Improving the Maxillary Arch Dimensions in Unilateral Cleft Lip and Palate Infants: A Randomized Controlled Trial. Cleft Palate-Craniofacial J. 2020;57(12):1370-81.
17. Shen C, Yao CA, Magee W, Chai G, Zhang Y. Presurgical Nasoalveolar Molding for Cleft Lip and Palate: The Application of Digitally Designed Molds. Plast Reconstr Surg. 2015;135(6):1007e-15.
18. Mankovich NJ, Cheeseman AM, Stoker NG. The display of three-dimensional anatomy with stereolithographic models. J Digit Imaging. 1990;3(3):200-3.
19. Ortega-hernandez E. Aplicaciones de la impresión 3D en cirugía plástica reconstructiva. 2020;68(4):603-7.
20. Rendón-Medina MA, Hanson-Viana E, Montoya-García SC, Vázquez-Morales HL, Pacheco-López RC. Time Reduction by Prebending Osteosynthesis Plates Using 3D-Printed Anatomical Models, In Patients Treated With Open Reduction and Internal Fixation. J Craniofac Surg. 2021;32(4):1491-3.

**Cite this article as:** Rendón-Medina MA, Arias-Salazar L, Covarrubias-Noriega A, Araiza-Gómez E, Mendoza-Velez MDL, Hernandez-Ordoñez R, et al. 3D printing for surgical planning in bone grafts for cleft-palate: a case report. Int J Res Med Sci 2023;11:688-90.